

PERSONALIA

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On the 100th Birthday of Aleksandr Mikhailovich Prokhorov

Aleksandr Mikhailovich Prokhorov was a Russian physicist, academician, one of the originators of quantum electronics, laser physics and laser technologies, winner of the 1964 Nobel Prize in Physics 'for fundamental work in the field of quantum electronics, which has led to the construction of oscillators and amplifiers based on the maser–laser principle' (shared with N.G. Basov and Ch.H. Townes), Lenin Prize and State Prize winner and twice Hero of Socialist Labour.

Prokhorov was born on 11 July 1916 in Atherton, Queensland, Australia. His parents arrived there after escaping from Siberian exile in 1912. His father was Mikhail Ivanovich Prokhorov, a patternmaker, and his mother was Mariya Ivanovna Prokhorova (née Mikhailova).

In 1923, the family returned to Russia. After living first in Orenburg and then in Tashkent, they moved to Leningrad in 1930. After graduating from a seven-year school, Prokhorov was admitted without exams to workers' faculty at the Leningrad Electrotechnical Institute. In 1934 he entered the Faculty of Physics, Leningrad State University, from which he graduated with honours in 1939. After that, the future Nobel Prize winner entered a postgraduate programme at the P.N. Lebedev Physics Institute (LPI), USSR Academy of Sciences (UAS), Moscow.

In 1941, he married Galina Alekseevna Shelepina, and in 1945 they had a son, Kirill.

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During World War II, Prokhorov fought in a reconnaissance unit. He was wounded twice and was awarded the Medal for Courage.

After receiving a severe battle wound in 1944, he was demobilised and returned to his postgraduate studies at LPI. In 1946, he defended his candidate of science dissertation, concerned with the theory of nonlinear oscillations. This work, done in co-operation with S.M. Rytov and M.E. Zhabotinskii, was awarded the Academician Mandelstam Prize (Mandelstam was an eminent Soviet radiophysicist). In 1947, Prokhorov began to study synchrotron radiation and in 1951 he defended his doctoral dissertation in this area of research.

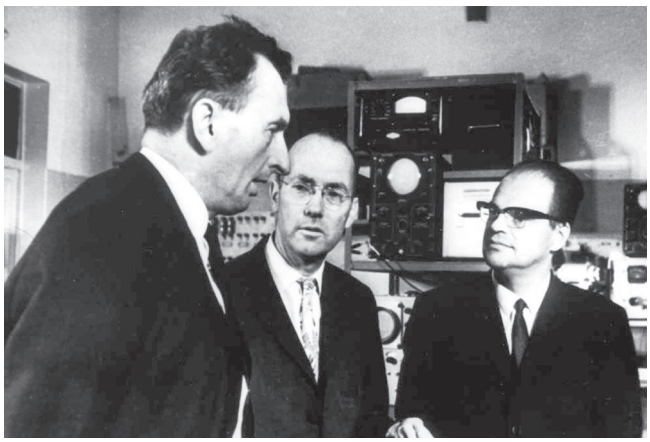
After he defended his candidate of science dissertation, Prokhorov became a senior research fellow at the Laboratory of Oscillations, LPI. He was appointed head of a division in the Laboratory in 1952 and head of the Laboratory in 1954. In 1968, he became deputy director of LPI.

Prokhorov was elected a corresponding member of UAS in 1960 and became academician in 1966. For 18 years (from 1973 to 1991), he was the Secretary of the General Physics and Astronomy Division, UAS.

Through his initiative, based on Division A, LPI, the General Physics Institute (GPI), UAS, was organised in 1982, and Prokhorov was its director until 1998. In 1996, he became head of the Natural Sciences Center, organised by him at GPI.

His scientific interests included radiophysics, physics of accelerators, radio-frequency (rf) spectroscopy, quantum electronics, its applications and nonlinear optics. In his first studies, he examined the propagation of radio waves along the Earth's surface and in the ionosphere. After World War II, he began to develop rf oscillator frequency stabilisation methods, which became a basis of his candidate of science dissertation. He proposed a new millimetre wave generation mode in a synchrotron, demonstrated a coherent nature of the resulting waves and prepared his doctoral dissertation using the results of those studies.

In developing quantum frequency standards, Prokhorov and Basov (1952–1954) formulated the basic relationships in the quantum amplification and generation of electromagnetic waves on a fundamentally new principle, with the use of stimulated emission. Their ideas were implemented by the Townes group in creating the first ammonia gas maser oscillator. In 1955, Prokhorov and Basov proposed a three-level scheme for producing an inverted population of levels using auxiliary electromagnetic radiation, which found wide application in masers and lasers. The most important idea proposed by Prokhorov was to use an open resonator (1958) for producing feedback in coherent short-wavelength radiation sources. His electron paramagnetic resonance work focused on characterisation of oxide crystals containing various paramagnetic ions. In the next few years, his research effort was concentrated on microwave quantum paramagnetic amplifiers, and a number of active crystals, e.g. ruby, were proposed for use in such amplifiers (a detailed study of the properties of ruby turned out to be extremely helpful in creating the ruby laser). The results of that work were subsequently used in developing solid-state lasers.



A.M. Prokhorov, Ch.H. Townes and N.G. Basov at LPI.

For the development of the new principle of radio wave generation and amplification (creation of molecular oscillators and amplifiers), Prokhorov and Basov were awarded the 1959 Lenin Prize and the 1964 Nobel Prize in Physics (shared with Ch.H. Townes).

Prokhorov created a number of distinct laser types: a laser based on two-photon transitions (1963), a series of cw and IR lasers and a high-power gas dynamic laser (1966). He investigated nonlinear effects originating from the propagation of laser light in matter: multifocus structure of light beams in a nonlinear medium, propagation of optical solitons in optical fibres, excitation and dissociation of molecules under the action of IR radiation, laser generation of ultrasound and the properties of solids and plasmas exposed to laser radiation. The results found application in industry, medicine and specialised engineering products.

The use of microwave masers in space communications systems and radio astronomy ensured e.g. delivery of a high-quality image of the surface of Venus, which helped to successfully accomplish unique space programmes.

Prokhorov and his group made an invaluable contribution to the development of specialised high-power laser systems under the directives adopted by the Central Committee of the CPSU and the USSR Government. This required huge scientific and organisational efforts to prepare experts and retool production plants and research institutes, which made it possible to rapidly convert the USSR into a laser superpower, along with the United States.

Prokhorov is the author of the scientific discovery 'Optohydraulic Effect', which has No. 65 in the USSR State Registry of Discoveries (priority date 28 February 1963). Another Prokhorov's discovery (No. 147, recorded in 1974) is 'Multifocus Structure of a Light Beam in a Nonlinear Medium' (priority date 19 June 1967).

He paid a great deal of attention to pedagogical activities. Starting in 1954, he was professor at Moscow State University and the Moscow Institute of Physics and Technology and headed departments at these higher education institutions.

Being a secretary academician and the principal investigator of a number of interdisciplinary programmes, he exhibited outstanding talent as a science organiser on the country scale.

Starting in 1969, Prokhorov was head of the Scientific/Editorial Board of the Sovetskaya Entsiklopediya Publishers and editor-in-chief of the third edition of the Great Soviet Encyclopaedia and the Physical Encyclopaedic Dictionary.

His most important, outstanding results, which were so abundant in Prokhorov's creative career, gained worldwide recognition. He was a Honorary Foreign Member of the American Academy of Arts and Sciences in Boston (USA), a member of the European Physical Society, a member of the Bulgarian Physical Society, a Honorary Foreign Member of the Hungarian Academy of Sciences and the National Academy of Sciences of Ukraine and Honorary Professor at the Delhi University, the Sofia University, the Florida State University (USA), the University of New South Wales (Australia), the Prague Polytechnic Institute and other institutions.

Prokhorov created a large school of physicists. Among his pupils are Academicians N.G. Basov, F.V. Bunkin, E.M. Dianov, V.V. Osiko and I.A. Shcherbakov and the corresponding members N.V. Karlov, V.I. Konov, P.P. Pashinin, I.A. Bufetov and M.M. Bubnov. He was editor-in-chief of the Laser Physics international journal and a member of the editorial boards of the Zhurnal eksperimental'noi i teoreticheskoi fiziki (Journal of Experimental and Theoretical Physics) and Poverkhnost': fizika, khimiya, mekhanika (Surface: Physics, Chemistry and Mechanics) journals.

Prokhorov was twice Hero of Socialist Labour. He was awarded five Orders of Lenin, the Order for Merit to the Fatherland 2nd class and many other orders and medals, including foreign ones. He was a State Prize and USSR Council of Ministers Prize winner and was awarded the Lomonosov Gold Medal and the Helmholtz Medal (GDR AS).

Monument to A.M. Prokhorov in Moscow.

Prokhorov died on 8 January 2002 in Moscow. He was entombed in the Novodevichy Cemetery.

His name was given to the General Physics Institute and the Academy of Engineering Sciences. The Presidium of the Russian Academy of Sciences launched the Prokhorov Gold Medal for outstanding work in physics. In 2015, a monument to Prokhorov, sculpted by E.I. Kazantseva, was erected in Moscow at the intersection of Leninsky and University Avenues.

E.M. Dianov, V.I. Konov, O.N. Krokhin,
V.V. Osiko, P.P. Pashinin, I.A. Shcherbakov