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PERSONALIA

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In memory of Evgenii Pavlovich Velikhov

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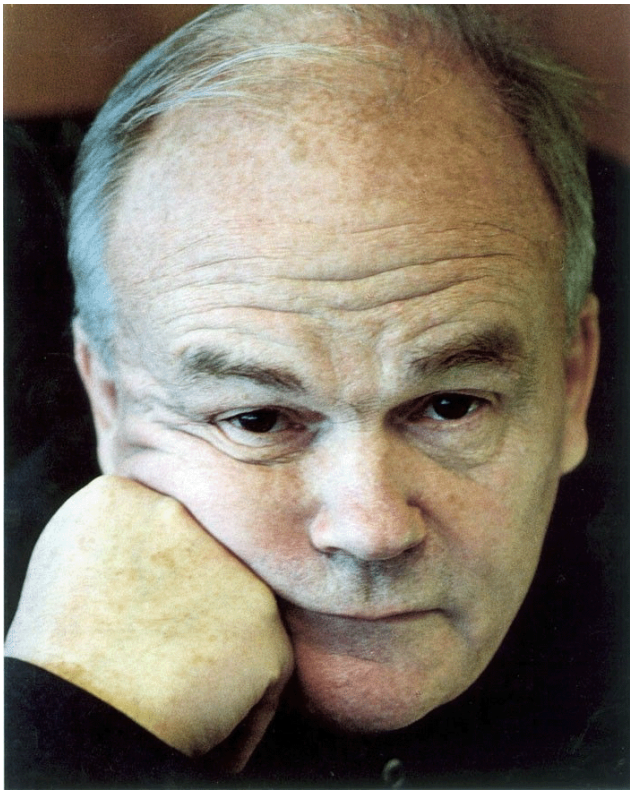
Evgenii Pavlovich Velikhov was a world-famous scientist, Hero of Socialist Labor and Hero of Labor of the Russian Federation, full Cavalier of the Order 'For Merit to the Fatherland,' academician of the USSR Academy of Sciences (AS) and the Russian Academy of Sciences (RAS).

He was born on February 2, 1935 in Moscow into the family of a railway engineer. The scientific career of the graduate (1958) of the Physics Department of Lomonosov Moscow State University (MSU) in the specialty of Theoretical Physics developed rapidly: when 30 years old, he became a doctor of sciences, bypassing the candidate stage, at 33, a corresponding member, and when not yet 40, an academician, the youngest vice president of the USSR Academy of Sciences (1978). From 1961, E.P. Velikhov worked at the I.V. Kurchatov Institute of Atomic Energy (IAE), where he moved up from junior research fellow to director and president of the National Research Center (NRC) Kurchatov Institute.

In 1956, as a student of the Physics Department of MSU, E.P. Velikhov was sent to do his diploma work at the Laboratory of Measuring Instruments of the USSR Academy of Sciences (now NRC Kurchatov Institute) at the theoretical center of Academician M.A. Leontovich, a part of the Plasma Research Department of Academician L.A. Artsimovich. A research supervisor of Evgenii Pavlovich was S.I. Braginsky, who suggested Velikhov to study the stability of a flow of ideally conducting liquid along a magnetic field in connection with the problem of generating terrestrial magnetism. The diploma work of the student Velikhov was highly praised and was published in 1959 in the leading physical journal, the *Journal of Experimental and Theoretical Physics* (*JETP*). Another *JETP* paper of the same year, concerning magnetorotational instability, became one of the most frequently cited Russian papers in astrophysics.

When working in M.A. Leontovich's sector and actively participating in studies of controlled thermonuclear fusion (CTF), E.P. Velikhov entered the postgraduate course in 1961 and published, together with A.A. Vedenov and R.Z. Sagdeev, a review on plasma stability in *Uspekhi Fizicheskikh Nauk* journal (*Sov. Phys. Usp.* **4** 332 (1996)), as well as a paper on nonlinear oscillations of rarefied plasma in the journal *Nuclear Fusion*. These studies and their presentation Quasilinear Plasma Oscillation Theory at the Conference of the International Atomic Energy Agency (IAEA) in Salzburg became a fundamental basis of modern plasma theory, including the theory of its weak turbulence.

Evgenii Pavlovich's infatuation with magnetic hydrodynamics (MHD) from his student years became a trigger for many of his practical undertakings. With the support of Academician M.D. Millionshchikov, he developed experimental, theoretical, and computational work on high-power liquid-metal and noble-gas MHD generators of electricity with added cesium and became a research supervisor at the rapidly growing laboratory in the city of Troitsk.



Evgenii Pavlovich Velikhov
(02.02.1935 – 05.12.2024)

Keen on designing MHD generators, E.P. Velikhov was somewhat delayed with his candidate of science thesis, which he defended in 1964. The Academic Council of the Kurchatov Institute rated his results so highly that it rendered the applicant the higher degree — doctor of physical and mathematical sciences.

Evgenii Pavlovich's unique focus on bringing the achievements of theoretical and experimental physics to practical implementation led him to a new field associated with high-power lasers. While still an MSU student, E.P. Velikhov made a maser spectrometer and got acquainted with the future Nobel laureate A.M. Prokhorov, who would create in the late 1970s a unique neodymium glass laser fed precisely by Velikhov's MHD generator. When he became a professor at MSU in 1966, E.P. Velikhov supervised the creation of powerful CO_2 lasers at the Physics Department of MSU and was actively involved in the development of 'strategic' lasers, which required a powerful energy source to power them. A

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series of powerful MHD generators based on solid propellant powders was designed under his leadership.

In 1968, E.P. Velikhov was elected a corresponding member of the USSR Academy of Sciences.

In 1970, he became the head of the Plasma Power Engineering Department of the Kurchatov Institute of Atomic Energy in Troitsk, which was transformed in 1971 into a branch of the I.V. Kurchatov Institute of Atomic Energy. The same year, the director of Kurchatov IAE, Academician A.P. Aleksandrov appointed Evgenii Pavlovich his deputy for scientific work, assigning him responsibilities for scientific management and coordination of the institute's research in the field of plasma physics and controlled thermonuclear fusion (CTF). After the death of L.A. Artsimovich in 1973, E.P. Velikhov became the scientific supervisor of CTF research in the USSR and a representative of our country on the International Council on CTF at IAEA.

In 1974, E.P. Velikhov was elected a full member of the USSR Academy of Science.

In the 1970s–1980s, E.P. Velikhov became a leader in innovative developments in the field of MHD generators and lasers, including the creation of a whole series of MHD generators with a capacity of 10–1000 MW and an operating time of 1–100 s, their use to probe the structure of Earth's crust (to depths of 100–150 km), pumping superhigh-power lasers, creating powerful compact power plants in remote areas, and the development of strategic (for instance, a unique 1-MW CO_2 laser) and technological lasers.

In 1976, work on ultra-depth probing of Earth's crust began on the Kola peninsula with the use of the Khibiny MHD installation up to 70 MW in capacity. Similar studies were carried out in the Caspian Lowland, the Middle Urals, Pamir, and Tien Shan. E.P. Velikhov and his colleagues were awarded the 1977 USSR State Prize for the design and creation of a compact pulsed MHD power system.

In 1984, E.P. Velikhov and his colleagues were awarded the Lenin Prize for the creation of high-power gas-discharge lasers. Later, a research center for technological lasers (since 1998, the Institute for Problems of Laser and Information Technologies of RAS) was founded in Shatura on his initiative, which became one of the leaders in the development of powerful technological CO_2 lasers.

Another major area of E.P. Velikhov's work was information technology. Evgenii Pavlovich was the initiator of the creation in 1983 and a long-term academician-secretary of the Department of Informatics, Computer Engineering and Automation in the USSR Academy of Sciences (now the Department of Nanotechnology and Information Technologies of RAS). Under his guidance, a unique production of very-large-scale integrated circuits and microprocessors was founded at the Kurchatov Institute, and Russia's participation in the global information project GLORIAD (the fiber-optic network communication ring covering the entire globe) was ensured for providing the world scientific community with network services, including those related to the ITER project. Everyone recognized the role of E.P. Velikhov in building in 1990 the mass computer network RELCOM on the basis of the I.V. Kurchatov IAE, which was the first in the USSR and RF and marked the emergence of the Internet in the USSR and the subsequent emergence of Runet.

An important milestone in the life of E.P. Velikhov was the elimination of the consequences of the accident at the Chernobyl Nuclear Power Plant (NPP) in 1986. Numerous flights over the accident site, the incredible workloads on the team, and the personal initiative of Evgenii Pavlovich entered the heroic history of struggle to minimize the consequences of the accident.

Having become director in 1989 and later (in 1992) president of the I.V. Kurchatov Institute of Atomic Energy, E.P. Velikhov did everything possible for its survival during the 1990s, extremely difficult years for the country.

Since the mid-1980s, events in the country have opened up new possibilities for international cooperation concerning CTF, in which E.P. Velikhov was a constant leader on our side from 1973. On the initiative of Evgenii Pavlovich, unprecedented international scientific cooperation started in 1985 within the framework of the new thermonuclear project, called ITER. From 1992 to 2001, E.P. Velikhov was the chairman of the Council for Technical Design of the International Project (European Union, India, China, Republic of Korea, Russia, USA, Japan) ITER, in 2006, Evgenii Pavlovich became a Russian member of the international Council of ITER, and from 2010 to 2012, he was chair of the Council of ITER. For "the development of the scientific and engineering foundation for the creation of the international thermonuclear reactor (ITER)," E.P. Velikhov, together with the French scientist R. Aymar and the Japanese scientist M. Yoshikawa, was awarded the international 2006 Global Energy prize. Evgenii Pavlovich considered ITER to be the major project of his life.

E.P. Velikhov's attention to the national CTF program never wavered. He was a research supervisor of the creation of unique inductive energy storage, in particular, the largest power complex in the world with an inductive 900-MJ energy storage for power supply of pulse thermonuclear and modeling installations, including Angara-5-1 in Troitsk, the largest installation in Europe and Asia. On the initiative of E.P. Velikhov and M.V. Kovalchuk, the T-15MD tokamak — a prototype of the fusion neutron source (FNS) — was constructed in 2010–2020 and the design was started of a demonstrational FNS for the introduction of stationary hybrid 'fusion–fission' type tokamak-based systems into nuclear power engineering. Under the leadership of M.V. Kovalchuk, the T-15MD tokamak was physically launched in 2021 and energetically in 2023.

We should recall that the first tokamak project was proposed in the 1950s in our country just as the FNS project. The realization of the necessity of immediate practical orientation of work on magnetic CTF for closing the fuel cycle of the existing nuclear power industry on 'thermal' neutrons fostered an innovative approach based on the use of a thorium blanket for fuel production for an NPP based on thermal neutrons. Combining and enhancing the scientific inheritance of academicians A.P. Aleksandrov and L.A. Artsimovich, E.P. Velikhov became a research supervisor of Russian studies in support to the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO). In 2002–2014, Evgenii Pavlovich was an organizer and chair of the Russian board of directors of enterprises-participants of INPRO.

Another important area of the development of A.P. Aleksandrov's heritage was E.P. Velikhov's idea of founding the Rosshelf company (he was its president in 1992–2001) on the basis of the Gazprom company and atomic shipbuilding enterprises for exploration and production of hydrocarbons on the Arctic shelf of Russia. The world's first offshore ice-resistant stationary platform was

designed and created with the active support by E.P. Velikhov. It has operated from 2013 at the Prirazlomnoe oil field in the Barents Sea.

Evgenii Pavlovich's international activity also covered such problems as control over nuclear explosions and global strategic issues. In the 1980s, he organized the interaction of Soviet and American scientists and politicians to verify the efficiency of seismic registration of underground nuclear explosions. After successful model tests on nuclear fields in the USSR and the USA, a Soviet-American treaty to cease nuclear tests was signed (not ratified but complied with to date). From 1981 to 1988, Evgenii Pavlovich was a co-chair of the joint commission of the USSR AS and the USA National Academy of Sciences on strategic issues.

His active protection and promotion of fundamental science (from 1978 to 1996, E.P. Velikhov was vice-president of the USSR Academy of Sciences and the Russian Academy of Sciences) received a response abroad: Evgenii Pavlovich was an honorary professor at several universities in Europe and the USA, a member of the European Academy of Sciences and the Swedish Engineering Academy, and a foreign member of the American Association for the Advancement of Science (AAAS). He was the initiator of the creation in 2011 and the chair of the presidium of the Russian Association for the Advancement of Science (RAAS).

From his extensive educational university activity, we will mention that, in 1973–1988, E.P. Velikhov headed the departments of atomic physics, plasma physics, and microelectronics at the Physics Faculty of MSU, and in 1984 he organized the Department of Problems in Physics and Energetics at the Moscow Institute of Physics and Technology and up to 1986 he was dean and scientific director of this department.

In 1991, E.P. Velikhov founded the Russian branch of the international public organization Youth Achievements and from 2003 was a member of the International Council of this organization. He was also the initiator (in 1987) and president of the International Public Foundation, For the Survival and Development of Humanity. The crown of E.P. Velikhov's multifaceted public activity was his position as the first secretary of the Public Chamber of the Russian Federation (2005–2015), the first in the history of our country, and then its honorary secretary.

E.P. Velikhov was the author of over 200 publications, including monographs, books, and papers. For his 80th birthday, Evgenii Pavlovich published a book of memoirs, *I'll go to the 35th on felt boots*, where he vividly described his biography as a reflection of the history of our country and domestic science.

A list of E.P. Velikhov's awards and prizes produces an indelible impression: Hero of Socialist Labor of the USSR (1985), Hero of Labor of the Russian Federation (2020), Full Cavalier of the Order For Merit to the Fatherland (2000–2015), laureate of the Lenin Prize of the USSR (1984), of State Prizes of the USSR (1977) and of the Russian Federation (2002), three Orders of Lenin (1971, 1981, and 1985), the Order of the Red Banner of Labor (1975), and the Order of Courage (1997). His international awards include the Szilard Prize of the American Physical Society, the Science for Peace Prize of the World Federation of Sciences, the A.P. Karpinsky Prize (1986), the international Global Energy Prize (2006), the Prize of the People's Republic of China for international cooperation in science and technology (2016). In 2022, E.P. Velikhov and M.V. Kovalchuk were awarded the I.V. Kurchatov Gold Medal of RAS for the series of studies Development, Creation, and Use of Nuclear-Physical Mega-Installations for Interdisciplinary Research and Energetics.

Evgenii Pavlovich Velikhov was undoubtedly one of those few people whose life and activity were on a civilization scale, vision, and movement towards goals 'beyond the life' of one generation. He was always an inseparable part of the Kurchatov Institute and the USSR Academy of Sciences and then RAS. His departure is an irreparable loss for domestic and world science, for all those who were lucky to work and communicate with this outstanding person.

V.B. Betelin, Yu.A. D'yakova, V.I. Il'gisonis, V.V. Kveder, M.V. Kovalchuk, G.Ya. Krasnikov, V.A. Matveev, O.S. Naraikin, V.Ya. Panchenko, V.N. Parmon, A.I. Rudskoi, V.A. Sadovnichy