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Éduard Pavlovich Kruglyakov (on his seventieth birthday)

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October 22, 2004 marked the 70th birthday of Éduard Pavlovich Kruglyakov, deputy director of the G I Budker Institute of Nuclear Physics of the Siberian Branch (SB) of the Russian Academy of Sciences (RAS), full member of the Academy.

Éduard Pavlovich is well known in the world physics community as an expert in experimental physics (plasma physics, physics of condensed media, laser physics) and a brilliant representative of the G I Budker school. In 1958 he graduated from the Moscow Institute of Physics and Technology (MIPT) and since then has stayed at the Institute of Nuclear Physics of the Siberian Branch of the RAS — first in Moscow on the territory of the Kurchatov Institute and since 1961 in the Novosibirsk Academic Township to which the Institute of Nuclear Physics moved at that time.

Kruglyakov began his research career at a time when controlled thermonuclear fusion studies became the focus for the leading research centers of most developed countries, including the USSR. His first research paper, completed while he was still in Moscow, was devoted to creating and analyzing the plasma placed in a toroidal magnetic field and containing a high circular current of accelerated electrons in the plasma. Despite optimistic macroscopic evaluations of stability and impressive values of the parameters achieved, this electron current existed for only a fraction of a microsecond and then disappeared. We remember that no laboratories achieved success in experiments testing most of the various designs of plasma traps. As a result, the world scientific community reached the understanding that it needed long-term systematic work on more profound theoretical and experimental investigation of the properties of hot plasma. Such investigations required development of contactless plasma diagnostic techniques, and Kruglyakov contributed considerably to solving this problem. Already in 1964 he created one of the pioneer dissectors — a combination of the simplest electron-optical converter, deflecting plates, a slit, and an electron multiplier. This instrument, mounted at the output slit of a classical optical spectrometer, makes it possible to measure line profiles of the emission of excited atoms with high temporal resolution. The broadening of the hydrogen lines in the plasma is caused by collisions and electric fields, so the measured profile makes it possible to calculate the plasma density and temperature, as well as some other parameters. The LI-601 and LI-602 modifications were manufactured in Novosibirsk by Ekran works until the mid-1990s.

We need to especially emphasize Kruglyakov's contribution to the progress in optical techniques of plasma diagnostics. Even at the beginning of the 1960s, when the first lasers started to be available, he began active work on the introduction of laser methods into plasma diagnostics.

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Éduard Pavlovich Kruglyakov

Within minimum time, he had to organize the independent manufacture of lasers within the institute: ruby, neodymium, helium-neon, and CO_2 lasers were built. Kruglyakov organized in the Institute of Nuclear Physics an optical production line whose technological culture was not generally that of plasma laboratories but rather inherent in specialized optics labs. Kruglyakov's group produced everything: vaporization-coating of multilayer mirrors, polishing of various materials to optical precision, manufacturing of unique high-precision elements for laser diagnostics, pumping lamps of unique design, Kerr-effect-based shutters, even their own power supply units, etc. In 1966 Kruglyakov pioneered the use of optical interferometer techniques in plasma experiments and, year later, he was one of the first to conduct measurements of electron temperature and density of the plasma using Thompson scattering (scattering of photons by electrons). In subsequent years the Institute of Nuclear Physics of the Siberian branch of the RAS produced a whole set of integrated kits for measuring Thompson scattering, which were installed in all large laboratories that were running hot plasma physics studies. In 1986 Kruglyakov received the USSR State Prize for the "Development of laser diagnostics

and research on high-temperature plasma in the physical experiment.''

In the 1970s Kruglyakov was the first to conduct unique experiments on the electrical breakdown of water with electrodes shielded by conducting diffusion layers; this work made it possible to determine the maximum electric strength of water. A practical result of this research was an increase in the electric strength of water by a factor of 4 to 5, which is equivalent to nearly a 20-fold increase in the energy content of a unit volume of water. This series of experiments included high-precision measurements of the Kerr constant of water. We must emphasize that international handbooks of physical constants also included the most precise values obtained by Kruglyakov for the probability of transition of the CO_2 molecule (denoted as P20) and for collision broadening in collisions of CO_2 , N_2, and He molecules.

During the same period Kruglyakov headed a group of experimenters working on plasma confinement in a multimirror trap [an improved version of the classical Budker – Post mirror machine ('probkotron')] suggested by G I Budker, D D Ryutov, and V V Mirnov. The results of the experiment conclusively confirmed all the main ideas constituting the principle of multimirror plasma confinement.

Later on, Kruglyakov's research was connected with studying collective effects in plasmas, including the strong Langmuir turbulence, and methods of plasma confinement and plasma heating by strong-current relativistic electron beams in open systems. In 2001 Kruglyakov won the L A Artsimovich Prize of the Russian Academy of Sciences for a series of experimental studies of strong Langmuir turbulence in plasma placed in a magnetic field.

In recent years, Kruglyakov has headed research into controlled thermonuclear fusion and plasma physics at his institute. He devotes a large part of his time to working on the problem of creating a high-power multiple-use source of thermonuclear neutrons, based on the concept of the gas-dynamics trap that operates at the Institute of Nuclear Physics of the RAS Siberian Branch. With a source of this type it is possible to design explosion-proof subcritical nuclear reactors for atomic power stations, to achieve 'afterburning' of radioactive wastes, and finally to test promising construction materials for future thermonuclear reactors.

Kruglyakov is responsible for a good deal of science-management tasks. He is chairman of the Specialized Learned Council on thesis presentations and is a member of several learned councils. He actively participates in the organization of large international and national conferences and is a member of their program and organizational committees. Kruglyakov is deputy Editor-in-Chief of the *Journal of Applied Mechanics and Technical Physics* (in Russian), and is a member of the editorial board of the *Great Russian Encyclopedia* and of the journals *Plasma Physics* (in Russian) and *Plasma Device and Operation*, and some others. His science popularizing articles and papers aimed at exposing pseudosciences are published in the leading Russian journals and magazines; they have been translated in many countries the world over and achieved widespread resonance. Kruglyakov is the Editor-in-Chief of a *Science Popularizing Book Series*, published by the RAS Siberian Branch, and also heads the Academy's commission on fighting pseudosciences and the falsification of research results.

Kruglyakov gives much of his time to training young generations of scientists. In 1962 he was one of the organizers of the First All-Siberian Physics and Mathematics Olympiad for school children and headed the teaching program at the First All-Siberian Summer School. The framework of such olympiads and schools is still in operation, feeding Novosibirsk State University and other higher-education institutions of Siberia with talented pupils. Kruglyakov was a constant organizer and chair of contests among young scientists. For many years he has been a chair of plasma physics at the Novosibirsk State University and is surrounded with numerous PhD and DSc students.

The Academy of Sciences always held Kruglyakov in high regard, having elected him to corresponding membership (1987) and later full membership (1997). The government presented him with the orders of ''Sign of Merit'' and ''Order of Friendship''.

His wide range of interests, impeccable professionalism, and encyclopedic knowledge make it possible for Kruglyakov to find interesting solutions to the most different scientific problems that time and again confront his colleagues at the institute in other fields of science. He is full of energy and, a brilliant and emotional person, participates actively and efficiently in the scientific activities of the Institute of Nuclear Physics of the Siberian Branch of the RAS and of the Academy in Siberia.

We wish Éduard Pavlovich Kruglyakov happy 70th birthday and wish him health, happiness, and continued success.

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