IN MEMORY OF YAKIV BORYSOVYCH FAINBERG

On March 7, 2005, Yakiv Borysovych Fainberg, one of the outstanding physicists-theorists in Ukraine, Academician of the National Academy of Sciences of Ukraine, died. Ya.B. Fainberg was the founder of a new direction in plasma physics, plasma electronics, one of the initiators of developing the physics and technology of linear accelerators in the USSR. He was the first who elaborated the theory of linear traveling-wave accelerators, proposed an idea of alternating-phase focusing, and developed the theory of such a focusing. In collaboration with V.I. Veksler and G.I.Budker, he laid the foundation for a new direction in physics of accelerators, collective methods of acceleration.

Yakiv Borysovych Fainberg was born in a small Ukrainian town of Zolotonosha (now in the Cherkasy region) on September 7, 1918. His father, Borys Musiiovych, worked as pharmacist. His mother, Rozaliya Yukhymivna, taught at school. In 1935, he entered the physical branch of the Faculty of Physics and Mathematics at the Kharkiv State University. He was lucky to listen to the lectures of the prominent physicist-theorist of the 20-th century Lev Davydovych Landau and Academician of the Academy of Sciences of the UkrSSR Kyrylo Dmytrovych Synelnykov.

The first independent scientific research of Ya.B. Fainberg, his M.Sc. degree work, was carried out under the guidance of K.D. Synelnykov. After graduating from the State University in 1940, Yakiv Borysovych Fainberg was distributed to a postgraduate study. But the Great Patriotic War had isolated him from the university for long 6 years. During the late years of the war (1944–1945), he served as a senior engineer in one of the technical military units of the Chief Intelligence Agency under the command of Major-General B.P. Aseev, considered by Yakiv Borysovych as one of the best teacher-instructors in his life.

After the demobilization, Ya.B. Fainberg returned back to Kharkiv. At the end of 1948, Yakiv Borysovych married Evgeniya Volodymyrivna Lifshits. Their home life, according to Ya.B. Fainberg, was "an unclouded romantic travel for the whole life long".

Since October 1946, the scientific activity of Ya.B. Fainberg has been connected with the Kharkiv Institute of Physics and Technology (KIPT) of the Academy of Sciences of the UkrSSR. During his almost sixty-year scientific activity, Yakiv Borysovych manifested himself as a scientist who was able to combine deep theoretical researches together with resolving actual practical problems, including those of defense significance. In 1947, Ya.B. Fainberg carried out the first theoretical studies conserning the dynamics of particles accelerated in the field of a traveling wave. In these works, the theory of the phase and radial stabilities of particles accelerated in slow-wave waveguides was developed. The latter had been used at the KIPT as the basis for constructing the linear accelerators (LAs) for electrons, the first ones in the

USSR. Later on and with the immediate participation of Ya.B. Fainberg, the 2-GeV LA greatest in Europe was constructed as well. Yakiv Borysovych fulfilled a large cycle of researches dealing with the dynamics of particles and the electrodynamics of accelerating systems in proton accelerators, in particular, all proton accelerators constructed at the KIPT.

Ya.B. Fainberg was among the first to carry out the researches on the acceleration of charged particles in anisotropic media and spiral waveguides. In 1953, he proposed an essentially new method of ensuring the simultaneous radial and longitudinal stabilities of particles in linear accelerators, namely, the establishment of a two-dimensional dynamic stability of accelerated particles with the use of HF accelerating fields, the phase of which changes periodically along the accelerator – the so-called alternating-phase focusing which has been realized in recent years at a number of accelerator models.

The reports of V.I. Veksler, G.I. Budker, and Ya.B. Fainberg at the Geneva conference on physics of high energies in 1956 aroused a huge interest. In these reports, the basic ideas of the absolutely new direction in the physics of accelerators, the collective methods of acceleration, have been formulated. The method of acceleration, proposed by Ya.B. Fainberg, with the help of charge density waves in plasma waveguides and non-compensated electron and ion beams (the problem of the acceleration dynamics in plasma was investigated together with M.A. Khyzhnyak) is nowadays under experimental verification. This method of acceleration with the use of charge density waves has been widely adopted and is considered nowadays as one of the most promising methods for the creation of accelerators of the new generation with an extremely high rate of acceleration.

A large contribution was made by Ya.B. Fainberg to the development of plasma physics. In 1948, he (together with A.I. Akhiezer) predicted theoretically and studied the first and most widespread microinstability of nonequilibrium plasma, a beam instability, i.e. it was shown for the first time that the inverse effect of the Landau attenuation may take place in such a plasma. It is hard to overestimate the significance of this conclusion, which has already become classical, for the theory of collective processes in plasma and various practical applications. In his experimental researches (1957–1958), Yakiv Borysovych (together with I.F. Kharchenko, A.K. Berezin, and E.O. Kornilov) discovered and studied, for the first time, a beam instability, provided either the absence or presence of a magnetic field; discovered a new type of the discharge – a plasma-beam one, and a new way of collisionless plasma heating – a beam-induced one.

Ya.B. Fainberg is a co-author (together with E.K. Zavoiskii, V.O. Suprunenko, and others) of the discovery "Turbulent heating and abnormal resistance of plasma" (diploma No. 112). He was the first (1961) who put forward the problem of controlling microinstabilities in plasma, in particular, he proposed the method to control the beam instability, which was put into practice in 1961–1965. Yakiv Borysovych was one of the first who apprehended and estimated the ample opportunities that the use of relativistic beams gave. In 1969, together with V.D. Shapiro and V.I. Shevchenko, he carried out the first researches in the field of the nonlinear theory of interaction between relativistic electron beams (REBs) and plasma. Together with V.I. Kurylko, he developed a theory of the nonlinear interaction of a REB with a plasma resonator. Experimental researches of the interaction between high-current REBs and plasma, carried out together with Yu.V. Tkach, confidently demonstrated, for the first time, a high efficiency of such an interaction. Those researches allowed large powers of UHF-emission to be achieved (1974–1975) and a powerful collective-interaction-based ultraviolet laser to be created (1969–1971). In 1974–1987, Ya.B. Fainberg (together with A.K. Berezin) carried out a cycle of experimental researches concerning the interaction of monochromatic REBs possessing a very small angular divergence with a dense plasma ($10^{15} - 10^{17}$ cm^{-3}), where the abnormally fast relaxation of a beam was obtained. In 1984, he (together with Yu.P. Bliokh, V.I. Karas', and I.M. Onyshchenko) proved that, for high-current beams of relativistic electrons that propagate in plasma waveguides, a replacement of the Cherenkov emission mechanism by the abnormal Doppler one takes place, and, as a result, the efficiency of emission does not decrease while the degrees of system's nonequilibrium and beam's relativity enhance.

An interesting cycle of theoretical researches of a nonhomogeneous plasma-beam discharge was carried out by Ya.B. Fainberg together with S.S. Moiseev in 1971–1976. Together with E.O. Kornilov, large powers of emission in a long pulse were obtained under the interaction between high-current electron beams from a linear plasma betatron and the plasma in an open resonator.

One cannot help saying that the theoretical and experimental works carried out by Ya.B. Fainberg, O.G. Zagorodnov, O.M. Egorov, and other collaborators as early as in 1955–1960 have been extensively developed

recently. In these works, a frequency multiplication effect caused by the double Doppler effect at a reflection from plasma that moves in a system of slow waves was foreseen and observed, and the theory of this effect was developed.

The exclusive persistence in achieving the final goal distinguished Ya.B. Fainberg as a scientist. Aiming his theoretical researches at resolving the most challenging fundamental and applied tasks, he tried to get a full comprehension of all aspects of the problem and to obtain the experimental confirmation without fail. Yakiv Borysovych attached the exclusive significance to intuition. In most cases, his intuition did not betray him indeed. His scientific ideas are striking by their novelty and boldness.

In 1949, Yakiv Borysovych Fainberg started his pedagogical activity as a senior lecturer at the Kharkiv State University. For more than twenty years, he had being lectured about physics, the theory of accelerators, and additional chapters of electrodynamics to mostly advanced students-physicists. His lectures were always of the highest scientific quality. The basic pedagogical concepts of Ya.B. Fainberg were (i) to teach to study and (ii) understanding is more important than knowing. For about 60 years, he had been devoting much time and attention to the talented youth. At the same time, he had never mentioned about his scientific school, although more than 25 doctors and 30 candidates of physical and mathematical sciences call themselves disciples of Academician Yakiv Borysovych Fainberg's school.

The scientific school of Ya.B. Fainberg is characterized by the effective training of a scientific staff of the highest qualification, not only theorists but, what is even more important, experimenters as well. A lot of his disciples is working at the National Science Center of the KIPT, other institutes in Moscow, and laboratories in the USA until now. All publications of Prof. Fainberg's school are distinguished by the high rigor of a statement and the extreme clearness in formulating the results.

Owing to his outstanding scientific merits, Ya.B. Fainberg was elected Corresponding member of the AS of the UkrSSR in 1964, and Academician in 1979. Yakiv Borysovych Fainberg was a Honored scientist of the UkrSSR (1982), Head of the Scientific council "Plasma electronics and new methods of charged particle acceleration" at the National Academy of Sciences of Ukraine (1991), honorary academician of the Academy of Sciences of Applied Radioelectronics of Ukraine, Russia, and Belarus (1993), Honored Soros professor (1995), the winner of the State prize of Ukraine in science and technique (1996). He was awarded with a decoration "Labor Red Banner" (1988), decorations "For merits" of the 3-rd and 2-nd degrees (1998, 2003), a medal "For Victory over Germany" (1945), a medal "To the Defender of Motherland" (2001), and others.

For more than six decades, Ya.B. Fainberg had remained among the most authoritative physicists-theorists of our state. His scientific works had been recognized, they are widely known and cited. At the same time, it should be also recognized that scientific successes did not turn his head, he always remained an extremely democratic and great toiler. During all his life, Yakiv Borysovych "struggled and sought, found and did not give up". A very cultured and refined person in heart-to-heart connections, a bright and ardent speaker at seminars and Academic councils, intolerant to any distortion of scientific truth or scientific ethics — this image of Yakiv Borysovych remained forever in the memory of his friends, colleagues, and relatives.

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