Vladimir Borisovich Berestetskiĭ (Obituary)

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Usp. Fiz. Nauk 122, 543–546 (July 1977)

PACS numbers: 01.60.+q

Soviet and world science has suffered a severe loss. Professor Vladimir Borisovich Berestetskiĭ, one of the most prominent of Soviet theoretical physicists, died suddenly on January 25, 1977.

Berestetskiĭ was born in Khar'kov on October 3, 1913. On completing grade school, he attended classes at the "Hammer and Sickle" factory training school in Khar'kov. After moving to Leningrad in 1932, he went to work at the mechanical optics plant, and, at the same time, attended a workers' evening school, from which he graduated the following year. He was then admitted to the physico mechanical faculty of Leningrad Polytechnic Institute (LPTI), which he completed in 1937. From that year until 1941, Berestetskiĭ worked at the Leningrad Physicotechnical Institute. His field of scientific interest was determined during the first few years of his work at the LPTI: the theory of β and γ transitions in nuclei, quantum electrodynamics, and elementary-particle theory.

Berestetskiĭ's first paper, which was written in 1937 under the supervision of M. P. Bronshteĭn, was devoted to derivation of the equations of optics of material bodies and to quantum-mechanical interpretation of the resulting macroscopic parameters on the basis of the quantum theory of emission of individual atoms. Berestetskiĭ remained interested all his life in quantum electrodynamics, the groundwork of which was laid by this study.

However, Berestetskiĭ's subsequent papers, dating from the late 1930s, were on the theory of β decay; he investigated the form of the β spectra for forbidden transitions in the then popular Konopinski-Uhlenbeck theory and showed that the predictions of this theory contradict experiment.

The war interrupted Berestetskiĭ's scientific career as a theoretical physicist; during the wartime years he worked at one of the defense plants as a senior engineer and then as deputy chief designer.

After a hiatus due to the war, Berestetskiĭ returned to active scientific work at the LPTI and worked on the theory of emission of γ quanta by nuclei. To investigate these problems, he developed an original mathematical formalism—spherical vectors and spinors, which he constructed using the properties of rotation-group representations. On the basis of this general approach, Berestetskiĭ obtained a number of concrete results in the theory of internal conversion of γ rays and angular correlations in nuclear transitions. The methods that

Berestetskiĭ developed and his results are still fundamental to the theory of multipole emission.

At this time, during the 1940's, Berestetskiĭ joined the group of young theoretical physicists that had gathered around L. D. Landau. It included I. Ya. Pomeranchuk, A. B. Migdal, I. M. Shmushkevich, and others. The lively scientific discussions that took place within this group made no small contribution to the acquisition of new results.

In 1949, Berestetskiĭ became involved in the development of positronium theory. With Landau, he derived a wave equation for the electron-positron system with account taken of exchange interaction and studied the fine structure of the positronium and the Zeeman effect for this system. Interesting properties of positronium that distinguished it from ordinary atoms were established (for example, the absence of a Zeeman effect linear in the field). The results of these studies were subsequently fully confirmed in experiment. In 1950, Berestetskiĭ established a fact of fundamental importance, proving the theorem that the fermion and antifermion have opposite intrinsic parities. This result is cited in all atomic physics textbooks and is now in the ABCs of elementary-particle physics.

 0038-5670/77/2007-0651$01.10

In 1946, Berestetskiĭ transfered to a new institute organized by A. I. Alikhanov to do research on nuclear reactors, nuclear physics, and elementary-particle physics and now known as the Institute of Experimental and Theoretical Physics (ITEP). For a number of years, Berestetskiĭ worked closely with Pomeranchuk, who headed the theoretical division of the ITEP, and after the latter's death in 1966 he was recognized as head of the ITEP's theoreticians.

Berestetskiĭ participated in the research then pursued intensively at the ITEP on the development of nuclear reactors, and in investigations of other problems of applied nuclear physics. He made a theoretical study of the moderation of neutrons in matter and, among other things, derived a formula for the moderation length in a mixture of substances. He was awarded a "Badge of Honor" in 1954 for his work in applied nuclear physics. A new stage in Berestetskiĭ's scientific career, a stage associated with advances in quantum electrodynamics, began in the 1950's. In 1955, Berestetskiĭ and Pomeranchuk published a paper in which they computed the cross section of the process $e^+e^- \to \mu^+\mu^-$. Simple as the calculations themselves were, they are extremely important from the contemporary standpoint: the results of nearly all experimental studies of hadron production in colliding e^+e^- beams are now presented in the form of ratios of the cross sections of these processes to the cross sections of $e^+e^- \to \mu^+\mu^-$, and most accurate verification of quantum electrodynamics has been attained precisely in the process $e^+e^- \to \mu^+\mu^-$.

In 1955, starting with solutions of the equations of quantum electrodynamics at short range, Landau and Pomeranchuk presented weighty arguments indicating an internal contradiction of quantum electrodynamics—the vanishing of the physical electron charge because of the increase of vacuum polarization at short distances. The question arose: does this phenomenon persist when other, nonelectromagnetic, interactions are taken into account? Berestetskiĭ analyzed the behavior of the electromagnetic polarization of vacuum with allowance for meson interactions in the Yukawa pseudoscalar theory with $e^2 \ll g^2 \ll 1$ and showed that allowance for these interactions does not change the vacuum polarization at short distances, i.e., nonelectromagnetic interaction does not lead to a particle form factor that changes its interaction with the electromagnetic field. This study was the first in the world literature to indicate that form factors of strongly interacting particles can vanish in deep-inelastic processes, and it can be regarded as the forerunner of much later papers in which the idea of scale invariance (scaling) was advanced.

In the context of the speculation on possible violation of quantum electrodynamics at short distances, Berestetskiĭ showed that a good way to verify quantum electrodynamics would be by precision measurement of the magnetic moment of the muon. With his co-workers, he established a quantitative relation between the scale of the distances up to which quantum electrodynamics is valid and the magnitude of the radiative correction to the magnetic moment of the muon. This relation is still used to find the limits of validity of quantum electrodynamics. After the discovery of parity nonconservation in weak interaction, Berestetskiĭ returned again to study of β decay. In joint papers with B. L. Ioffe, A. P. Rudik, and K. A. Ter-Martirosyan, he undertook a systematic study of β-decay processes (electron spectra and polarization, various types of angular correlations, decay of oriented nuclei, forbidden transitions, etc) for the most general case of all five interaction variants. Possible methods of verifying T-invariance in β decay were also indicated, and the effect of polarization of internal-conversion electrons subsequent to β decay was discussed.

Berestetskiĭ made a significant contribution to the study of the asymptotic behavior of the cross sections of strongly interacting particles at high energies. In a 1960 paper by Berestetskiĭ and Pomeranchuk, an analysis of the peripheral mechanism of production of one or more particles was used to demonstrate that the assumption of one-meson exchange and constancy of the elastic cross section is not compatible with the hypothesis that the cross section is constant at high energies, and advanced arguments in favor of a logarithmic decrease of the elastic cross sections with energy. This study was an important preliminary step in the subsequent development of the theory of diffraction and multiperipheral processes on the basis of the Regge-pole model.

Studying the problem of nonconservation of CP parity (1966), Berestetskiĭ showed that an interaction with the electromagnetic field arises when CP parity is not conserved for neutral particles, and analyzed the ensuing consequences for neutral-particle production in colliding beams.

Berestetskiĭ's original papers of recent years showed an interest in the structure of baryons as bound states of three relativistic quarks. Berestetskiĭ and M. V. Terent'ev investigated the general properties of the wave functions of such systems on the light cone and obtained several results concerning the asymptotic behavior of the elastic and inelastic electromagnetic and weak form factors of baryons and their magnetic moments. Berestetskiĭ's death came in the course of these interesting and promising investigations.

Berestetskiĭ devoted much effort and attention to science teaching. For more than twenty years, he headed the theoretical physics department at the Moscow Physico-technical Institute. Many of his students are now doctors and candidates of sciences. He was the author of a number of books and reviews on quantum electrodynamics and quantum field theory. Best known is the joint monograph (with A. I. Akhiezer) "Quantum Electrodynamics," which is undoubtedly the best and most complete exposition of its subject in all of the world's literature. It has gone through three editions in the USSR and has been translated into English, German, Spanish, and several other languages. Berestetskiĭ's review papers (on quantum electrodynamics, on SU_3 symmetry, on gauge-field theory, on the problem of zero charge and asymptotic freedom) were always concerned with the most absorbing problems of physics.

They were distinguished by depth and clarity of exposition and made an important contribution to the development of elementary-particle physics in the USSR.

In science and in his life, Berestetskiĭ was a strongly principled individual. Although retiring, modest, and even shy in his relationships with people, patient and broad-minded, with an ability to listen and understand, he was inflexibly strict and principled in his scientific and social activity, but at the same time always direct and obliging. Having thought out and solved a problem, he never deviated from the chosen line, and only new facts could force him to change his position.

He was unusually quick to appreciate everything new, unexpected, or even baffling, whether it came up in his beloved field of physics or in art, literature, or human relations, and sometimes, it would appear, even the most commonplace of phenomena. His depth of involvment was combined with the ability to question with a light touch of irony. He was a man with a rich, complex, and intense inner life. His many gifts were made manifest in everything that he did: he found expression not only in theoretical physics, but also in literature. He published his "Baĭgurskaya Shkola" under the pseudonym "Vladimir Volkov" in the journal "Novyĭ Mir" (No. 2, 1976), and other works await publication. The combination of the clarity and profundity of thought of a scientist and artist with the subtle emotional coloring of his ponderings and the esthetic uniqueness of form of his literary efforts give him the right to be regarded as a new voice in literature.

He loved and was able to feel and express paradoxes that struck the imagination, but was a complete stranger to posturing and always remained himself. He combined profound understanding of human problems with great internal purity, so that people and circumstances often left him with a touch of bitterness tempered by irony, which at times gave way to sorrow.

He was never one to sermonize, but preferred, like Plato, whose works he read, to carry on an easygoing, multilevel, faintly humorous dialogue, and it would often happen that a problem that he had seen from a new angle would unexpectedly reveal its essential nature to him, becoming simple and clear. To converse with him was a pleasure: the visitor always left richer for the experience.

Vladimir Borisovich was young in spirit, full of interest in life, full of new ideas that his sudden death prevented him from realizing.

The "Baĭgurskaya Shkola" opens with the words: "It is good at the age of fifty to have a past that one does not want to forget." Berestetskiĭ lived a life that bears looking back upon, leaving us with the feeling that an irreplaceable loss has befallen us and a sense of gratitude that we were privileged to associate with him.

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Translated by R. W. Bowers