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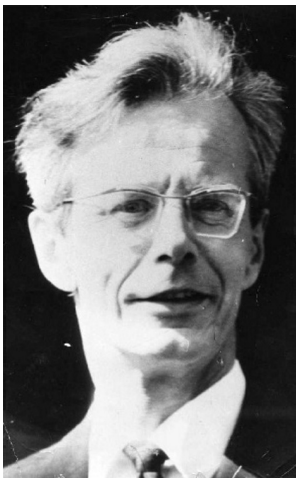
TO THE 90-th ANNIVERSARY OF DMITRII VASIL'EVICH VOLKOV'S BIRTHDAY



On July 3, ninety years will have passed after the birthday of Dmitrii Vasil'evich Volkov, an outstanding physicist, Honoured Science Worker, Academician of National Academy of Sciences of Ukraine, one of the pioneers of the theory of supersymmetry and supergravity, who made the fundamental contribution to elementary particle physics and quantum field theory. In his works, D.V. Volkov laid the foundation of the new approach to the understanding of the space-time structure and the unification of quantum theory with general relativity. After the discovery of the Higgs boson at CERN in 2013, the detection of new particles predicted by supersymmetry became one of the top priorities in the research program of the Large Hadron Collider.

D.V. Volkov was born on July 3, 1925, in the city of Leningrad (now St.-Petersburg). His father Vasilii Nikolaevich Volkov was a carpenter, his mother Ol'ga Ivanovna Kazakova was a kindergarten teacher. In 1941, when the Great Patriotic War started, Vasilii Nikolaevich joined the Leningrad volunteer corps and went missing in action. Dmitrii's elder brother Lev, a military cadet, was fatally wounded in December of 1941 in Leningrad. During the hard war years, Dmitrii worked at a collective farm and at a factory. In 1943, he was drafted into the Red Army as an eighteen-year-old youth and participated in the battles at the Karelsky and First Far East fronts. The war strengthened his character and formed his civic stand. After the demobilization, he came back to Leningrad and passed examinations for the 9-th and 10-th grades without attending lectures and entered the Physics Department of the Leningrad State University in 1947. Dmitrii studied during four years in Leningrad and, together with other excellent students, was transferred to the Kharkiv State University in 1951, where the Nuclear Physics Division was organized at the Physics and Mathematics Department at that time.

After graduating from the University, Dmitrii entered into a doctoral program under the supervision of Prof. Aleksandr Il'ich Akhiezer, who organized a group of talented postgraduate students for investigating the problems of quantum electrodynamics. This group included V.F. Aleksin, V.G. Bar'yakhtar, P.I. Fomin, S.V. Peletminskii, and D.V. Volkov, who later became world-known scientists. The 1950s are known as a period of extensive development in the field of nuclear and elementary particle physics and quantum electrodynamics. In 1956, D.V. Volkov defended his Candidate of Science dissertation on scalar electrodynamics and was invited to work at the Ukrainian Institute of Physics and Technology (now National Science Center "Kharkiv Institute of Physics and Technology"), where he studied quantum field theory. A world recognition came to D.V. Volkov in 1959, when he discovered the parastatistics (the Green–Volkov statistics), a new way of quantization

of half-integer spin wave fields, which generalized the Bose–Einstein and the Fermi–Dirac statistics.

Shortly after, Dmitrii Vasil'evich began to develop an original approach to studying the Regge pole theory. In 1962, in cooperation with Vladimir Naumovich Gribov, D.V. Volkov discovered the phenomenon of connection between Regge poles in the nucleon-nucleon and nucleon-antinucleon scattering amplitudes later called "the Regge pole conspiracy". This "conspiracy" theorem gave rise to a great flood of theoretical and experimental investigations in high energy physics. At the same period, D.V. Volkov introduced an important notion of collinear symmetry subgroups (simultaneously with G. Lipkin and S. Meshkov), that allowed one to describe the scattering amplitudes of particles and to give their classification on the basis of representations of the groups of higher symmetries.

In the middle of the 1960s, D.V. Volkov concentrated his scientific activity on the development of the current algebra and spontaneously broken symmetries. In 1968 he built a general approach to the description of the Nambu–Goldstone fields associated with an arbitrary spontaneously broken group of internal symmetry. Simultaneously, analogous results were obtained by J. Wess, S. Coleman, B. Zumino, and C. Callan. Volkov's approach was based on the deep insight into the group-theoretical methods of Elie Cartan and on understanding their universal role in the description of physical systems with degenerate vacua. Volkov's papers of this cycle gave a remarkable example of the unity of rigorous mathematical methods and a great physical intuition so typical of his creative approach. In statistical physics, D.V. Volkov applied his approach to the description of the magnons as Nambu-Goldstone particles. In 1970, D.V. Volkov together with his students built a general phenomenological Lagrangian for spin waves in magnetically ordered and disordered media. These papers became the basis for a novel approach that allowed one to obtain new results in condensed matter theory.

At the same time, D.V. Volkov started thinking over the problem of the existence of Nambu–Goldstone fermions. At the International Seminar at the Lebedev Physical Institute in Moscow in 1971, he presented a new construction generalizing the concept of spontaneously broken internal symmetry groups to the case of groups of a new type including the Poincaré group as a subgroup. This new symmetry, later called supersymmetry, allowed one to overcome the well-known no-go theorem of Coleman and Mandula forbidding a non-trivial unification of internal and space-time symmetries. Volkov's construction proved the possibility of the existence of Nambu–Goldstone fermions. In 1972, D.V. Volkov together with his student V.P. Akulov built the appropriate phenomenological Lagrangian. A little bit earlier in 1971, supersymmetry was discovered by Yurii Golfand and Evgenii Likhtman and rediscovered in 1974 by J. Wess and B. Zumino. The latter extended the two-dimensional world-sheet graded Lie algebra discovered in 1971 in dual models and string theory by P. Ramond, J. Schwarz, A. Neveu, D. Gervais, and B. Sakita to the four-dimensional space-time. Since then the ideas of supersymmetry and strings became the fundamental theoretical conceptions in elementary particle physics and astrophysics.

In 1973, D.V. Volkov advanced the idea of the unification of supersymmetry with general relativity and, together with his student V.A. Soroka, constructed the first theory of supergravity based on the consideration of the super-Poincaré group as a gauge group. This unification extended the Hilbert–Einstein theory treated as the gauge theory of a boson field with spin 2 (graviton), by the addition of the 3/2-spin Rarita-Schwinger fermionic gauge field (gravitino) accompanied with a Nambu–Goldstone fermion. They showed that the spontaneous breakdown of the local supersymmetry in the presence of a Nambu–Goldstone fermion resulted in a supersymmetric extension of the Higgs effect to a gravitino. This seminal paper stimulated the appearance of the papers by D. Freedman, P. van Nieuwenhuizen, S. Ferrara and by S. Deser and B. Zumino published in 1976, where pure supergravity including only the graviton and gravitino fields was built.

During the 1970s, Dmitrii Vasil'evich in collaboration with his students solved the complicated problem of spontaneous vacuum transitions in the dual resonance models of Veneziano and Neveu–Schwarz. This allowed them to discover a hidden quark structure of the Regge trajectories accompanied with a new infinite-dimensional symmetry of the dual amplitudes.

Later, D.V. Volkov proposed the mechanism of spontaneous compactificaton of redundant space dimensions in the supersymmetric theories of gauge fields. In collaboration with his students, D.V. Volkov

built new models for interacting gauge and gravitational fields that generalized the Kaluza–Klein model and are invariant under the symmetries of the Standard Model.

In the late 1980s, D.V. Volkov developed a new supertwistor approach in the supersymmetric theory of particles, strings, and membranes and, in collaboration with his students, built new twistor-like models of these objects. Based on this, D.V. Volkov explained the mystery of the fermionic kappa-symmetry as the superdiffeomorphisms of world lines and world sheets of particles and strings. The progress achieved with the use of supertwistors stimulated an intense activity in many research groups over the world.

Volkov's works in the field of supersymmetry and the associated problems won a wide international recognition. They are cited as the basic ones for the present-day stage in the development of high-energy physics and field theory. In 1994, D.V. Volkov was invited as a guest of honor with the talk "Supergravity before 1976" at the International conference in Erice, Sicily, which was devoted to the history of original ideas and basic discoveries in particle physics of the twentieth century.

In his last talk presented at the SUSY-95 conference in Paris, D.V. Volkov proposed a new generalized action principle for superstrings and supermembranes. In view of his great contribution to the development of elementary particle physics, the organizers devoted the Conference Proceedings to the memory of Dmitrii Volkov.

The scientific activity of Dmitrii Vasil'evich was inseparably linked with the Kharkiv Institute of Physics and Technology, where he worked for more than 40 years and created a scientific school known far outside Ukraine's borders. D.V. Volkov made a lot of efforts into the scientific-organizational and administrative work. He was a member of the Scientific Committee on Nuclear Physics at the National Academy of Sciences of Ukraine, a member of the editorial board of the Soviet Journal of Nuclear Physics (Moscow), the journal "Problems of Nuclear Physics and Cosmic Rays" published by V.N. Karazin Kharkiv National University. For more than 30 years, he was the head of the Library Council of KIPT, a member of many scientific boards, and the supervisor of the scientific seminar at the V.N. Karazin KNU.

The achievements of D.V. Volkov were acknowledged through orders and medals. Posthumously, Dmitrii Volkov was awarded the Walter Thirring Medal in 1997 and the State Prize of Ukraine in Science and Technology in 2009 (together with his co-workers).

The colleagues and co-workers of Dmitrii Vasil'evich highly appreciated a great profoundity of his thinking, a subtle feeling of beauty in science, his ability to catch instantly the essence of the discussed problem and to react with original solutions.

Many people noted on his uncompromising attitude to any violation of scientific ethics, to careerism, bureaucracy in science and to injustice. Dmitrii Vasil'evich was a modest person with good will and respectful attitude to people, readiness to help those in need.

Despite the heart disease which resulted from the hard war years, D.V. Volkov worked on the maximum of his physical forces, inspired by new ideas. Contacts and discussions with Dmitrii Vasil'evich on any problems of science and life gave enormous enjoyment, created optimism and belief in the triumph of wisdom and kindness. The name of D.V. Volkov, a knight of theoretical physics, forever remains in the history of science and in the memory of his colleagues and friends.

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