

## DMITRI IVANENKO

Dmitri Ivanenko (29.07.1904-30.12.1994), Professor of Physics, Lomonosov Moscow State University, was one of the greatest theoreticians of the XX century, an author of the proton-neutron model of atomic nucleus.

D. Ivanenko was born on July 29, 1904, in Poltava (Russian Empire), where he began his creative path as a school teacher of Physics. In 1923 Ivanenko entered Petrograd University. In 1926, while still a student, he wrote his first scientific works together with his friends, George Gamov and Lev Landau (Nobel Laureate in 1962). After graduating the university, from 1927 to 1930 D. Ivanenko was a scholarship student and a researcher at the Physical Mathematical Institute of the USSR Academy of Sciences. That time he collaborated with Vladimir Fok and Viktor Ambartsumian, who later become world-known scientists.

In 1929–31, Dmitri Ivanenko worked at the Kharkiv Institute of Physics and Technology, being the first director of its theoretical division; Lev Landau followed him in 1932–37. Paskual Jordan, Victor Wieskopf, Felix Bloch and Paul Dirac visited D. Ivanenko in Kharkiv. In 1929, Ivanenko organized the 1<sup>st</sup> Soviet theoretical conference and then in 1932 he launched the first Soviet journal **“Physikalische Zeitschrift der Sowjetunion”** in foreign language.

After returning to Leningrad at the Ioffe Physical-Technical Institute, D. Ivanenko concentrated on nuclear physics. In May 1932, Ivanenko published the proton-neutron model of the atomic nucleus in *“Nature”*, and two months later Werner Heisenberg referred to his work. In August 1932, D. Ivanenko and E. Gapon proposed the pioneering nuclear shell model describing the energy level arrangement of protons and neutrons in the nucleus in terms of energy levels. Later this model was developed by Eugene Paul Wigner, Maria Goeppert-Mayer and J. Hans D. Jensen who shared the 1963 Nobel Prize for their contributions.

Ivanenko's success pushed forward the nuclear physics in the USSR. In 1933 on the initiative of Dmitri Ivanenko and Igor Kurchatov, the 1<sup>st</sup> Soviet nuclear conference was organized. Paul Dirac, Fr̄yd̄ric Joliot-Curie (Nobel laureate in 1935), Francis Perrin, Ettore Majorana, Victor Wieskopf and many others participated in this conference.

The realization of Ivanenko's far-reaching plans and hopes was interrupted in 1935, when he was arrested in connection with the Sergey Kirov affair, and exile to Tomsk followed. D. Ivanenko was a professor at Tomsk and Sverdlovsk Universities till the beginning of the World War II. Then, from 1943 till the last days of his life, he was closely associated with the Faculty of Physics Faculty, Lomonosov Moscow State University.



D. Ivanenko

Dmitri Ivanenko made the fundamental contribution to many areas of nuclear physics, field theory and gravitation theory.

In 1928, Ivanenko and Landau developed the theory of fermions as skew-symmetric tensors in contrast with the Dirac spinor model. Their theory, widely known as the Ivanenko-Landau-Kahler theory, is not equivalent to Dirac's one in the presence of a gravitational field, and only it describes fermions in contemporary lattice field theory.

In 1929, Ivanenko and Fock generalized the Dirac equation and described parallel displacement of spinors in a curved space-time (the famous Fock-Ivanenko coefficients). Nobel laureate Abdus Salam called it the first gauge field theory.

In 1930, Ambartsumian and Ivanenko suggested the hypothesis of creation and annihilation of massive particles which became the corner stone of contemporary quantum field theory.

In 1934 Dmitri Ivanenko and Igor Tamm (Nobel Laureate in 1958) suggested the first non-phenomenological theory of paired electron-neutrino nuclear forces. They made the significant assumption that interaction can be undergone by



D. Ivanenko, P.A.M. Dirac and W. Heisenberg (Berlin, 1958)

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an exchange of massive particles. Based on their model, Nobel laureate Hideki Yukawa developed his meson theory.

In 1938, Ivanenko proposed a non-linear generalization of Dirac's equation. Based on this generalization, W. Heisenberg and he developed the unified nonlinear field theory in 1950th.

In 1944, Dmitri Ivanenko and Isaak Pomeranchuk predicted the phenomenon of synchrotron radiation given off by relativistic electrons in a betatron. This radiation was soon discovered by American experimenters D. Blüthner (1946) and H. Pollock (1947). Synchrotron radiation possesses a number of very particular properties which provide its wide applications. In particular, neutron stars also are sources of this type radiation. Classical theory of synchrotron radiation was developed by Dmitri Ivanenko in collaboration with Arseny Sokolov in 1948, and independently by Julian Schwinger (Nobel Laureate in 1965). For their work on synchrotron radiation, D. Ivanenko, A. Sokolov and I. Pomeranchuk were awarded the Stalin Prize in 1950. In 1956, D. Ivanenko developed the theory of hypernuclei discovered by Marian Danysz and Jerzy Pniewski in 1952.

Two of D. Ivanenko's and A. Sokolov's monographs "**Classical Field Theory**" and "**Quantum Field Theory**" were published at the beginning of the 50th. "**Classical field theory**" was the first contemporary book on field theory where, for instance, the technique of generalized functions was applied. Nobel laureate Ilya Prigogine referred to it as his text-book.

In the beginning of the 1960's, D. Ivanenko did intensive scientific and organizational work on the development and coordination of gravitation research in the USSR. In 1961, on his initiative the 1<sup>st</sup> Soviet gravitation conference was organized. D. Ivanenko was the organizer of Soviet Gravitation Commission, which lasted until the 1980's. He was a member

of the International gravitation Committee since its founding in 1959. In the 70–80th, D. Ivanenko was concentrated on gravitation theory. He developed different generalizations of Einstein's General Relativity, including gravity with torsion and gauge gravitation theory. In 1985, D. Ivanenko and his collaborators published two monographs "**Gravitation**" and "**Gauge Gravitation Theory**".

Theoretical physics in the USSR has been enormously influenced by the seminar on theoretical physics organized by D. D. Ivanenko in 1944 that has continued to meet for 50 years under his guidance at the Physics Faculty of Moscow State University. The distinguishing characteristic of Ivanenko's seminar was the breadth of its grasp of the problems of theoretical physics and its discussion of the links between its various divisions, for example, gravitation theory and elementary particle physics. The most prominent physicists in the world participated in the seminar: Niels and Aage Bohr, Paul Dirac, Hideki Yukawa, Julian Schwinger, Abdus Salam, Ilya Prigogine, Samuel Ting, Paskual Jordan, Tullio Regge, John Wheeler, Roger Penrose et al.

The scientific style of Dmitri Ivanenko was characterized by great interest in ideas of frontiers in science where these ideas were based on strong mathematical methods or experiment.

It should be noted that seven Nobel Laureates: P.A.M. Dirac, H. Yukawa, N. Bohr, I. Prigogine, S. Ting, M. Gell-Mann, G. 't Hooft wrote their famous inscriptions with a chalk on the walls of Ivanenko's office at Lomonosov Moscow State University.

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