PERSONALIA

Bruno Pontecorvo (On His Sixtieth Birthday)

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Bruno Pontecorvo, a prominent Soviet Physicist and Academician, observed his sixtieth birthday on August 22, 1973.

Pontecorvo was born at Pisa in Italy. A 1933 graduate of the University of Rome, he spent 1934—1936 working with other Italian physicists (F. Rasetti, E. Segre, E. Amaldi) under the supervision of a remarkable teacher, the great scientist Enrico Fermi. According to the testimony of Segre, the speed with which a young physicist was shaped in Fermi's "school" was something improbable. By his own example, Fermi taught his students and colleagues alike to love physics with a passion, as he taught them to understand the spirit and ethics of science. Pontecorvo's love for this teacher, the salutary influence of the latter's personality, and the high style of service to science that Fermi inculcated have remained with him to this day.

The work done by Fermi's group, which resulted in the discovery and detailed study of neutron moderation and capture of neutrons by nuclei, laid the foundation for the rapid development of neutron physics. The results of this development are now familiar to every student. For his participation in these studies, Pontecorvo was awarded a scholarship for study abroad. He moved to Paris to work at the Radium Institute.

Continuing his study of the interaction of slow neutrons with nuclei during his approximately two-year stay in Paris, Pontecorvo investigated resonance effects in the capture of slow neutrons by nuclei of various elements, was the first to measure the cross sections of scattering of slow neutrons by protons and by other nuclei, and studied the moderation of neutrons in inelastic collisions.

In 1937—1940, Pontecorvo turned his attention to nuclear isomerism. He advanced the hypothesis that beta-stable nuclear isomers exist and concluded that the isomer transitions must have large coefficients of internal conversion. He confirmed these predictions experimentally. He was the first to obtain a beta-stable isomer, by bombardment of cadmium by fast neutrons. During the same years, Pontecorvo was the first to observe "pure excitation" of an isomeric state in stable nuclei when he excited the indium nucleus with hard bremsstrahlung. He was the first to detect the phenomenon of nuclear phosphorescence. He received the Curie-Carnegie prize for his work on nuclear isomerism.

In 1940, Pontecorvo traveled to the USA, where he spent three years working on the practical elaboration of neutron logging, a new and highly efficient method that he had proposed for oilfield prospecting. This technique is of great practical importance even today.

In Canada from 1943 to 1948, Pontecorvo took part in the work of building and starting the large heavy-water research reactor at Chalk River. While still in Canada, his attention turned to fundamental problems of the microscopic universe—meson and neutrino physics. He was the first to observe that the building of powerful nuclear reactors would make it possible to design direct experiments for the detection of neutrinos and proposed an experiment that was unusually bold for its time and whose purpose was to answer the question as to whether the properties of the neutrino and antineutrino are identical. We should note that the courage to formulate unusual and, at the same time, feasible experiments was a characteristic feature of Pontecorvo's scientific activity. He proposed to bombard large numbers of chlorine nuclei with a stream of neutrinos from a nuclear reactor. The formation of radioactive argon nuclei that could be separated comparatively easily from the entire remaining mass of matter and identified would indicate that the neutrino and antineutrino are identical. This experiment was later carried out by R. Davis, and its result, which appears in every textbook, indicated that the neutrino and antineutrino are not identical. The reaction in which chlorine is transformed into argon is used today as the basic method for detection of neutrinos from the sun.

During the same period, Pontecorvo used his own improved proportional-counter method to study the electron spectrum from the beta decay of tritium and obtained an estimate of the mass of the electronic neutrino at a level of about 1 keV. A number of Pontecorvo's papers were devoted to establishing the decay scheme of the muon. He obtained the first experimental indication that the muon does not decay into an electron and a gamma quantum. In a study of the charged-particle spectrum produced by muon decay, he demonstrated that the particles are electrons and concluded that the muon decays into an electron and two neutrinos.

It was found in 1947 that the probability of nuclear capture of muons is much lower than the Yukawa theory would indicate. Discussing this fact, Pontecorvo observed that the probability of capture of a negative muon is of the same order of magnitude as the probability of K capture if the difference between the volumes of the K shell and the meson orbit is taken into account. He pointed to the fundamental analogy between beta processes and muon absorption, i.e., the profound analogy between the properties of the muon and the electron. In fact, he was stating for the first time the hypothesis that weak interactions are of universal character. Proceeding from this conception, Pontecorvo concluded that a neutrino appears on the capture of a muon by a nucleus. And, 10 years later, when the physics of strange particles had made its appearance, he stressed that the same mechanism (the universal Fermi interaction) underlies the decay of these particles, the decay of the previously known pions and muons, and the beta decay of nuclei.

Pontecorvo returned to Europe in 1948 and worked for a while at Harwell. In 1950, he traveled to the Soviet Union and became involved in the work on the recently built 480-MeV proton accelerator at Dubna, which was then the most powerful in the world. These were the years during which experimental high-energy physics grew through its infancy and came into its own in the USSR. Under Pontecorvo's supervision, and with his active involvement, a major cycle of investigations was carried out in 1951—1954, leading to the first observations of neutral-pion formation on protons and nuclei under bombardment by high-energy neutrons and a search for the H^4 nucleus.

During 1954—1957, much of Pontecorvo's attention was given to experimental study of the interaction of pions with nucleons and nuclei. During this time he also designed the experiment to detect the formation of Λ^0 particles by 680-MeV protons on the synchrocyclotron of the JINR Nuclear Problems Laboratory. In analyzing the first data on the production and decay of strange particles, Pontecorvo made a close approach to formulation of the basic problems of the physics of joint production of strange particles.

During the years that followed, Pontecorvo concentrated on the physics of weak interactions, and basically on the neutrino problem. On his initiative and with his participation, an experiment was performed on the synchrocyclotron of the JINR Nuclear Problems Laboratory in which capture of muons by helium-3 was observed for the first time, and the proton synchrotron of the JINR High-Energy Laboratory was used in a search for an anomalous interaction of neutrinos with nucleons. Using the same synchrocyclotron, Pontecorvo performed an experiment of his own design in which the phenomenon of nonradiative capture of muon's in heavy muonic atoms was observed.

Pontecorvo's profound scientific intuition and his character as a scientist and man were clearly in evidence in the part that he played in solving the fundamental problem of the existence of the two types of neutrinos.

It is not sufficient merely to read Pontecorvo's papers on this problem. It would be necessary to see the enthusiasm and energy with which Pontecorvo discussed ways of verifying experimentally the hypothesis of the two types of neutrinos at seminars, scientific councils, and All-Union and international conferences. Pontecorvo's suggestions and, to a major degree, his promotional activity were responsible for the experiments to study the interaction of neutrinos produced on powerful accelerators with matter—experiments that demonstrated the existence of two neutrino species—electronic and muonic. Here Pontecorvo's ability not only to perceive and pose important fundamental questions, but also to find a way to their experimental solution are fully revealed.

Pontecorvo's range of scientific interests was not confined to the phenomena of the microworld. In 1959, he became the first to note that the weak interaction between the neutrino and the electron has a profound influence on the evolution of stars; a year later, he was the first to report another important mechanism of stellar evolution—the emission of neutrino pairs. He observed that the upper limit of energy density in the Universe can be estimated from data on cosmic muons. Astrophysical problems and the role of the neutrino in them interest Pontecorvo even today. He is one of the most active neutrino-astronomy enthusiasts and has worked seriously and diligently on the problems of creating effective neutrino detectors.

Several of Pontecorvo's papers have been devoted to the conservation of leptonic charge—the possibility of transformation of one species of neutrino to another. This fundamental problem still awaits its solution. Here again, Pontecorvo has not only advanced new ideas, but has also proposed concrete designs for the new experiments. The interest in astrophysics reverts to neutrino physics in Pontecorvo's proposal for the observation of neutrino oscillations generated in stellar objects, thus greatly furthering our knowledge of the law of lepton-number conservation and the magnitude of the smallest possible neutrino mass.

Not one to confine himself to the physics of weak interaction, Pontecorvo has proposed and is now conducting studies on the 70-GeV accelerator of the Institute of High-Energy Physics of the USSR State Committee for the Use of Atomic Energy (IFVÉ GKIAÉ) in a search for new metastable particles. Again the ideas are new and concern the existence of hadronic isomers.

Pontecorvo's works are widely recognized. In 1954, he was awarded a USSR State Prize. In 1963, for the aggregate of his work on the physics of weak interactions and neutrinos, he became a Lenin Prize laureate. He had been elected a Corresponding Member of the USSR Academy of Sciences in 1958, and became an active member in 1964. He has many responsibilities in the Academy of Sciences as chairman of its Scientific Council on Neutron Physics and a member of the board of the Nuclear Physics Division.

Pontecorvo's influence on the development of modern physics has not been limited to his scientific papers. Everyone who meets him feels the impact of his energy and his lucid, innovative, and critical turn of mind and goes away captivated by his charm. To converse with Pontecorvo and discuss scientific matters is not only highly interesting; it is also instructive, regardless of whether the subject is a profound and fundamental problem or a detail in the design of an experiment. Incidentally, Pontecorvo, who is a recognized master of the physical experiment, has always attached great importance to methodological research. He has done much to create an atmosphere in which objectivity of a high order is demanded in the scientific results obtained from complicated experiments. He has exerted and continues to exert a productive influence on the deliberations behind scientific research programs other than those of the JINR, where he works. Pontecorvo has been an active and authoritative figure on the Scientific Coordination Council of the IFVÉ GKIAÉ from the very inception of the 76-GeV Serpukhov accelerator.

Pontecorvo devotes much attention to the upbringing of the younger generation of physicists. He holds the chair of elementary particle physics at Moscow State University and lectures to undergraduate and graduate students. He has trained many Doctors and Candidates of Sciences.

A man of high civic conscience and a member of the Communist Party of the Soviet Union since 1955, Pontecorvo does much work of social significance. He is on the board of the Italian-Soviet Society and an active lecturer before the Zhanie (Knowledge) society. Pontecorvo rising to deliver a lecture or engaging in a lively and interesting conversation is a scene that might equally well be set in a factory club or on a ship of the Far Eastern fleet. Other problems that have come within his range are those of rail communications between Dubna and Moscow, the organization of a new theater group at Taganka, and many others.

For merit in the development of nuclear physics in the USSR and for his vigorous civic activity, Pontecorvo has been awarded the Order of Lenin and two Orders of the Red Banner of Labor.

Science and social activity are not the only spheres in which the richness of Pontecorvo's nature is displayed. In sports as in physics, he infects everyone with his enthusiasm. A master at tennis in his youth, he is top-seeded at Dubna. He was one of the originators and promoters of spear fishing in our country. He was one of the first of the Dubna group to take up water skiing. Even today, he is as good as the youngsters at many of these pastimes.

Today as always. Pontecorvo is full of vigor, energy, creative ideas, and infectious enthusiasm; his humor continues to sparkle, and he may at any time disconcert those around him with a good joke.

Pontecorvo has many friends, both in our country and abroad. We all wish Bruno Maximovich (as we call him in accordance with Russian custom) many years of good health, new happiness, and new ideas, enthusiasms and discoveries.

Translated by R. W. Bowers