Bruno Maksimovich Pontecorvo (on his eightieth birthday)

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The eminent physicist academician Bruno Maksimovich Pontecorvo attains his eightieth birthday on 22 August 1993.

B. Pontecorvo was born in Italy in Marino di Pisa. For the first two years he was a student at the engineering faculty in Pisa, and then following the advice of E. Fermi, he entered the faculty of physics and mathematics of the University of Rome. From 1931 to 1936, he was at first a student and later a member of the group widely known all over the world led by E. Fermi ("the boys from the Panisperna Street"). Pontecorvo participated in the classical investigations on the discovery of the properties of slow neutrons which laid the foundations for the practical utilization of nuclear energy.

In 1936–1940 Pontecorvo worked at the Radium Institute in Paris in the group of Joliot–Curie. Here he carried out an extensive series of experiments on the study of nuclear isomerism. These investigations led to the discovery of nuclear phosphorescence-excitation of metastable states of β-stable isotopes by γ quanta of energy in the MeV range.

During 1940–1942 Pontecorvo worked in the USA. The considerable experience gained in the work in the field of the physics of slow neutrons which Pontecorvo acquired in Fermi's group enabled him to propose and to develop a new and a very effective geophysical method of prospecting for oil—the method of neutron well-logging. This method is widely used at present.

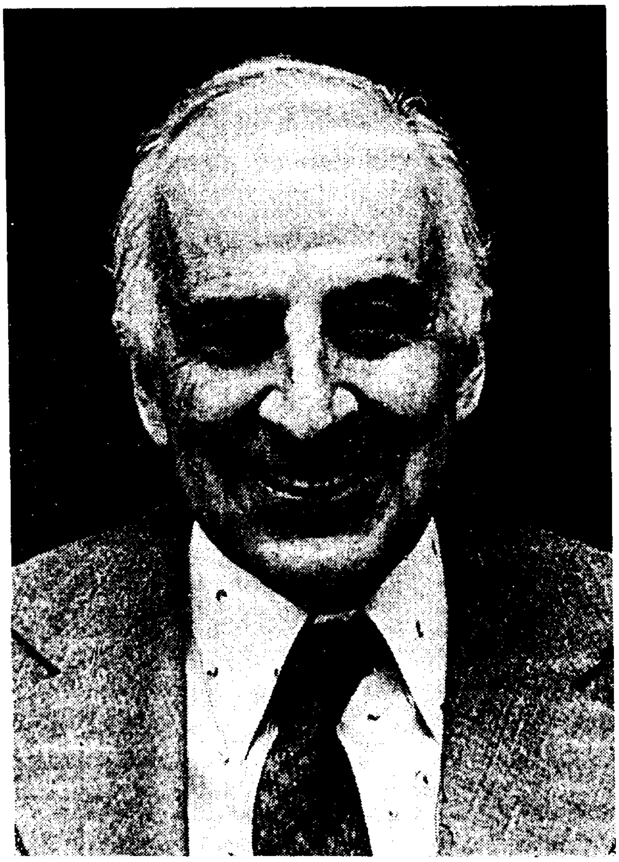
In 1943–1948, Pontecorvo worked in Canada. He participated in the development and commissioning of the research reactor based on heavy water that was the most powerful one at the time. In Canada, Pontecorvo carried out pioneering experiments on the investigation of the fundamental properties of muons. He proved that the charged particle formed in the decay of a muon is an electron, that a muon can decay into three particles, and that the decay of a muon into an electron and a photon is forbidden. Pontecorvo first called attention to the fact that the probability of μ-capture is characterized by the Fermi constant and advanced the hypothesis of the existence of a universal μ–e symmetric weak interaction.

B. Pontecorvo is justly regarded as the founder of experimental neutrino physics and astrophysics. He first proposed methods for recording neutrinos. In a well-known article published in 1946 in the form of a report from the Chalk River Laboratory he proposed a radiochemical chlorine-argon method for recording neutrinos from the sun, from nuclear reactors and from accelerators.

Pontecorvo's radiochemical method is at present the main method for recording solar neutrinos. The chlorine-argon method has been used for more than 20 years in the pioneering experiment of Davis in which solar neutrinos have been recorded of relatively high energies ($\geqslant$0.8 MeV). However it has turned out that Pontecorvo's radiochemical method possesses much wider possibilities. By using the transition gallium-germanium proposed by V. A. Kuz'min the two collaborating groups GALLEX and SAGE have been able to record solar neutrinos beginning with low energies ($E_\nu < 0.4$ MeV) which are products of the reaction $pp \to de^+\nu_e$ and comprise the main flux of neutrinos from the sun. As a result of the work by B. Pontecorvo, a new field of research has come into being—neutron astronomy which enables one to obtain information both concerning the internal invisible region of the sun, and also concerning the properties of neutrinos (masses and neutrino mixing). Pontecorvo also made a significant contribution to the development of the technique of recording solar neutrinos. He developed the proportional counter of small dimensions usually employed in the modern experiments with solar neutrinos, which enables one to count the negligible quantities of radioactive nuclei of argon or germanium separated out from the multi-ton masses of solution of chlorine or of gallium irradiated by these neutrinos.

In 1948–1950 Pontecorvo worked in Harwell (Englad), and at the end of 1950 he moved to the Soviet Union. Pontecorvo arrived in the USSR soon after the commissioning in Dubna of then the most powerful in the world synchrocyclotron. He became actively involved in the research being carried out at the synchrocyclotron. The process of the production of π^0 mesons in nucleon-nucleon collisions was investigated in the experiments of Pontecorvo's group. A large series of investigations was devoted to the study of the process of elastic scattering of pions by nucleons.

In 1953, Pontecorvo (independently of Pais) put forward the hypothesis of associated production of kaons and hyperons. In order to verify this hypothesis, Pontecorvo's group carried out an experiment on the search for the production of individual Λ hyperons in nucleon-nucleon collisions. From the fact that such processes were not observed Pontecorvo concluded that the isotopic spin of a kaon is equal to 1/2 and that there exist two neutral kaons—K^0 and K^0. Analyzing the data from the experi-



Bruno Maksimovich Pontecorvo

ments on the study of the $K^0 \leftrightarrow \bar{K}^0$ oscillations Pontecorvo arrived at the conclusion that in the weak interaction strangeness can change by not more than unity.

After 1957, Pontecorvo's scientific interests became primarily associated with weak interaction physics and particularly with neutrino physics. In 1959 he published the widely known paper "Electron and muon neutrinos," in which it was shown that the neutrinos from accelerators can be recorded by large detectors, and an experiment was proposed which would provide the answer to the question whether the electron and muon neutrinos are different. Beginning with the mounting of this experiment (Brookhaven, 1962) the physics of high energy neutrinos using accelerators began.

In 1957–1958 Pontecorvo put forward the hypothesis of neutrino oscillations. He was basing himself in this on the idea of the deep analogy of the weak interaction of leptons and hadrons which guided him long before the appearance of the quark-lepton analogy of the modern standard theory of the electroweak interaction. He regarded the neutrino oscillations as a phenomenon analogous to the oscillations of neutral kaons.

Neutrino oscillations are possible only in the case if the neutrinos have small masses different from zero. In 1958–1959 after the triumph of the two-component theory of neutrinos the hypothesis of neutrino masses differing from zero was a very bold hypothesis. At the present time dozens of experiments are devoted to checking Pontecorvo's hypothesis of neutrino oscillations. The search for neutrino oscillations is regarded as the search for effects going outside the framework of the effects of the standard theory.

Significant progress has been achieved in experiments on recording solar neutrinos. In all the modern experiments a lower flux of solar neutrinos is observed than the flux predicted by the standard solar model. This "deficit" may be evidence of the fact that the neutrino mass is different from zero and mixing occurs. Pontecorvo drew attention to the importance of effects of oscillations for experiments on recording solar neutrinos even before the first experiments of Davis.

Pontecorvo shows great interest in astrophysics. In 1959 he was the first to point out the importance of processes of weak interaction of neutrinos and electrons for stellar evolution.

The ability of Pontecorvo to generate ideas in any field of physics that attracts his attention and to indicate paths toward their realization evokes general admiration. This is well illustrated by the example of antiproton physics. In 1956 literally half a year subsequent to the discovery of the antiproton he published an article on the possibility of exotic reactions of annihilation forbidden for a single nucleon, but allowed when an antiproton is annihiliated in a nucleus. It is interesting that only now has it become possible to study experimentally these processes that have been called the Pontecorvo reactions, and it turned out that they present new possibilities for meson spectroscopy.

It is difficult to overestimate the role played by Pontecorvo in creating an atmosphere of high demands placed on the level of scientific work and the benevolent strictness in discussing new experimental and theoretical results. He invariably exerts a great influence on the formation of direction of scientific investigations at the JINR (Dubna) and also at the Institute for High Energy Physics (Protvino).

Pontecorvo's scientific activity has been widely recognized internationally. In 1953 he was awarded the State Prize for his research in pion physics. In 1963 for his work on neutrino physics he was awarded the Lenin Prize (1963). He was elected a Corresponding Member (1958), and later a Full Member of the Academy of Sciences of the USSR (1964). In 1980 Pontecorvo was the recipient of an Honorary Doctorate of the University of Budapest and in 1981 he was elected a foreign member of the Italian Lincei Academy.

Pontecorvo devoted much attention and energy to teaching. For many years he was in charge of the department of elementary particle physics of the Moscow State University in Dubna. Many students who graduated from Pontecorvo's department have become well-known scientists, and were placed in charge of large experimental establishments. His lectures attract a wide audience. He often relates interesting recollections of E. Fermi, E. Majorana, the school of E. Fermi in Rome etc. On Pontecorvo's initiative the complete collection of the publications of E. Fermi has been translated and published in Russian. For this edition Pontecorvo wrote a biography of the great physicist and provided the articles with very interesting comments.

Culture and elegance of presentation characterize the scientific activity of Bruno Pontecorvo. A scientist of the highest rank he combines in himself the gift of deep penetration into the essence of physical phenomena with exceptional abilities of an experimentalist. His contribution towards our knowledge of the microworld is invaluable. He has achieved recognition and respect in the entire world of science. But for those who had the possibility of knowing him closely no less esteemed his exceptional personal qualities. An indelible impression is created by his benevolence, love of science, a clear critical mind, unbiased opinions, and his broad and deep culture. Bruno Pontecorvo illuminates the life of those who have the good fortune to be among his friends. He passes on to them his unshakable faith in the future, which is beautifully expressed in the Italian saying which he often repeats:

Se oggi seren non e
Doman seren sara
Se non sara seren
Si rasserenera.
(If there is no serenity today
It will come tomorrow
If serenity has not yet come
It will still arrive).

The friends of Bruno Pontecorvo are well familiar with his love and enjoyment of life, his soft sense of humor, his magnanimity and generosity.

In these days of his jubilee we from the bottom of our hearts wish for Bruno Maksimovich good health, prosperity and new creative inspirations.

Translated by G. Volkoff