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Colloquia: The Legacy of Bruno Pontecorvo

Bruno Pontecorvo, knowing him and indebtedness to him

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Summary. — Pontecorvo, in 1947, in a Physical Review Letter, pointed out that given the results of the experiment of Conversi, Panciini and Piccioni, the Fermi interaction may very well be universal, but this was too imaginative at the time and universally rejected. I owe to Pontecorvo the suggestion to do the experiment for which I shared a Nobel prize.

I met Pontecorvo when I was a PhD student at the University of Chicago, 1946 – 1948. He came several times from Canada to see his teacher and friend Enrico Fermi, who was also my teacher. In 1947 Pontecorvo published a *Physical Review* letter in which he noted that experimental results on the interaction strength of cosmic ray mesotrons with nuclear matter, which could be deduced, very roughly, within a factor of ~ 400, from the experiment of Conversi, Pancini and Piccioni (1946), which had demonstrated that the interaction of the mesotron is much too weak to be the particle proposed by Yukawa to be responsible for nuclear forces, were, within that factor, compatible with the interaction strength of nuclear β-decay, and that therefore there might be a universal Fermi interaction.

Only a year later, with the help of my thesis experiment, this was clearly correct, but at the time it was an enormously imaginative suggestion, and no one (except Pontecorvo), in particular also Fermi, could imagine a parallel between the mesotron, now the muon, and the electron. The article was completely rejected by the community, and is still forgotten, although the universal Fermi interaction, and more generally lepton flavour symmetry, are now Pillars of particle physics, and this was their first suggestion.

I am personally very indebted to Pontecorvo for his proposal, in 1959, that, using beams of neutrinos produced by high energy accelerators, one could check whether the neutrino in muon decay is the same as that in β-decay, or is a different particle. Independently at about the same time, Mel Schwartz proposed that one could use neutrino beams to learn about the weak interaction at higher energies although the article does not mention the possible application of neutrino beams to the question of the possible difference of electron and muon neutrinos.

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Pontecorvo could not do the experiment, since by this time he was in the USSR, and there were no accelerators in the USSR of sufficient energy, but in Brookhaven and CERN 25 GeV proton accelerators were just being completed and permitted the experiment. In 1962 we were able to show that muon and electron neutrinos are different particles, and for this Mel Schwartz, Leon Lederman and I received the Nobel Prize.

These are just two examples of Pontervo's insights and imagination; there are others. Modern particle physics, especially as it concerns neutrinos, owes a great deal to Bruno Pontecorvo.