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Beta decay is one of the important nuclear reactions in particle physics. Through this reaction, ${}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}X + e^{-}$, an unstable nuclei converts into a stable daughter nuclei by emitting a beta particle (e^{-}). Energy and momentum conservation required that all the energy of the reaction, determined by Q-value of the decay, should be associated to the emitted electron. On the contrary, the energy spectrum of the electrons was found to be continuous. This indicated that some part of total energy of the reaction was missing. In the year 1927 Charles Drummond and William Alfred Rooster performed an experiment using radioactive element radium E (bismuth-210). The observations drawn from this experiment confirmed this unstability in electron energy distribution and hinted at the prospect for development of new physics that could provide a better understanding of the same. This unsettled problem of missing energy got a possible breakthrough due to the genius of Wolfgang Pauli. According to a letter that he sent to his friends in the month of December 1930, Pauli mentioned that he believed there might be another particle being emitted along with electron in β-decay [?]. He went a little further, with some hesitation, that this particle must be electrically neutral and exhibit weak interactions. Also it became very difficult for theorist and experimentalists to detect these unknown mysterious particles because of its very small interactions via weak force. Enrico Fermi, another brilliant minds in physics, named this particle 'neutrino' at the Solvay conference in the year 1933. Based on the hypothesis of Pauli, Fermi developed a new theory of beta decay. This new theory elegently incorporated the problem of missing energy and provided a suitable explanation by associating this energy to neutrinos. As neutrino is an electrically neutral particle, it is immune to any kind of electromagnetic interactions. Also due to its very feeble weak interaction it becomes immensely difficult to detect these ghost particles. But situation changed during the second world war when a new dawn for neutrinos happened. At this time due to great advent in science, particularly in nuclear power, a large source of radioactive nuclei was available to the scientific community. This immense supply of radioactive nuclei, apart from its use in nuclear weapons, became a tremendous source for neutrinos and increased its number manifold.

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Theory and phenomenology of neutrino masses and mixing in the light of latest neutrino and cosmology data

by Jotin Gogoi

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