



Introduction to the Physics of Massive and Mixed Neutrinos (Lecture Notes in Physics)

Samoil Bilenky

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For many years neutrino was considered a massless particle. The theory of a two-component neutrino, which played a crucial role in the creation of the theory of the weak interaction, is based on the assumption that the neutrino mass is equal to zero. We now know that neutrinos have nonzero, small masses. In numerous experiments with solar, atmospheric, reactor and accelerator neutrinos a new phenomenon, neutrino oscillations, was observed. Neutrino oscillations (periodic transitions between different flavor neutrinos, ν_e, ν_μ, ν_τ) are possible only if neutrino e, μ, τ mass-squared differences are different from zero and small and flavor neutrinos are "mixed". The discovery of neutrino oscillations opened a new era in neutrino physics: an era of investigation of neutrino masses, mixing, magnetic moments and other neutrino properties. After the establishment of the Standard Model of the electroweak interaction at the end of the seventies, the discovery of neutrino masses was the most important discovery in particle physics. Small neutrino masses cannot be explained by the standard Higgs mechanism of mass generation. For their explanation a new mechanism is needed. Thus, small neutrino masses is the first signature in particle physics of a new beyond the Standard Model physics. It took many years of heroic efforts by many physicists to discover neutrino oscillations. After the first period of investigation of neutrino oscillations, many challenging problems remained unsolved. One of the most important is the problem of the nature of neutrinos with definite masses. Are they Dirac neutrinos possessing a conserved lepton number which distinguish neutrinos and antineutrinos or Majorana neutrinos with identical neutrinos and antineutrinos? Many experiments of the next generation and new neutrino facilities are now under preparation and investigation. There is no doubt that exciting results are ahead.

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