Self energy of the neutrino

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In recent years, there has been considerable effort to understand the neutrino oscillations and hence the mass of the neutrino. We define the wave vector of the wave which measures the probability of production of the neutrino in one flavour and observation in other flavour. We find that the self energy of the neutrino becomes a complex quantity, the real part of which contributes to the mass and the imaginary part gives the life time. When starting mass of the neutrino becomes zero, the entire mass arises from the self energy only. An estimate of the coupling constants shows that the scalar part is $10^{-3}$ times the vector part and the tensor part is $< 10^{-2}$ times the axial vector term. The first order calculation is sensitive up to 0.2 eV. The calculation of the matrix element of $d \rightarrow u e^- \bar{\nu}$ is limited to the first order so that the energy is a real quantity and hence the imaginary part has not been estimated. The Kamiokande limit on the mass difference of the neutrino between two states, i.e. the electron neutrino and the tau neutrino after propagating several kilometers is $< 0.06$ eV. The present day, theoretical estimates are sensitive up to $\sim 0.2$ eV. We discuss the mass of the neutrino arising from the self energy.

References