Non-standard neutrino oscillations

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02 December 2015

What is a neutrino?

An elementary particle, predicted by Wolfgang Pauli (1930) and detected by Clyde Cowan and Frederick Reines (1956).

- weakly interacting
- light: $\sum m_\nu \lesssim 0{,}2$ eV
- stable
- ultrarelativistic
- electrically neutral
- three flavours: ν_e, ν_μ, ν_τ
- spin-$\frac{1}{2}$ fermion

Fact #1

Neutrinos are massless in Standard Model

Fact #2

Neutrino oscillations $\Rightarrow$ $m_\nu > 0$

Neutrino oscillation (1998) indicates physics beyond the SM!

Solution: Non-Standard interactions

New physics responsible for neutrino masses and mixing may change the effects of matter on propagating neutrinos.

$\Rightarrow$ Long baseline neutrino experiment (DUNE, JUNO, INO, Hyper-Kamiokande...)

In low energy regime:

$$\mathcal{L}_{\text{NSI}} = -2\sqrt{2}G_F\varepsilon^{fC}_{\alpha\beta}(\overline{\nu}_\alpha\gamma^\mu P_L\nu_\beta)(\overline{f}\gamma^\mu P_C f)$$

$$H = \frac{1}{2E_\nu}\left\{U\begin{pmatrix} A(x) & 0 & 0 \\ 0 & \Delta m^2_{21} & 0 \\ 0 & 0 & \Delta m^2_{31}\end{pmatrix}U^\dagger + A(x)\epsilon^m\right\}$$

High energy regime: Seesaw, Triplet Higgs, Zee-Babu, Inverse Seesaw, GUT...

Discovery potential best with long baseline

Current experimental limit: $\lg|\epsilon^m_{e\mu}|, \lg|\epsilon^m_{e\mu}| <$ -0,48.