Neutrinophilic Higgs Doublet Models

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12 June 2017
Invisibles17 Workshop

In collaboration with Katri Huitu, Subhadeep Mondal and Santosh K. Rai.

Work in progress.

How do neutrinos acquire their mass?

Neutrino mass is not included in SM!

- Dirac neutrinos: assume weak neutrino Yukawa coupling ($y_\nu \lesssim 10^{-11}$) to SM Higgs.

$$m_\nu \propto y_\nu v$$

- Seesaw scenario: assume large new physics scale $M \gtrsim 10^{11}$ GeV.

$$m_\nu \propto \frac{y_\nu^2 v^2}{M}$$

- Third option: assume neutrino mass is generated by a *neutrinophilic* Higgs with small VEV $v_\nu \ll v$.

$$m_\nu \propto \frac{y_\nu^2 v_\nu^2}{M}$$

Field structure of ν2HDM

- We introduce an additional Higgs doublet H_ν and three right-handed neutrinos $N_{1,2,3}$.
- H_ν has the same gauge quantum numbers as the SM Higgs and N is a gauge singlet with respect to SM symmetries.
- How to prevent SM Higgs coupling to N_i and the new Higgs to charged leptons?
    - Introduce $\mathbb{Z}_2$ parity, where all SM fields are even and H_ν and N odd.
    - Introduce a global $U(1)_X$ symmetry, where H_ν and N carry a charge $X = 1$ and all SM particles are chargeless.