μ-problem and neutrino masses in supersymmetry

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Work in progress with:
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μ-problem

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$$W_{MSSM} = \mu H_u H_d + Y^u_{ij} Q_i U^c_j H_u + Y^d_{ij} Q_i D^c_j H_d + Y^e_{ij} L_i E^c_j H_d$$

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We should explain the origin of μ-term and soft terms in a single theory.

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$$W = \Lambda^2 S + W_{MSSM}, \quad K = S^\dagger S + \sum \Phi_i^\dagger \Phi_i$$

where S is a hidden sector field, Φ_i is any MSSM field and $\Lambda \sim 10^{10}$ GeV.

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The scalar potential in supergravity contains all soft terms with corresponding parameters as

$$m_{soft} \sim \frac{\Lambda^2 \langle S \rangle}{M_P^2} \sim \text{ TeV}, \quad \text{if } \langle S \rangle \sim M_P.$$

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To explain the μ-term, let us assume some symmetry group G. Let us assume G forbids the usual $H_u H_d$ term, but allows a term

$$W = \frac{X_1^2}{M_P} H_u H_d,$$

where X_1 is some other hidden sector field. If $\langle X_1 \rangle \sim \Lambda$, the above term gives a μ-paramter of order TeV.

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To achieve the required scalar vaccum expectation values (vev's), we may have to choose non-minimal Kahler potential.

$$\begin{aligned} W &= \Lambda^2 S + \cdots \,, \\ K &= S^\dagger S + X_1^\dagger X_1 + \left(a \frac{S}{M_P} S^\dagger S + b \frac{S}{M_P} X_1^\dagger X_1 + \cdots \right), \end{aligned}$$

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Since gravitational interactions do not respect global symmetries, we can choose a gauge

symmetry. The minimal choice for G is a U(1) gauge symmetry.

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Let us try to understand the neutrino masses with the known MSSM fields and hidden sector fields.

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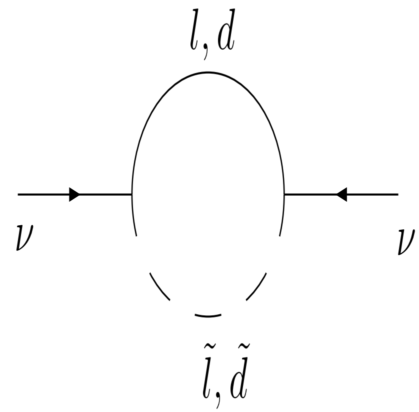
For $\langle X_2 \rangle \sim \Lambda$, we get $\frac{\langle X_2 \rangle^3}{M_P^2} \sim 10^{-4}$ GeV.

The remaining two terms λLLE^c and $\lambda' QlD^c$, generate neutrino masses at one-loop level.



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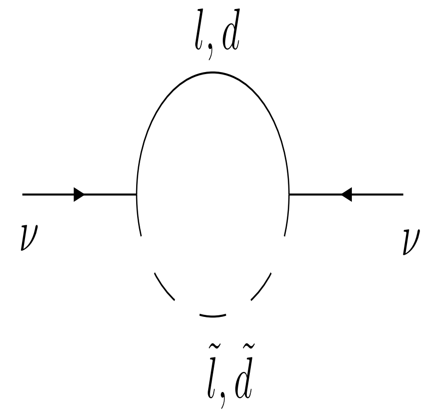

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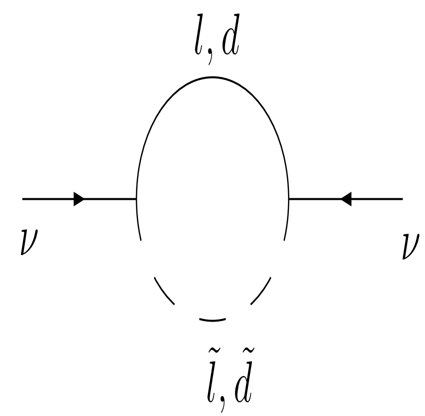

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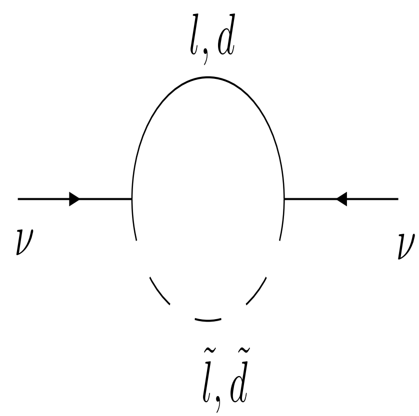

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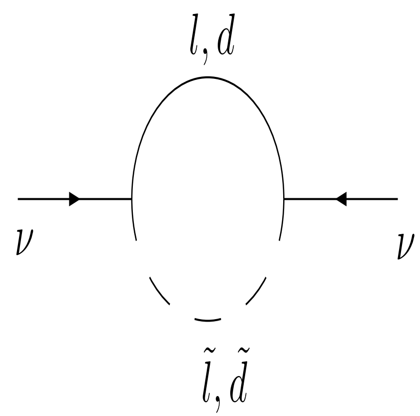

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We have $\frac{\langle Y_{1,2} \rangle}{M_P} \sim \frac{\Lambda}{M_P} \sim 10^{-7}$.

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$$F_{ab} = \frac{\delta_{ab}}{g_a^2} (1 + f \frac{S}{M_P})$$

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In our specific model with the help of additional U(1)$'$, we can forbid W_{BV} and W_5.

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Specifically, we need vector-like triplets and some additional hidden sector fields.

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- We are studying the physical implications of the additional fields that have been introduced to cancel the anomalies.