Decoupling of heavy sneutrinos in low-scale seesaw models

based on arXiv:1312.5318

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in collaboration with

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MEASUREMENT OF NEUTRINO MIXING:

- $m_\nu \neq 0 \;\Rightarrow\;$ calls for an extension of the SM
- lepton flavor is violated in the neutral sector

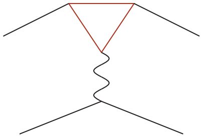
WHAT ABOUT CHARGED LEPTON FLAVOR VIOLATION?

- can arise at 1-loop
- examples: $\mu \to e\gamma$, $\mu \to 3e$, $\mu - e$ conversion in nuclei, ...
- can be especially large and low-scale seesaw models

SUPERSYMMETRY:

New sources of cLFV, especially by slepton mixing usually in supersymmetric models:

- γ penguin contributions dominate
- $\mu \to e\gamma$ most likely to observe



BUT [Hirsch,Vicente,Staub '12; Abada,Das,Vicente,Weiland '12]:
large enhancement of Z penguins in low-scale seesaw models:
$Z - \text{peng}/\gamma - \text{peng} \sim (M_{SUSY}/M_Z)^4$

more explicitly: minimal supersymmetric inverse seesaw model

$$W = W_{\mathrm{MSSM}} + Y_\nu \hat{\nu}^c \hat{L} \hat{H}_u + M_R \hat{\nu}^c \hat{N}_S + \frac{\mu_N}{2} \hat{N}_S \hat{N}_S$$

Using loop form factors of [Arganda,Herrero '05]:

$$\bar{\ell}_j \gamma_\mu \left(F_L P_L + F_R P_R \right) \ell_i Z^\mu \,,$$

$$F_L = \underbrace{-\frac{g}{128\pi^2 \cos\theta_W} \left(Y_\nu^\dagger Y_\nu \right)_{ij} \left(\cos^2\theta_W - \frac{1}{2} \right)}_{Z-\text{mediated } \tilde{\chi}^\pm - \tilde{\nu} \text{ contribution}}$$

$$+ \,[\text{mass} - \text{dependent}]$$

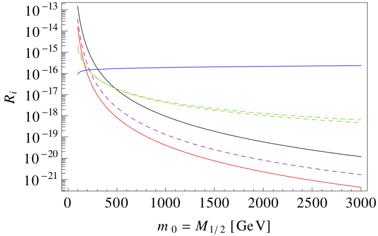
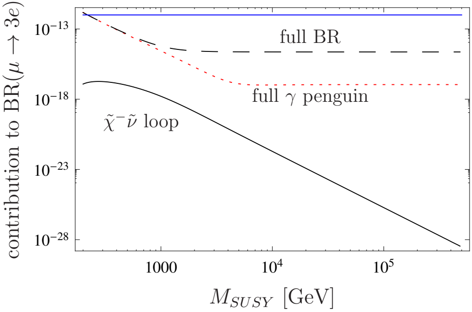


FIGURE: from [Abada,Das,Vicente,Weiland '12]

nondecoupling contribution stems from constant part in effective 1-loop $Z - \ell_i - \ell_j$ vertex (Wilson coefficient)!

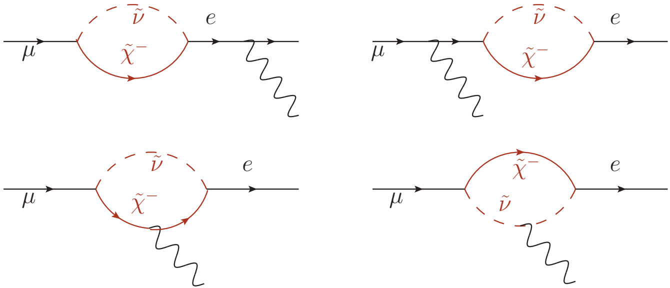
- constant nondecoupling term – no $1/\Lambda_{NP}$ suppression?
  $\Rightarrow$ critical look necessary
- recalculation: amplitude in [Arganda,Herrero '05] is wrong by a constant term
  [MEK,Porod,Staub,Abada,Vicente,Weiland '13]



Outlook

- ∃ differences in box form factors in the literature
- independent calculation of these operators + all still missing diagrams in a SUSY framework
  [Abada,MEK,Porod,Staub,Vicente,Weiland `arXiv:1407.XXXX`]
- calculating flavour observables made easy with `FlavorKit`
  [Porod,Staub,Vicente '14]

BACKUP SLIDES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SUSY algebra

$$\{Q_\alpha, Q_\beta\} = \{\bar{Q}_{\dot{\alpha}}, \bar{Q}_{\dot{\beta}}\} = 0$$
$$\{Q_\alpha, \bar{Q}_{\dot{\beta}}\} = 2\sigma^\mu_{\alpha\dot{\beta}} P_\mu$$
$$[P^\mu, Q_\alpha] = 0$$

Defining quantity of a SUSY model: Superpotential

$$W(\Phi) = \frac{1}{2} m_{ij} \Phi_i \Phi_j + \frac{1}{3} \lambda_{ijk} \Phi_i \Phi_j \Phi_k$$
$$W^i = \frac{\partial}{\partial \phi_i} W(\phi), \qquad W^{ij} = \frac{\partial^2}{\partial \phi_i \partial \phi_j} W(\phi)$$

such that

$$\mathscr{L}_{\text{chiral}} = \partial_\mu \phi_i^* \partial^\mu \phi_i + i\bar{\psi}_i \bar{\sigma}^\mu \partial_\mu \psi_i - \underbrace{\frac{1}{2}(W^{ij}\psi_i\psi_j + W^*_{ij}\bar{\psi}^i\bar{\psi}^j)}_{\text{fermion mass terms and Yukawa interactions}} - \underbrace{W^i W^*_i}_{\text{scalar potential}}$$