Radiative neutrino masses and dark matter

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Moriond (YSF), La Thuile, March 2015
The need for BSM

- Gravitation
- Dark energy
- Dark matter
- Neutrino masses
- ...
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The least-dimensional term that can generate Majorana neutrino masses after EWSB is the unique $d = 5$ Weinberg operator

$$\delta \mathcal{L} = \frac{1}{2} \frac{K_{\alpha \beta}}{\Lambda} (\bar{\mathcal{L}}_\alpha \tilde{\mathcal{H}}^*) (\tilde{\mathcal{H}}^\dagger L_\beta)$$
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- Loop realizations $\rightarrow$ radiative seesaw models
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- **Tree-level realizations** → seesaw models

- **Loop realizations** → radiative seesaw models
  - 1-loop realizations

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$^1$Classified by Bonnet et al., JHEP **1207**, 153 (2012).
The model

Particle content

\[ D = \begin{pmatrix} \psi \\ E \end{pmatrix} \sim (2, -\frac{1}{2}, -), \quad S \sim (1, 0, -), \quad \phi \sim (1, 0, -). \]
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After mixing

- Three Majorana fermions \( \chi_i \) from \( \psi, S \)
- One charged fermion \( E^{\pm} \)
Neutrino mass generation

\[ \mathcal{L} \supset \alpha \bar{\psi} \nu \phi + \beta \bar{\psi}^c h S + \frac{1}{2} m_S \bar{S}^c S \]
Dark matter
Dark matter and LFV
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Conclusions

- Minimal viable models for neutrino masses and dark matter are an interesting phenomenological possibility... 

- ...because of strong phenomenological constraints:
  - Neutrino masses and mixing angles
  - Dark matter constraints
  - Lepton flavor violation processes
  - Collider constraints
Thank you for your attention.