Radiative neutrino masses and dark matter

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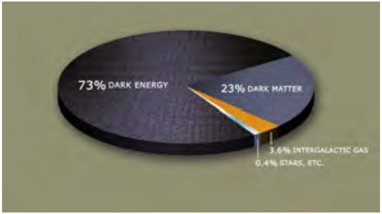
The need for BSM

- Gravitation
- Dark energy
- Dark matter
- Neutrino masses
- ...



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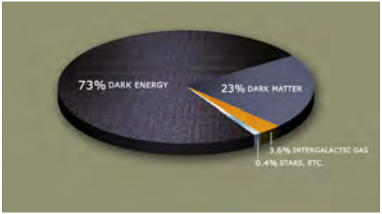

Neutrino masses

The least-dimensional term that can generate Majorana neutrino masses after EWSB is the unique $d = 5$ Weinberg operator

$$\delta\mathcal{L} = \frac{1}{2}\frac{K_{\alpha\beta}}{\Lambda}(\bar{L}_\alpha \tilde{H}^*)(\tilde{H}^\dagger L_\beta)$$

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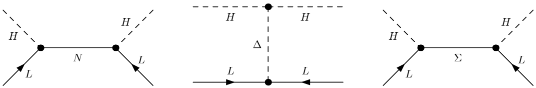
- Tree-level realizations $\rightarrow$ seesaw models



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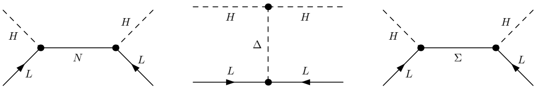

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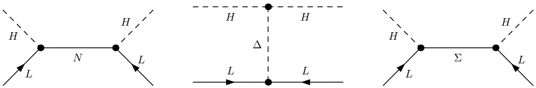

- Loop realizations $\rightarrow$ radiative seesaw models
  - 1-loop realizations[1]

[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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$$\mathcal{L} \supset \alpha \bar{D} L \phi + \beta \bar{D}^c \tilde{H} S - m_D \bar{D} D - \frac{1}{2} m_S \bar{S}^c S + \ldots$$

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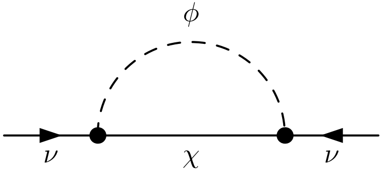
After mixing

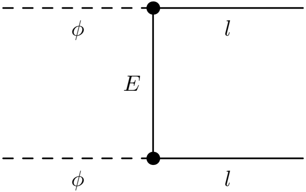
- Three Majorana fermions χ_i from ψ, S
- One charged fermion $E^{\pm}$

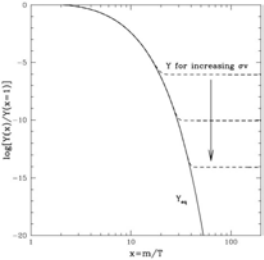
Neutrino mass generation



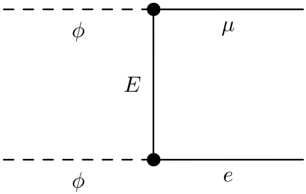
$$\mathcal{L} \supset \alpha\bar{\psi}\nu\phi + \beta\bar{\psi}^c hS + \frac{1}{2}m_S\bar{S}^c S$$

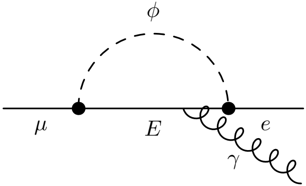
Dark matter





Dark matter and LFV





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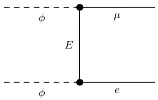

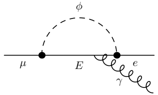

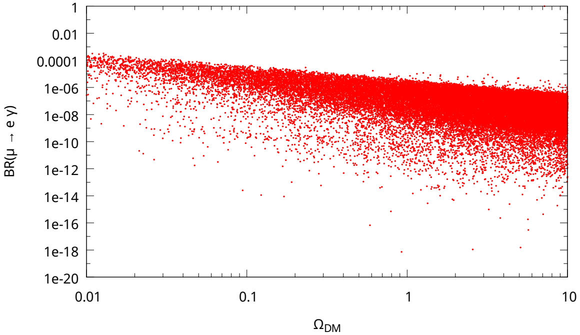

Conclusions

- 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.