Light scalars in the triplet seesaw model

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MEFT Boosting the Future

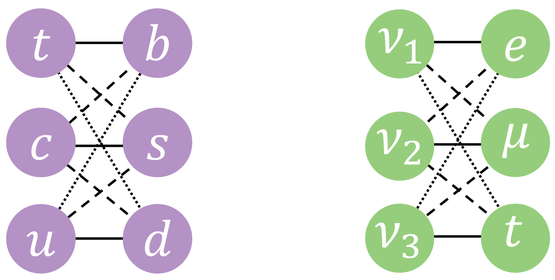
Open problems

Neutrino oscillations

- At least two neutrinos must be massive.
- Lepton mixing occurs.
- CP violation in the lepton sector?

Flavour puzzle

Why are there 3 generations of fermions, with their hierarchical masses and mixing patterns?



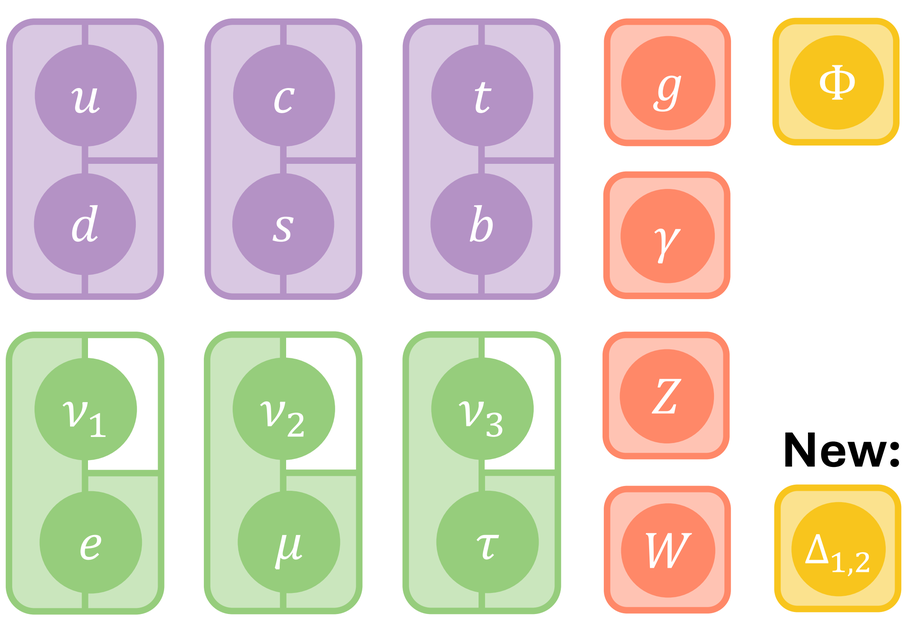
Baryon asymmetry

The Universe contains more matter than antimatter.

Dark matter

Galaxies contain more mass than can be accounted for by visible matter.

The two scalar triplet model



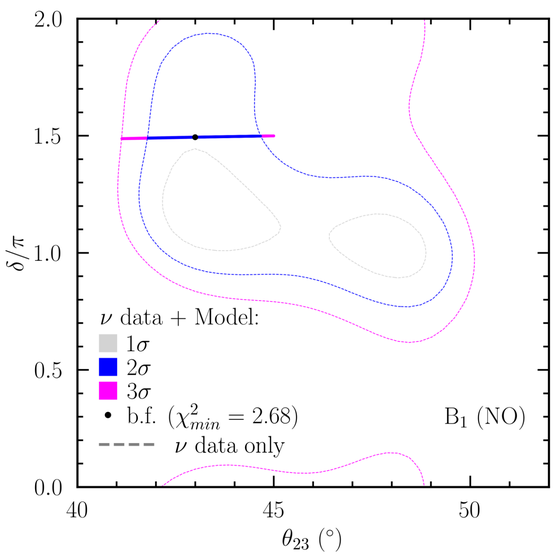
Generates small neutrino masses and enables CP violation in the lepton sector:

$$\mathbf{M}_\nu = \sqrt{2}\left(Y^{\Delta_1} u_1 e^{i\theta_1} + Y^{\Delta_2} u_2 e^{i\theta_2}\right)$$

The neutrino mass matrix accommodates texture zeros, imposed by a horizontal Abelian symmetry:

$$\mathrm{B}_1 : \mathbf{M}_\nu \sim \begin{pmatrix} \times & \times & 0 \\ \cdot & 0 & \times \\ 0 & \cdot & \times \end{pmatrix}, \quad \mathrm{B}_2 : \mathbf{M}_\nu \sim \begin{pmatrix} \times & 0 & \times \\ 0 & \times & \times \\ \cdot & \cdot & 0 \end{pmatrix}$$

Neutrino masses and mixing



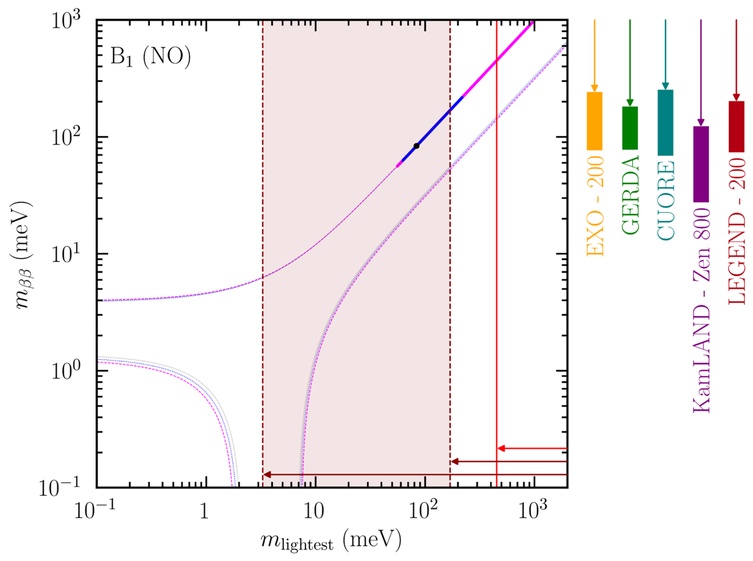
The textures lead to:

$$m_\nu \gtrsim 50\,\mathrm{meV}$$

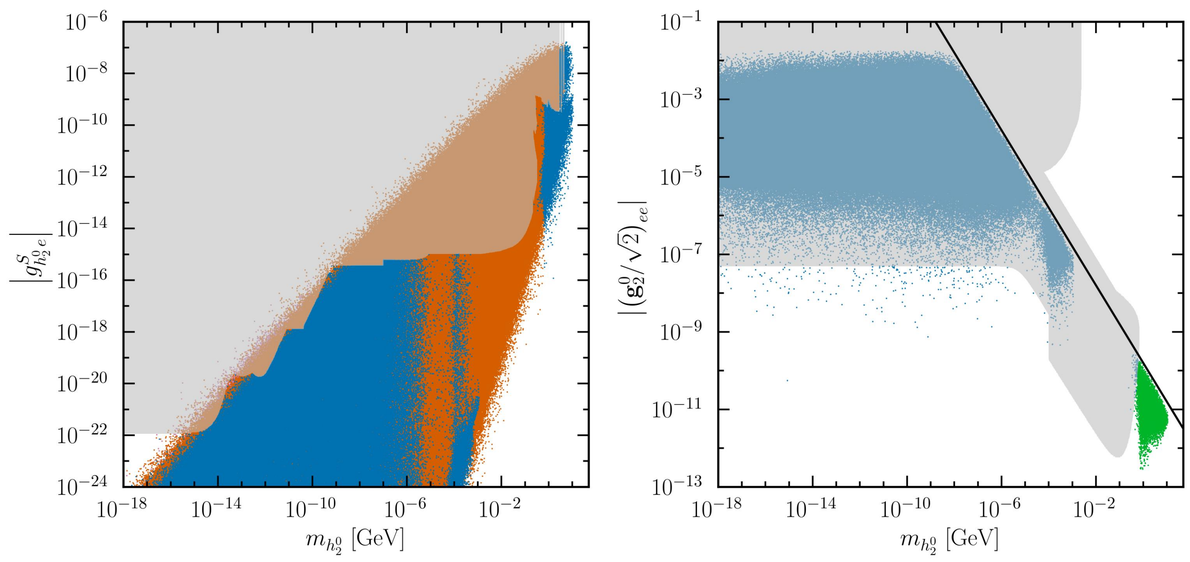
$$\delta \simeq 1.5\,\pi$$

$$\theta_1 - \theta_2 \simeq n\,\pi/3$$

$$m_{\beta\beta} \simeq m_{\mathrm{lightest}}$$



The 2STM predicts light scalars, but how light can they be?



We impose constraints from:

- Lepton universality
- cLFV decays
- Collider bounds
- Fifth-force tests
- Astrophysical data
- $\beta\beta$ decay experiments

Leading to:

$$\sqrt{u_1^2 + u_2^2} \gtrsim 0.4\,\mathrm{GeV} \qquad \text{and} \qquad m_{h^0_2} \gtrsim 0.4\,\mathrm{GeV}$$