

Higgs portal dark matter and neutrino mass and mixing with a doubly charged scalar

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Invisibles Workshop '16



Motivation

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Have a simple model that accounts for neutrino masses and dark matter.

We extend the SM by adding two new scalars

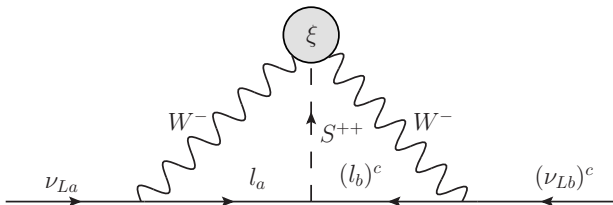
- Doubly charged scalar $S \implies$ neutrino masses.
- Singlet scalar $\phi \implies$ dark matter candidate.

Effective model with a doubly charged scalar

- From S.F. King et al, hep-ph/1406.4137:

$$\mathcal{L}_{SWW} = -\frac{g^2 \xi v^4}{4\Lambda^3} (S W^\mu W_\mu + h.c.)$$

$$\mathcal{L}_{Sll} = f_{ab} S^\dagger \bar{l}_a P_L l_b^c + h.c.$$



$$\mathcal{M}_\nu^{2\text{-loop}} = 2\xi f_{ab}(1 + \delta_{ab}) \frac{m_a m_b m_S^2}{\Lambda^3} \tilde{\mathcal{I}}(m_W, m_S, \mu)$$

Effective model with a doubly charged scalar

Constraints

- Neutrino masses and mixings
- Standard and non-standard contribution to $0\nu\beta\beta$
- Flavour violating leptonic processes.
- Dipole moments
- Leptonic radiative decays

Three benchmark scenarios

- 1 Benchmark Scenario A: $f_{ee} \simeq 0$ and $f_{e\tau} \simeq 0$.
- 2 Benchmark Scenario B: $f_{ee} \simeq 0$ and $f_{e\mu} \simeq -(f_{\mu\tau}^*/f_{\mu\mu}^*)f_{e\tau}$.
- 3 Benchmark Scenario C: $f_{e\mu} \simeq -(f_{\mu\tau}^*/f_{\mu\mu}^*)f_{e\tau}$.

Higgs portal DM with a doubly charged scalar

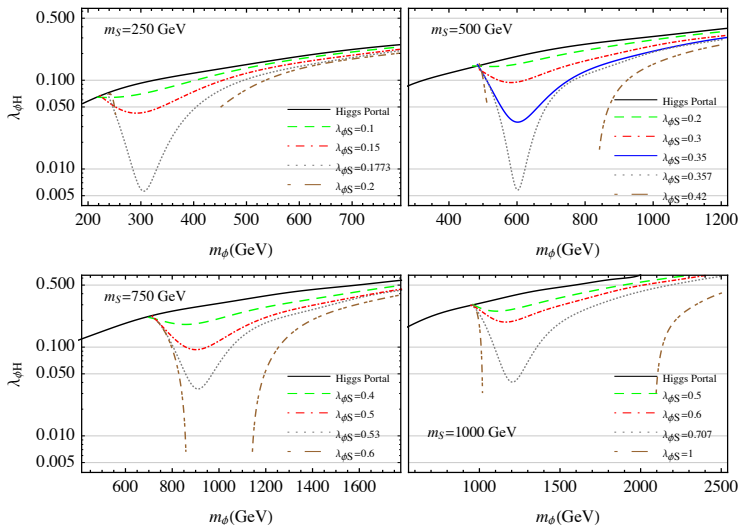
- \mathbb{Z}_2 symmetric scalar potential:

$$\begin{aligned}
 V(H, \phi, S) = & \mu^2 |H^\dagger H| + \lambda |H^\dagger H|^2 + \frac{1}{2} \mu_\phi^2 \phi^2 + \frac{1}{4} \lambda_\phi \phi^4 + \mu_S^2 S^\dagger S + \lambda_S (S^\dagger S)^2 + \\
 & + \frac{1}{2} \lambda_{\phi H} \phi^2 |H^\dagger H| + \lambda_{SH} (S^\dagger S) |H^\dagger H| + \frac{1}{2} \lambda_{\phi S} \phi^2 (S^\dagger S)
 \end{aligned}$$

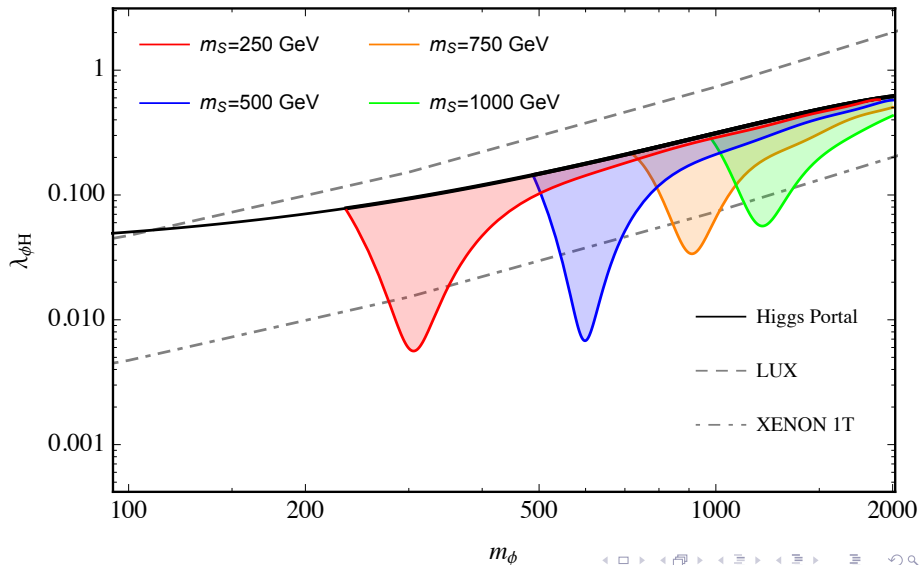
- Masses:

$$m_\phi^2 \equiv \mu_\phi^2 + \frac{1}{2} \lambda_{\phi H} v^2 \quad , \quad m_S^2 \equiv \mu_S^2 + \frac{1}{2} \lambda_{SH} v^2$$

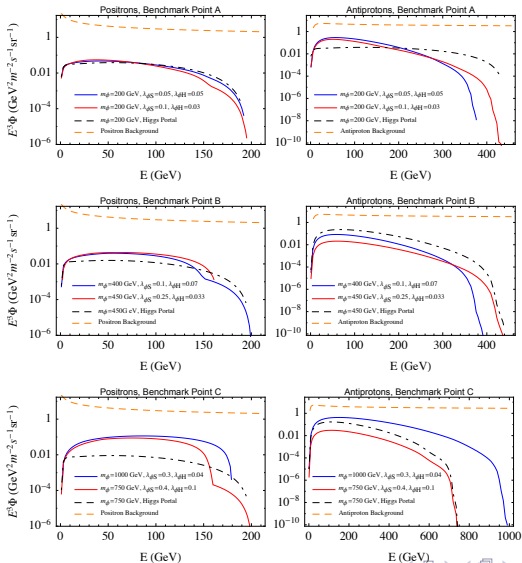
Relic abundance



Direct detection



Indirect detection



Thank you!

¡Muchas gracias!