

Probing the sterile neutrino portal to Dark Matter with γ rays

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Based on the paper:

Folgado, Gomez-Vargas, Rius and Ruiz de Austri (JCAP 1808 (2018) no.08, 002)

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Introduction

The current astrophysical experiments provide a new handle to test BSM physics:



- dwarf spheroidal galaxies (dSph).
- Galactic Center γ -ray excess.
- Antiprotons to protons ratio.
- Positrons to electrons ratio.

Could this be new DM signals?

Sterile neutrino portal: Set up of the model

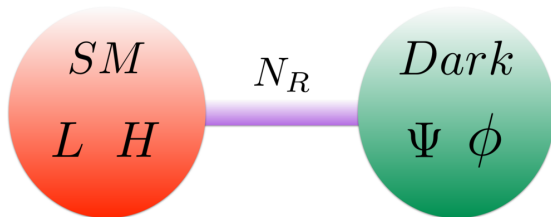


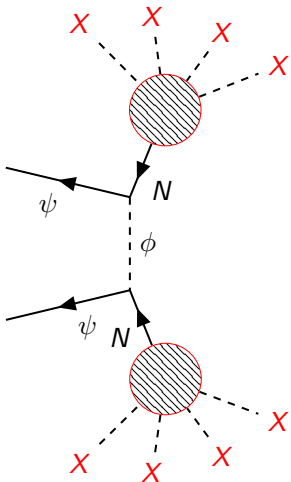
Figure: Escudero, Rius and Sanz (1607.02373)

$$\begin{aligned}
 \mathcal{L} = & \mu_H^2 H^\dagger H - \lambda_H (H^\dagger H)^2 - \mu_\phi^2 \phi^\dagger \phi - \lambda_\phi (\phi^\dagger \phi)^2 - \lambda_{H\phi} (H^\dagger H) (\phi^\dagger \phi) \\
 & - (\phi \bar{\Psi} (\lambda_a + \lambda_p \gamma_5) N + Y \bar{L}_L H N_R + \text{h.c.})
 \end{aligned}$$

- In this model we have two particles in the hidden sector: The fermionic DM and the scalar mediator that allow the DM annihilation to Sterile Neutrinos.
- The main feature of this model is that it connects the generation of neutrino masses and the DM.
- For any (M_ψ, M_N) in the ranges (1 - 3000) GeV we can always obtain the correct relic density using M_Φ and a perturbative coupling!!

$$\Omega h^2 \simeq \frac{10^{-37} \text{cm}^2}{\langle \sigma V \rangle} \longrightarrow \langle \sigma V \rangle \simeq 2.2 \times 10^{26} \text{cm}^3/\text{s}$$

Indirect signals

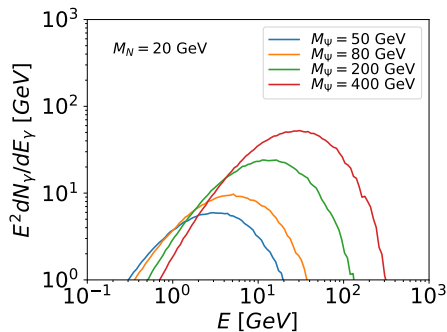
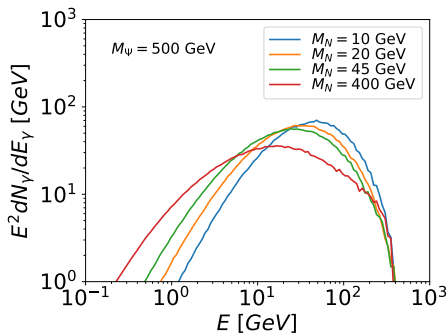


- After hadronization the final states of the process are:

$$X = \gamma, \bar{P}, e^+, \dots$$

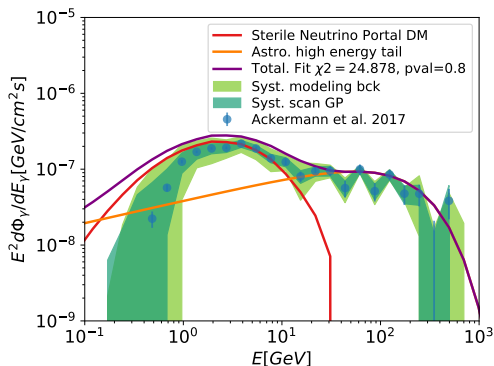
- How can we obtain this final spectra?
 - Sarah
 - SPheno
 - Madgraph
 - Pythia
 - MicrOMEGAs

γ -Spectrum of Neutrino Portal Model



- Variations in the DM and N masses induces changes in the form of the spectrum.

Can the model fit the GCE?



- Two sources for the GCE:

$$\Phi = \Phi_{astro} + \Phi_{DM}$$

- Best fit point (M_ψ , M_N):

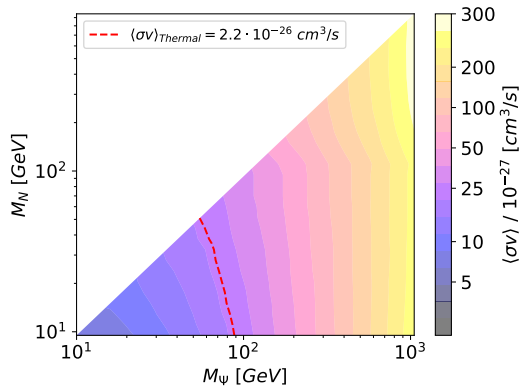
$$(55, 51) \text{ GeV}$$

- Very impressive p-value:

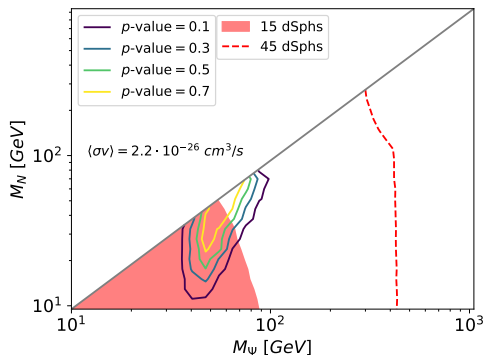
$$P - \text{value} \simeq 0.8 !!$$

Dwarf spheroidal galaxy (dSphs)

- The GCE is not the only constrain that we can use over the γ -rays.
- Not any excess detected in dSph by Fermi-LAT.

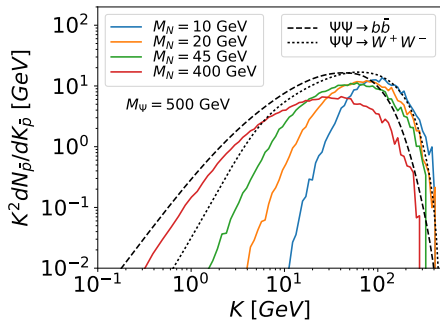
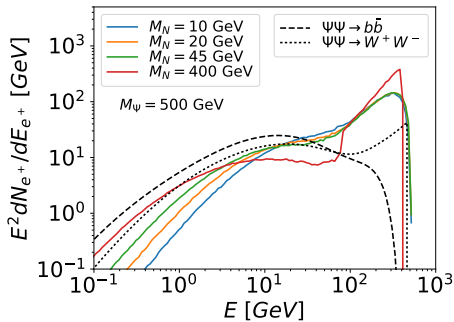


Is this new constraint compatible with the GCE fit?

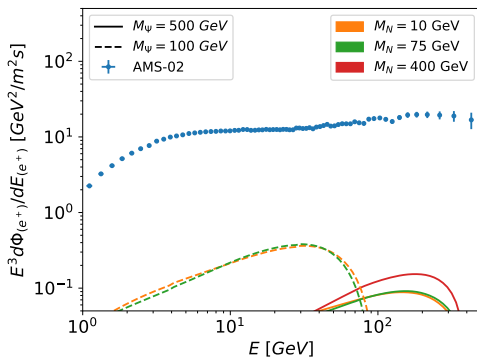


- The dSphs set an stringent limit which excludes DM masses below ~ 50 GeV for N masses near to 50 GeV (90 GeV for N masses near to 10 GeV).

e^+ and \bar{p} spectrum

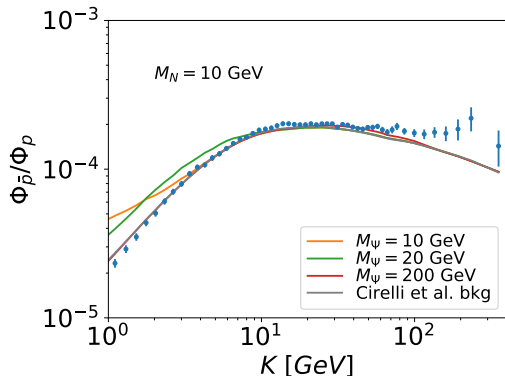


- The shape of the e^+ and \bar{p} spectra depends on the sterile neutrino and DM masses

About e^+ 

- e^+ flux well below AMS-02 data.

- This model can not account for the observed e^+ flux

And maybe... \bar{p} ?

- AMS-02 reports an anti-proton excess. There are many uncertainties in the propagation model, for this reason we have not fitted the excess.
- Even so, it provides a rough estimate of the constraint from \bar{p} .

Summary

Turning to the initial question:



- dwarf Spheroidal galaxies.
- Galactic Center γ -ray excess.
- Antiprotons.
- Positrons.

Can the model reconcile all of these measurements?

Summary

