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)

Invisibles 2018, Karlsruhe Institute of Technology (KIT)

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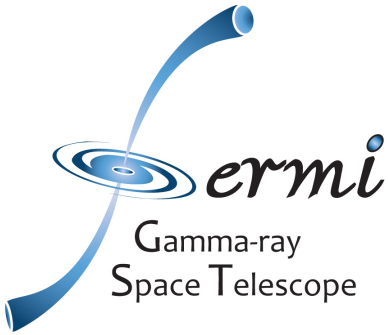
Introduction

The current astrophysical experiments provide a new handles 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

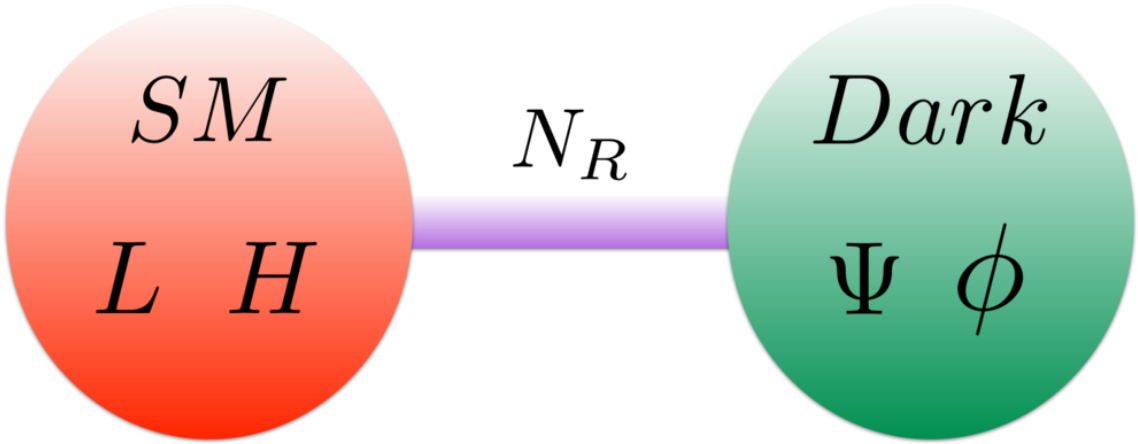


Figure: Escudero, Rius and Sanz (1607.02373)

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

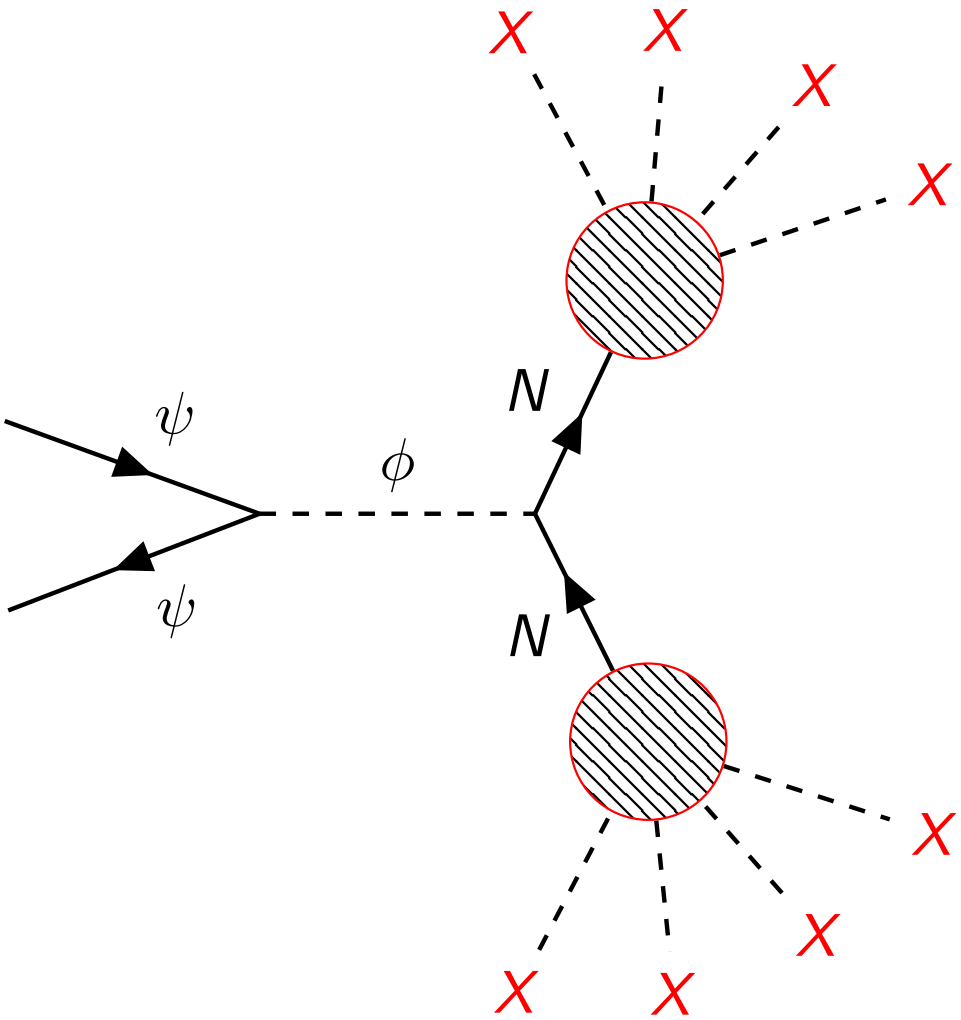
- In this model we have two particles in the hidden sector: The fermionic DM and the scalar mediator that allow the DM annihilation to Sterile Neutrinos.

- 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!!

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

Indirect signals

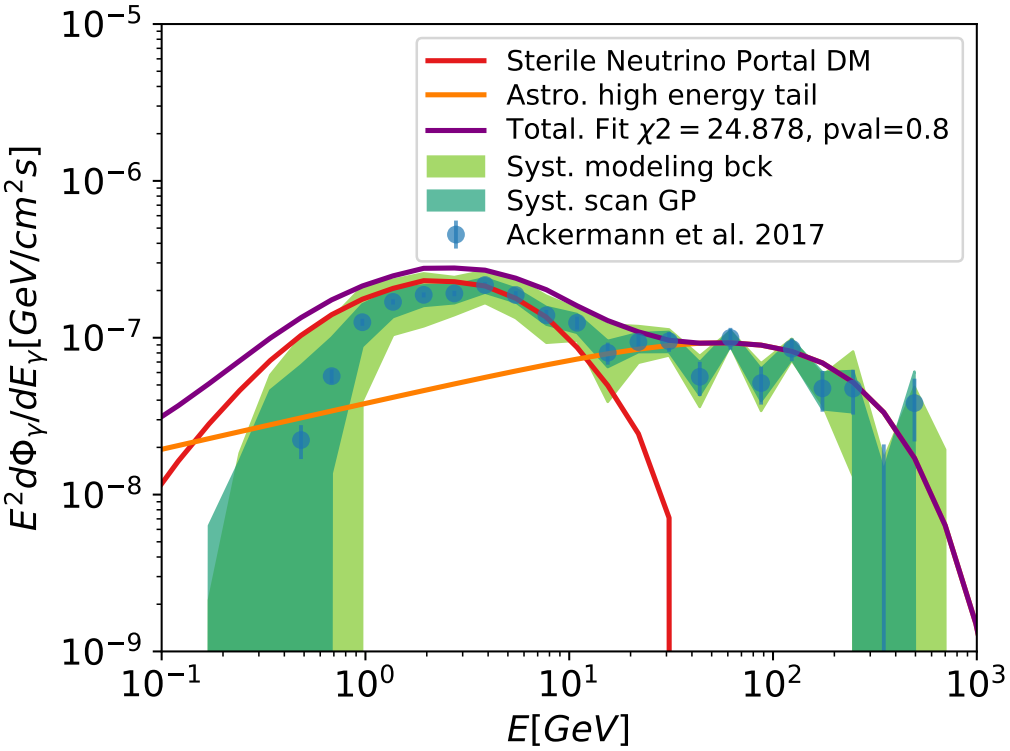


- After hadronization the final states of the process are:

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

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

Can the model fit the GCE?



- Two sources for the GCE:

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

- Best fit point $(M_\psi,\ M_N)$:

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

- Very impresive p-value:

$$P - value \simeq 0.8\ !!$$

Constrains from γ-ray and $\bar{p}$

γ-rays

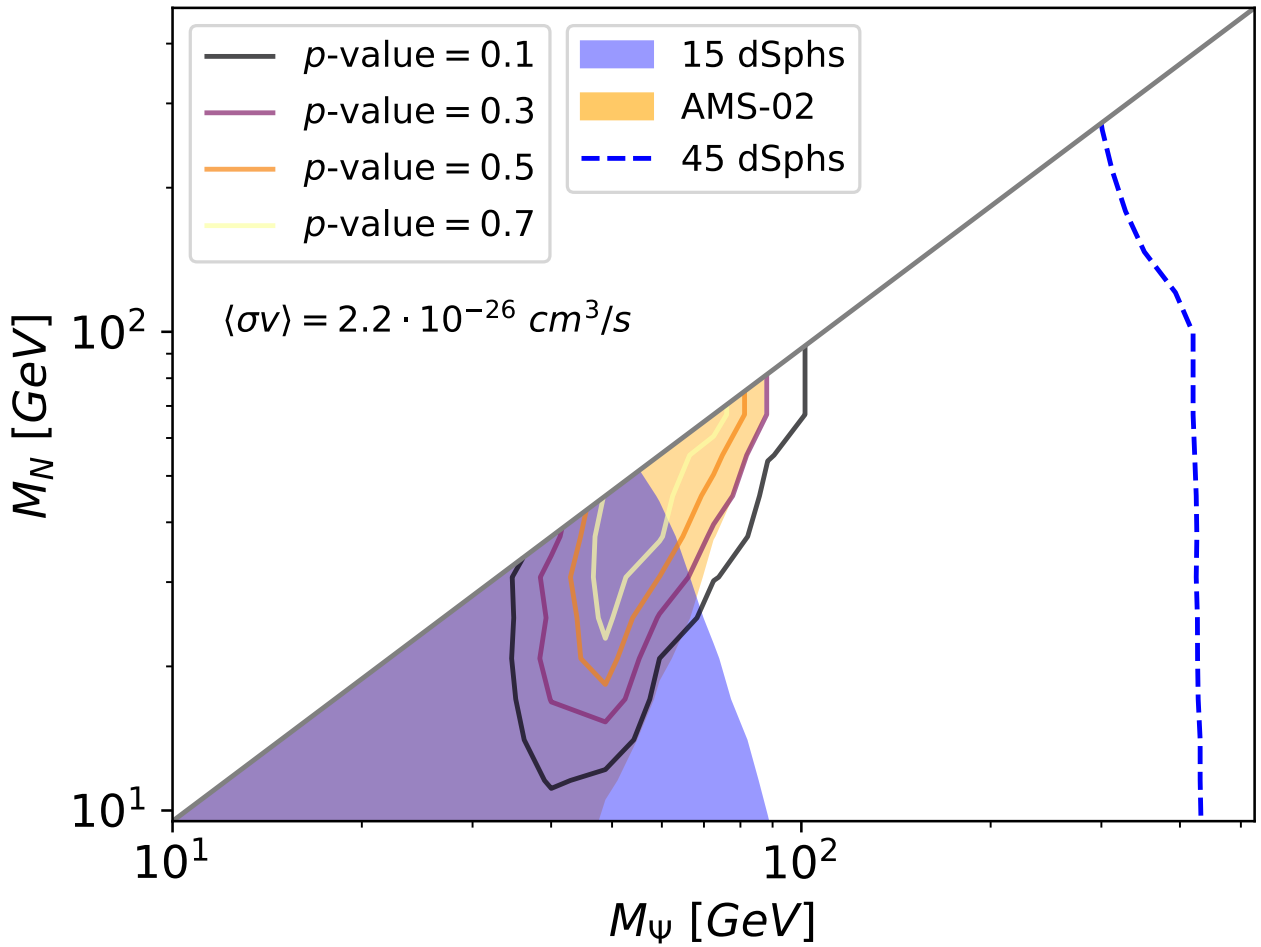
- Not any excess detected in dSph by Fermi-LAT.

$\bar{p}$

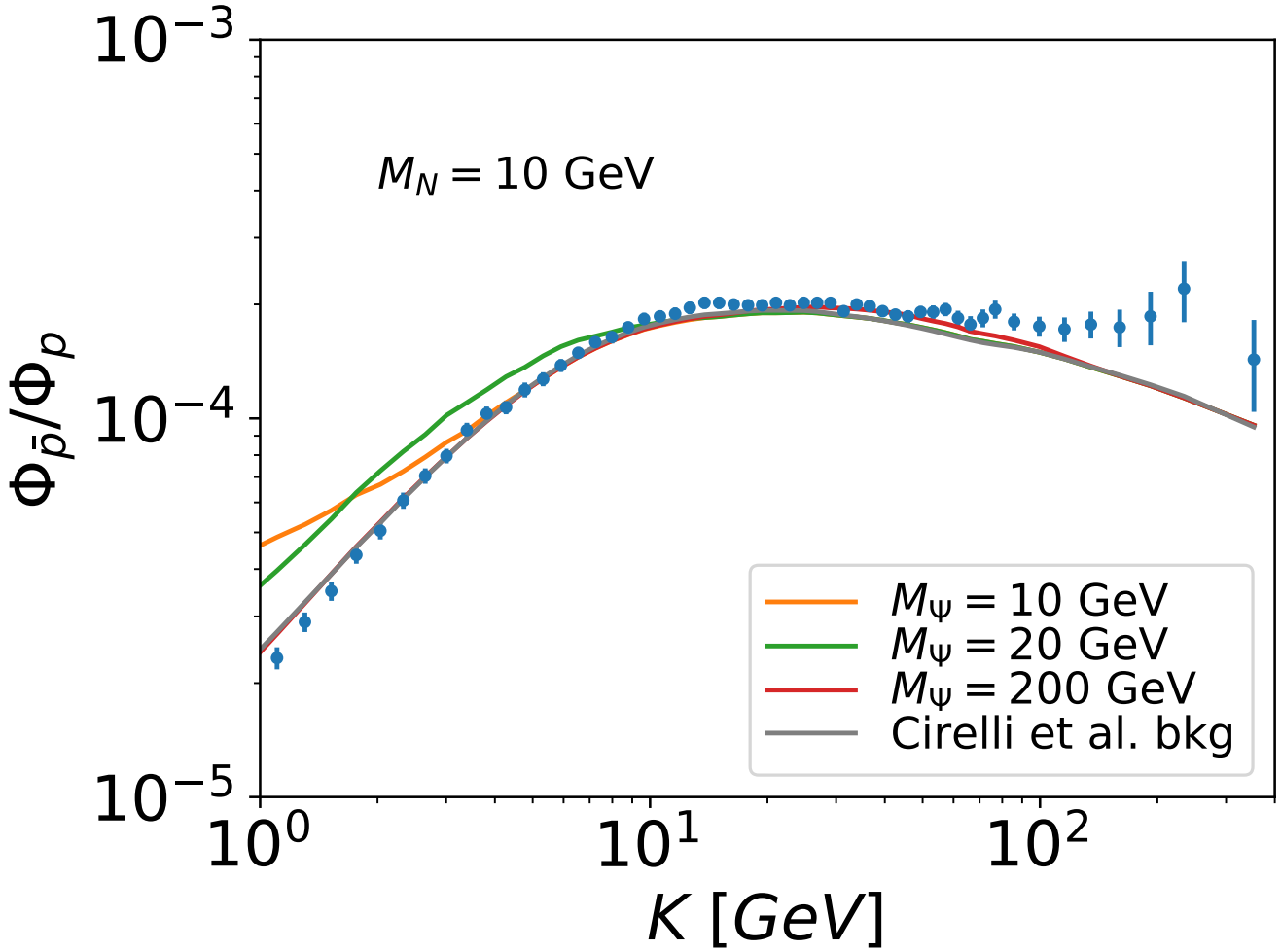
- AMS-02 reports an anti-proton excess. There are a lot of uncertainties in the propagation model, for this reason we have not fitted the excess.
- Even so, it provides a rough of the constrain from $\bar{p}$.

Can the model reconcile all of this measurements?

Summary


p-value = 0.1
p-value = 0.3
p-value = 0.5
p-value = 0.7
15 dSphs
AMS-02
45 dSphs
$\langle\sigma v\rangle = 2.2 \cdot 10^{-26}\ cm^3/s$
M_N [GeV]
M_Ψ [GeV]
10^1
10^2
10^1
10^2

Backup


10^{-3}
10^{-4}
10^{-5}
$\Phi_{\bar{p}}/\Phi_p$
$M_N = 10$ GeV
$M_\Psi = 10$ GeV
$M_\Psi = 20$ GeV
$M_\Psi = 200$ GeV
Cirelli et al. bkg
10^0
10^1
10^2
$K\ [GeV]$