Asymmetric Dark Matter and an Anti-ν signal

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A Rigid “New Physics”
Is WIMP sufficient?

• New physics must be at $O(\nu)$!

• Can we sincerely believe it?
Asymmetric DM (ADM)

\[ \rho_{DM} \sim 5 \rho_{baryon} \]

Can we use any symmetry?

DM with \( B - L \)
Basic properties of ADM

- Mass around GeV
- B-L sharing with the SM

\[ \Delta \mathcal{L}_{\text{ADM}} \sim \frac{\mathcal{O}_{\text{ADM}}^n \mathcal{O}_{\text{SM}}^m}{\Lambda_{\text{ADM}}^{n+m-4}} \]

- Conserving the total B-L
- SM singlet

\[ \cdots \text{Not constraining at all} \]
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<tr>
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<th>ADM</th>
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<td>(1-10) GeV</td>
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Assumption

• Use chem. equilibrium to share B-L
  • $n_B \sim n_{DM}$ w/o tuning
What can be signal?

- Let’s try!

$$\Delta L_{ADM} \sim \frac{\mathcal{O}^n_{ADM} \mathcal{O}^m_{SM}}{\Lambda_{ADM}^{n+m-4}}$$

- $\nu$ signal at indirect detection
neutrino and ADM

• Decay or scattering always lead (anti)neutrino signal!

\[ \Delta \mathcal{L}_{\text{ADM}} \sim \frac{\mathcal{O}_{\text{ADM}}^n \mathcal{O}_{\text{SM}}^m}{\Lambda_{\text{ADM}}^{n+m-4}} \]

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<th>e</th>
<th>p</th>
<th>( \nu )</th>
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<tr>
<td>B-L</td>
<td>-1</td>
<td>1</td>
<td>-1</td>
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<tr>
<td>( Q_{\text{EM}} )</td>
<td>-1</td>
<td>1</td>
<td>0</td>
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\( Q_{\text{EM}} = 0 \) and \( B-L \neq 0 \) ⇒ only \( \nu \)
Particle or Antiparticle?

• Is signal $\nu$ or anti-$\nu$?

• Is $(B-L)_{\text{ADM}}$ positive or negative?

• This seems to depend on $\Delta L_{\text{ADM}}$

Balancing chem. pot. $\mu$ $\rightarrow$ Particle densities
Earlier study

• DM mass is independent of $\Delta \mathcal{L}_{ADM}$
  • with a DM-only hidden sector

Ibe, Matsumoto and Yanagida 2012

$$m \sim \frac{5.1}{Q_{DM}} \text{GeV}$$

• $(B-L)_{ADM}$ is positive

• Complicated hidden sectors?
Symmetry and charge

- No relation depends on $\Delta L_{\text{ADM}}$
- $n_{\text{particle}}$ can be written in $n_{\text{charge}}$
Then⋯?

- \((B-L)_{ADM}\) is always positive
- **Always anti-\(\nu\) signal!**
  - Indirect detection is possible
Summary

• ADM is a hopeful DM model
• We predict a generic signal
  • Anti-$\nu$ signal is important
  • Hyper-K, INO, ⋅⋅⋅ etc.