ANTIMATTER FROM

SUPERSYMMETRIC

DARK MATTER

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Looking for supersymmetric (≡ neutralino) dark matter in galactic cosmic rays ...

I will discuss:

- $\tilde{\nu}$'s from neutralino ($\equiv \chi$) annihilation
- $\tilde{\nu}$'s galactic background
- $\chi$ signature in $\tilde{\nu}$'s cosmic rays
- looking for $\tilde{\nu}$'s by AMS/ISS
- conclusions
\[ \mathcal{Q}^\text{susy}_{\overline{p}}(T_{\overline{p}}) = \frac{dS(T_{\overline{p}})}{dT_{\overline{p}}} = \langle \sigma_{\text{ann}} \nu \rangle g(T_{\overline{p}}) \left( \frac{p_X}{m_X} \right)^2 \]

**Differential rate for \( \overline{p} \)'s production from \( X \times X \) annihilation.**

\[ \sigma_{\text{ann}} = \text{annihilation cross function} \]
\[ \nu = X \text{-velocity} \]
\[ m_X = X \text{-mass} \]
\[ p_X = X \text{ mass distribution function in the galactic halo} \]

\[ g(T_{\overline{p}}) = \frac{1}{\sigma_{\text{ann}}} \frac{d\sigma_{\text{ann}}(XX \rightarrow \overline{p} + X)}{dT_{\overline{p}}} = \sum_{\text{final states}} B_{Xh}^{(F)} \frac{dN_{\overline{p}}^h}{dT_{\overline{p}}} \]

\( F \) = final states
\[ B_{Xh}^{(F)} = \text{branching ratio into quark, or gluons } h \text{ in the channel } F \]

\[ \frac{dN_{\overline{p}}^h}{dT_{\overline{p}}} = \text{differential energy distribution of } \overline{p} \text{'s from hadronization} \]

**Low-energy \( \overline{p} \)'s:** \( T_{\overline{p}} \leq GeV \)
Antinuclei are produced as secondaries in scatterings between incoming cosmic-ray particles and the interstellar medium (ISM).

$\phi$'s of supersymmetric origin should be abundant at low-energies ($T_\phi \leq 1 \text{ GeV}$).

Indeed, it has recently been pointed out that the low-energy secondary $\phi$ spectrum is flatter than previously estimated.\(^{(1)}\)

Disentangling a supersymmetric component from the spallation $\phi$ background might be a very hard task.

\(^{(1)}\) H. Dobrescu, J. O., I. Fornengo, P. Salati, ARD(1998)123503


UNCERTAINTIES AFFECTING THE SECONDARY $\bar{\beta}$ SPECTRUM.

- primary proton spectrum
  Using data on the e p spectra from 5 experiments, this uncertainty can be cast at a level of ~ 10% (D. Maurin, F. B., P. Sabati, R. Bajlet, in preparation)

- nuclear processes in (C2) $\bar{\beta}$/(ISM) He scatterings

- diffusive reacceleration

- diffusion model

- solar modulation

LOT OF WORK IN PROGRESS!!
very preliminary!

\[ \Phi_p \] (m^{-2} s^{-1} sr^{-1} GeV^{-1})

\[ T_p \] (GeV/n)

uncertainty due to primary protons:

\sim 10\%
ANTIMATTERS: a new signature in indirect neutrino dark matter searches.

F. O., F. Fournget, P. Salati


In order for fusion to take place, the 2 antinuclei must be at rest:

• Kinematics of spallation reactions prevents the production of very low-energy particles
  ⇒ low-energy secondary $\bar{\Omega}$ spectrum is strongly depleted

• $X\bar{X}$ annihilate almost at rest and the ensuing $\bar{\Omega}$'s are produced at low energies.
  ⇒ low-energy supersymmetric $\bar{\Omega}$ spectrum is fairly flat

The low-energy suppression of spallation $\bar{\Omega}$'s with respect to the primary component is much more effective than for $\bar{\Omega}$'s.
Solar modulation of the secondary $\bar{D}$ flux
(obtained from the median proton flux).

$\Delta_{\text{max}} = 800 \text{ MV}$
$\Delta_{\text{min}} = 320 \text{ MV}$
\[ N_\delta = \int A(p_\delta^\circ) \Phi_\delta^\circ dT_\delta^\circ \]

\[ A(p_\delta^\circ) = \text{AMS/ISSA acceptance (takes into account geometrical acceptance, efficiencies, flying time, geomagnetic cut-off)} \]

\begin{tabular}{|c|c|}
\hline
& 0.1+100 GeV/n & 0.1÷3 GeV/n \\
\hline
\text{Solar Maximum} & 12.2 & 0.6 \\
\hline
\text{Solar Minimum} & 13.4 & 0.8 \\
\hline
\end{tabular}

A DOZEN spallation antideuterons should be detected by the future AMS experiment on board ISSA above few GeV/n.
NUMBER OF ANTIDEUTERONS $N_D$ WHICH AMS ON BOARD ISSA CAN COLLECT OVER THE RANGE OF IS ENERGIES EXTENDING FROM 0.1 UP TO 3 GEV/n. MODULATION AT SOLAR MAXIMUM

F. Donato, N. Fornengo, P. Salati (1999)
$D_{\text{AMS/ISSA}}$
(at solar maximum)

$N_B ((0.1 - 3) \text{ GeV/n})$

$\Phi_\overline{p} (T_\overline{p} = 0.24 \text{ GeV}) \quad (m^{-2} s^{-1} sr^{-1} GeV^{-1})$

BESS 95-97
(at solar minimum)

\overline{p}
Conclusions.

Disentangling a supersymmetric contribution from secondary galactic cosmic-ray $\bar{\nu}$’s may turn out to be a difficult task.

A more encouraging chance may be given by $\bar{\nu}$’s at low energy.

For $T(GeV/nucl) \leq 2.3$ GeV, the primary/secondary ratio much greater for $\bar{\nu}$’s than for $\bar{\nu}$’s.

The discovery of a few low-energy $\bar{\nu}$’s - by AMS/ISS - should seriously considered as a clue for the existence of neutralino dark matter in the Milky Way.