# Cosmic Ray Signatures from Decaying Gravitino Dark Matter

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# Outline

# The Standard Dark Matter Particle — the WIMP

- Mass $O(100)$ GeV
- Thermally produced in early universe.
- Annihilates to SM particles with $\langle \sigma v \rangle = O(10^{-26})$ cm$^3$s$^{-1}$.
- Potentially detectable in Direct Detection experiments.

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Stable Gravitino Dark Matter.

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- A $\mathbb{Z}_2$ symmetry stabilizes the WIMP.
- R-Parity, KK-Parity, etc.
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Minimal Dark Matter, Gravitino.

# R-Parity Violating SUSY and Dark Matter

- In SUSY models with trilinear R-Parity Violating terms;

$$\lambda_{ijk} L_i L_j \bar{E}_k + \lambda'_{ijk} L_i Q_j \bar{D}_k + \lambda''_{ijk} \bar{U}_i \bar{D}_j \bar{D}_k,$$

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# The PAMELA and Fermi/LAT Anomalies

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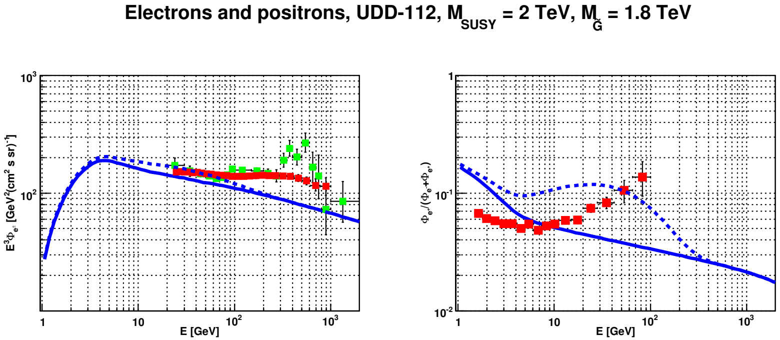

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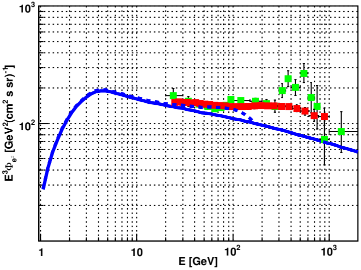
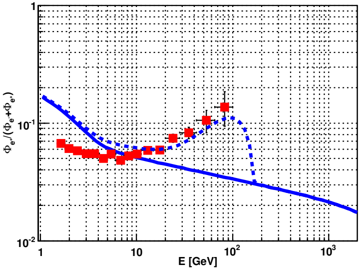
**Electrons and positrons, LQD-122, $M_{SUSY}$ = 1 TeV, $M_{\tilde{G}}$ = 320 GeV**



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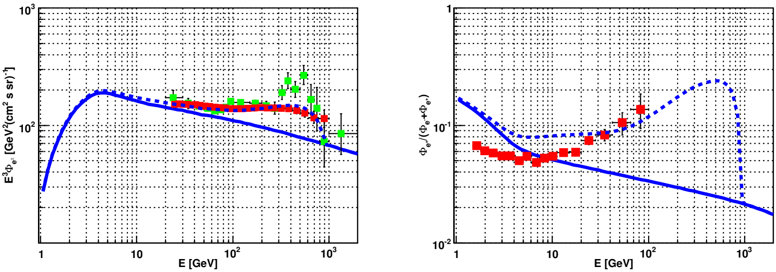

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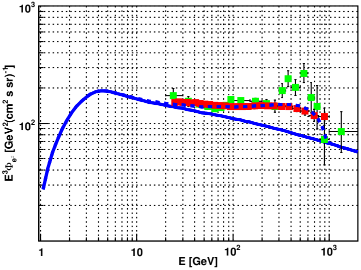


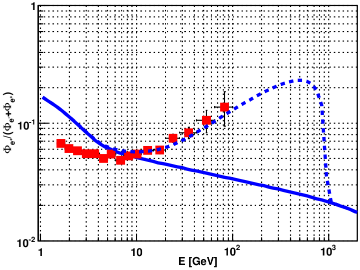

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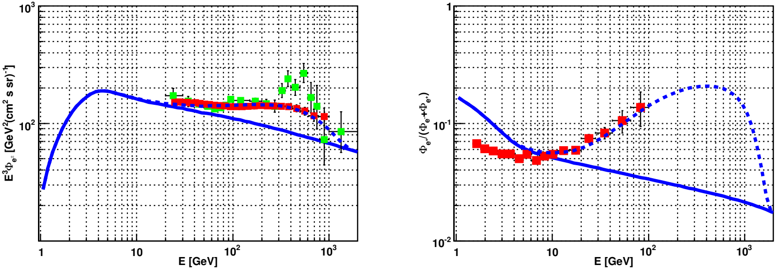
**Electrons and positrons, LLE-233, $M_{SUSY}$ = 6 TeV, $M_{\tilde{G}}$ = 3.7 TeV**



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|---|---|---|---|
| 121 | excluded | excluded | – |
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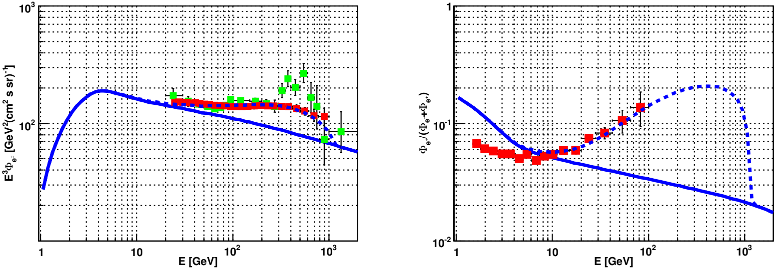

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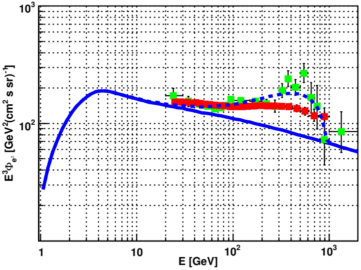


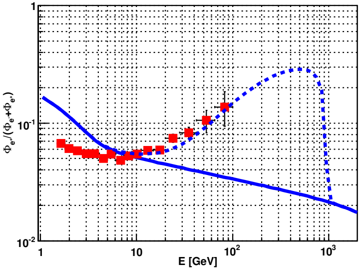

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# Constraints from the PAMELA $\bar{p}$ data

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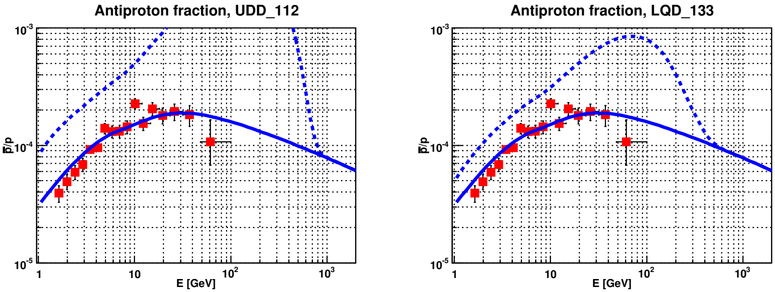
**Antiprotons, UDD-112, LQD-133**



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At least before Fermi/LAT has spoken about $\gamma$-Rays

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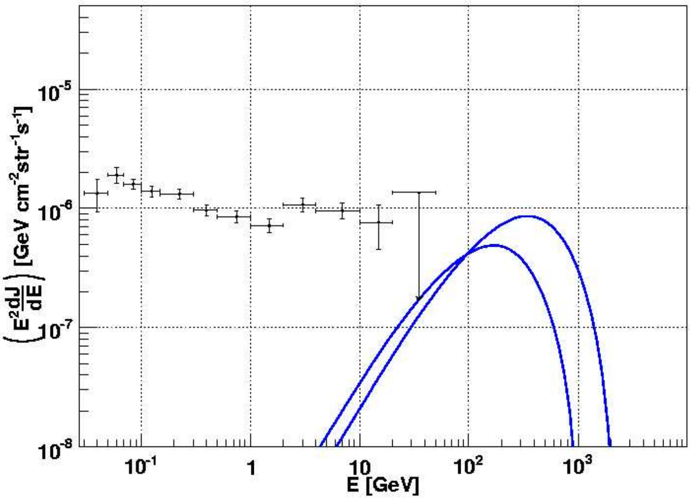
# Gamma Ray Signals for Fermi/LAT



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# What can the LHC see?

- Neutralinos decay inside detector if $\lambda \gtrsim 10^{-6}$.
  $\rightarrow$ We need $\lambda \approx 10^{-9} - 10^{-10}$.
- A stau NLSP could decay faster through two-body decay.
  $\rightarrow \tau$ rich operators are favoured by the data.
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