

R-violating gravitinos: Cosmological implications (and LHC phenomenology)

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February 04, 2009/ ENTApP DARK MATTER workshop
2008, CERN



Outline

Introduction

Gravitino Decay

Gamma Rays from Gravitino Decay
Constraints on RPV Operators
Antimatter

Summary



Introduction

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

- ▶ If R-Parity is violated, the **gravitino** is one of few **SUSY dark matter** candidates.
- ▶ The phenomenology depends strongly on which R-violating operators we have.
- ▶ We want to investigate how the phenomenology depends on the scenario and how the **flavour structure** of the R-violating operators can be determined.



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- ▶ Halo contribution
- ▶ Extragalactic, redshifted contribution
- ▶ Smeared to resemble 15% energy resolution
- ▶ Compared to EGRET data



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- ▶ NFW profile:

$$\rho_{\text{Halo}}(r) = \frac{\rho_h}{r/r_C(1+r/r_C)^2}$$

$$r_C = 20 \text{ kpc}$$

$$\rho_h = 0.33 \text{ GeV cm}^{-3}$$

- ▶ Averaged excluding disc:
 $|b| > 10^\circ$



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Procedures for Calculating γ -Ray Flux

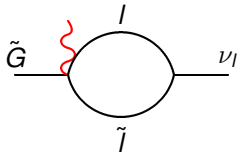
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$$E^2 \frac{dJ}{dE} = 1.37 \times 10^{-6} \left(\frac{E}{1\text{GeV}} \right)^{-0.1} \frac{\text{GeV}}{\text{str s cm}^2}$$

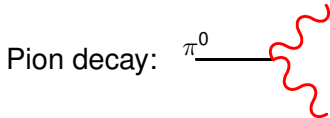
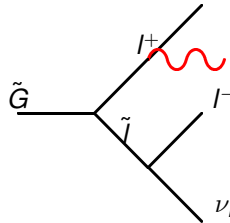


High Energy Gamma Rays from Decaying Gravitinos

Monochromatic line.



Internal bremsstrahlung off leptons.

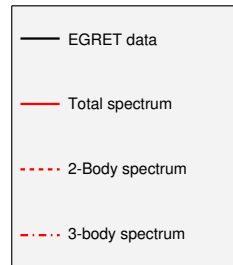
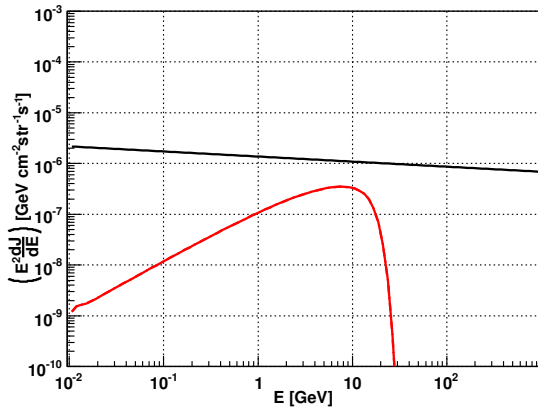


For Bilinear RPV see:
 A. Ibarra and D. Tran
 [arxiv:0709.4593]



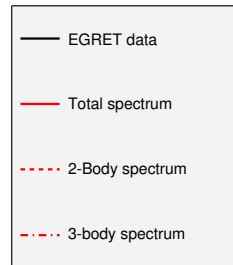
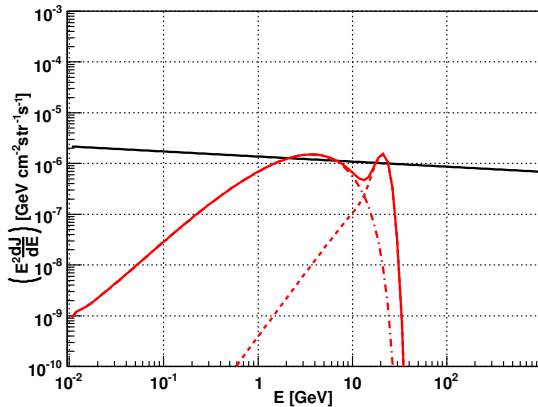
Typical γ -Ray Spectra from Gravitino Decay

Photon energy spectra, 040eq200LLE_121



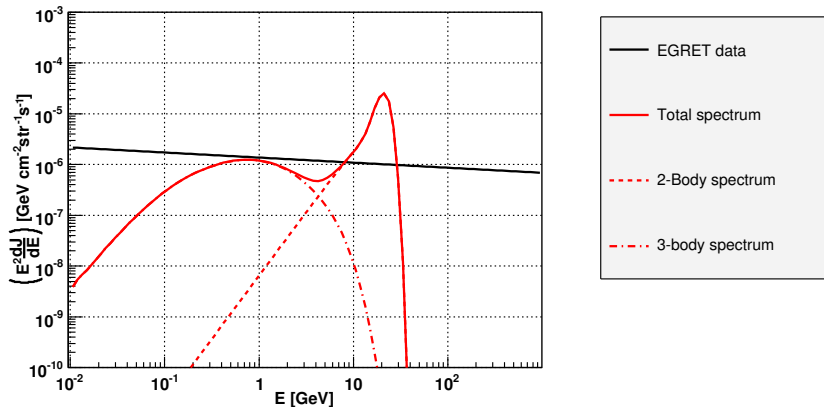
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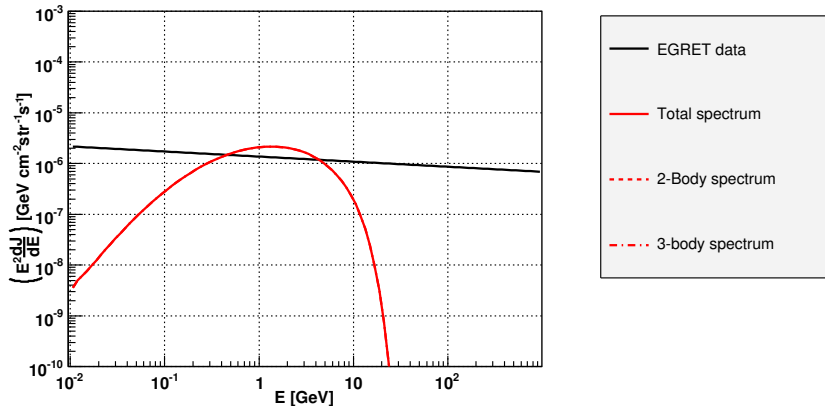
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Typical γ -Ray Spectra from Gravitino Decay

Photon energy spectra, 040eq200UDD_112



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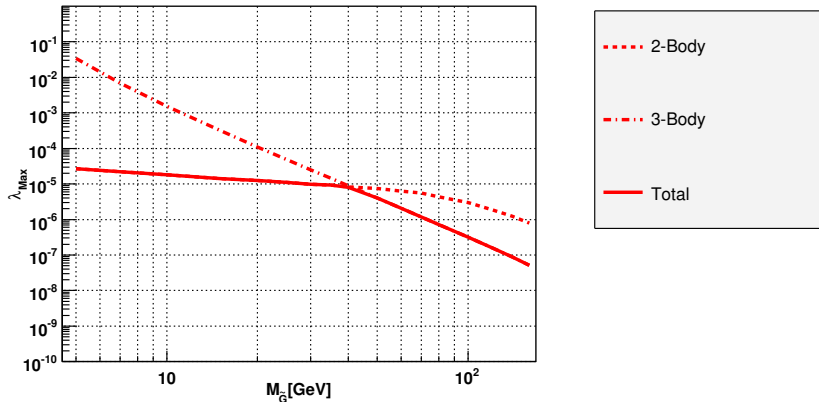
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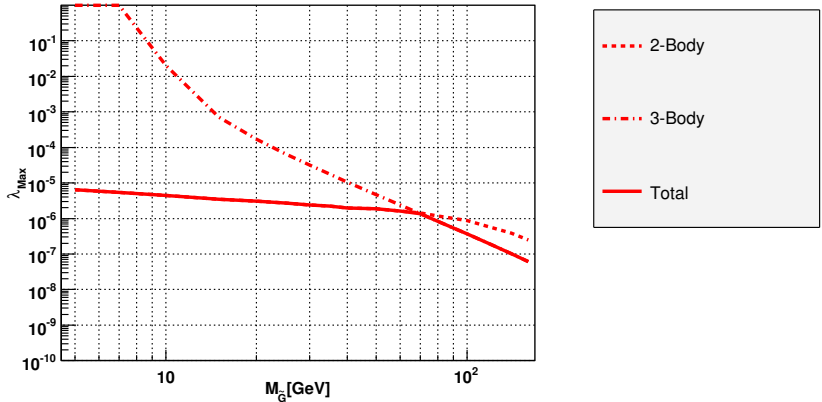
λ_{max} Plots

eq200LLE_133



λ_{max} Plots

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λ_{max} Plots

$$\Gamma_{2\text{-body}} \propto m_{\tilde{G}}, \quad \Gamma_{3\text{-body}} \propto m_{\tilde{G}}^7$$
$$N \propto m_{\tilde{G}}^{-1}, \quad Flux \propto E(\propto m_{\tilde{G}}) N \Gamma$$

$$\lambda_{max} \propto \sqrt{\frac{Flux_{EGRET}(\propto m_{\tilde{G}}^{-0.1})}{Flux_{gravitino\ decay}}}$$

$$\lambda_{max}(2\text{-body}) \propto m_{\tilde{G}}^{-0.55}, \quad \lambda_{max}(3\text{-body}) \propto m_{\tilde{G}}^{-3.55}$$



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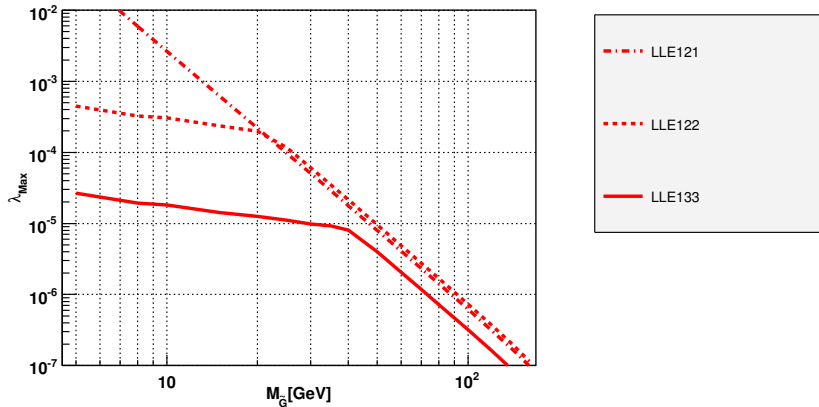
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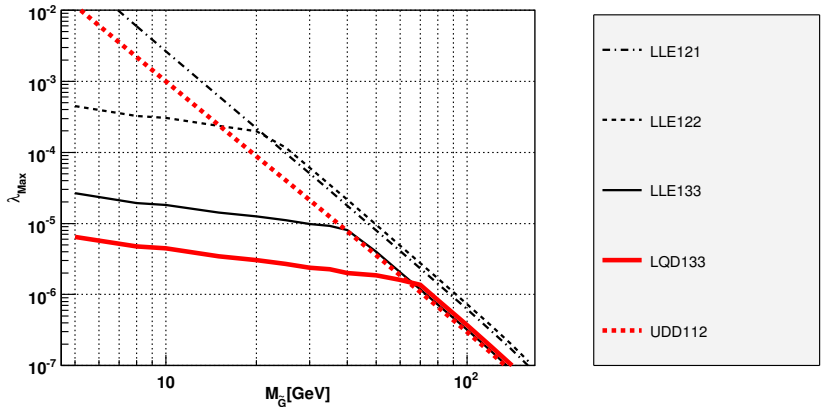
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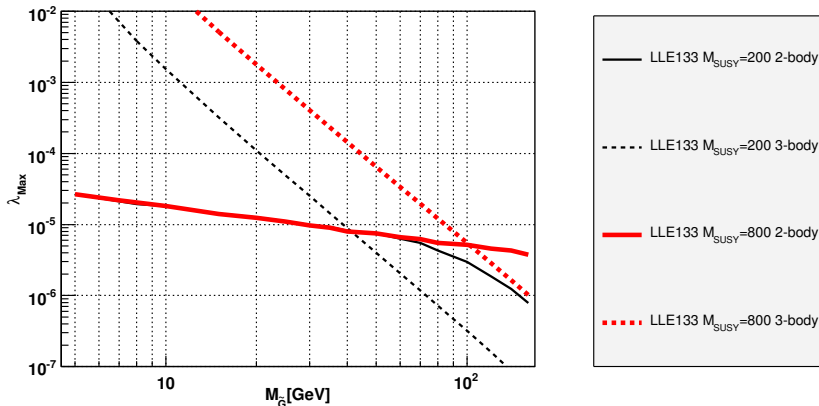
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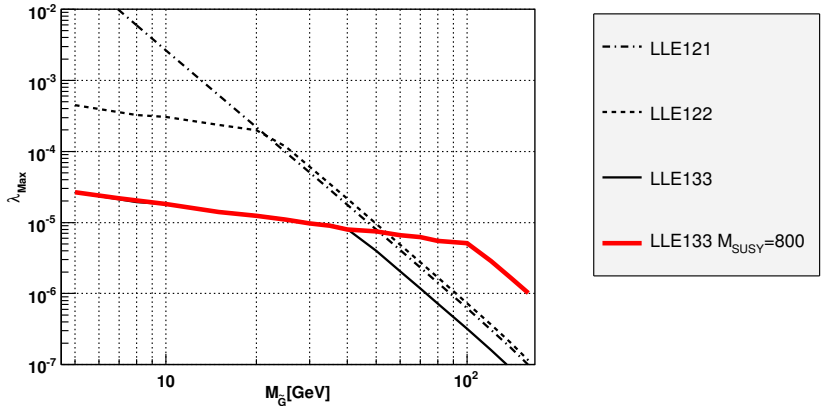
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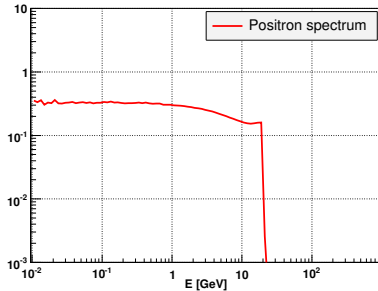
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Positron spectrum, 040eq200LLE_121

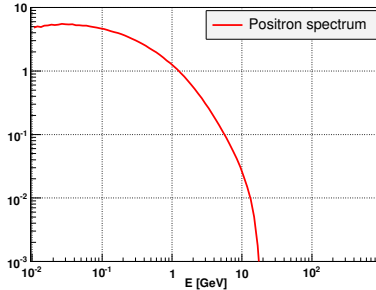


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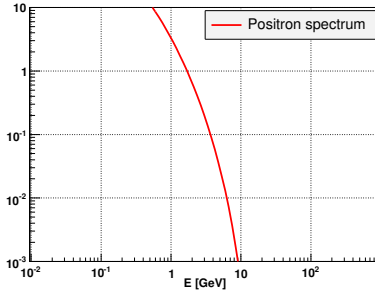


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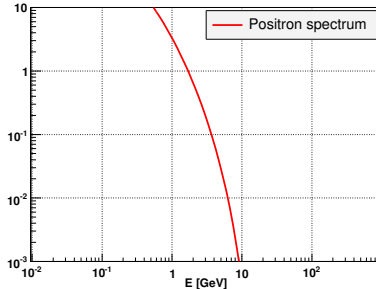


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- ▶ Cosmic ray data, combined with LHC measurements, might allow us to extract the dominant R-violating couplings.
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