Cosmic Ray Signatures from Decaying Gravitino Dark Matter

N.-E. Bomark\textsuperscript{1} S. Lola\textsuperscript{2} P. Osland\textsuperscript{1} A. Raklev\textsuperscript{3}

\textsuperscript{1}University of Bergen, Norway
\textsuperscript{2}University of Patras, Greece
\textsuperscript{3}University of Cambridge, UK

July 16, 2009/ EPS-HEP, Krakow
Outline

Introduction

Charged Particles
  Electrons and Positrons
  Antiprotons

Photons and the LHC
  Gamma Rays
  LHC
The Standard Dark Matter Particle — the WIMP

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

What if this is all wrong?

A disturbing thought: Dark Matter might be practically impossible to detect.

Stable Gravitino Dark Matter.
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.
The Standard Dark Matter Particle — the WIMP

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

What if this is all wrong?

A disturbing thought: Dark Matter might be practically impossible to detect.

Stable Gravitino Dark Matter.
The Standard Dark Matter Particle — the WIMP

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

What if this is all wrong?
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.

What if this is all wrong?

A disturbing thought:
Dark Matter might be practically impossible to detect.
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.

What if this is all wrong?

A disturbing thought:
Dark Matter might be practically impossible to detect.

Stable Gravitino Dark Matter.
The Standard Dark Matter Particle — the WIMP

- A $\mathbb{Z}_2$ symmetry stabilizes the WIMP.
- R-Parity, KK-Parity, etc.
- Has to be exact to prevent WIMP decay.
- But discrete symmetries tend to be violated (C, P, CP)
The Standard Dark Matter Particle — the WIMP

- A $\mathbb{Z}_2$ symmetry stabilizes the WIMP.
- R-Parity, KK-Parity, etc.
- Has to be exact to prevent WIMP decay.
- But discrete symmetries tend to be violated ($C$, $P$, $CP$)
The Standard Dark Matter Particle — the WIMP

- A $\mathbb{Z}_2$ symmetry stabilizes the WIMP.
- R-Parity, KK-Parity, etc.
- Has to be exact to prevent WIMP decay.
- But discrete symmetries tend to be violated (C, P, CP)
The Standard Dark Matter Particle — the WIMP

- A $\mathbb{Z}_2$ symmetry stabilizes the WIMP.
- R-Parity, KK-Parity, etc.
- Has to be exact to prevent WIMP decay.
- But discrete symmetries tend to be violated (C, P, CP)
The Standard Dark Matter Particle — the WIMP

- A $\mathbb{Z}_2$ symmetry stabilizes the WIMP.
- R-Parity, KK-Parity, etc.
- Has to be exact to prevent WIMP decay.
- But discrete symmetries tend to be violated (C, P, CP)

Can we get around this?
The Standard Dark Matter Particle — the WIMP

- A $\mathbb{Z}_2$ symmetry stabilizes the WIMP.
- R-Parity, KK-Parity, etc.
- Has to be exact to prevent WIMP decay.
- But discrete symmetries tend to be violated (C, P, CP)

Can we get around this?

Minimal Dark Matter, Gravitino.
R-Parity Violating SUSY and Dark Matter

In SUSY models with trilinear R-Parity Violating terms;

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

all sparticles decay.

But the Gravitino can still be long lived enough to be Dark Matter.

The Decay Products might explain recent anomalies in Cosmic Rays measurements.
R-Parity Violating SUSY and Dark Matter

- In SUSY models with trilinear R-Parity Violating terms:
  \[
  \lambda_{ijk} L_i L_j \bar{E}_k + \lambda'_{ijk} L_i Q_j \bar{D}_k + \lambda''_{ijk} \bar{U}_i \bar{D}_j \bar{D}_k,
  \]
  all sparticles decay.

- But the Gravitino can still be long lived enough to be Dark Matter.

- The Decay Products might explain recent anomalies in Cosmic Rays measurements.
R-Parity Violating SUSY and Dark Matter

- In SUSY models with trilinear R-Parity Violating terms;
  \[ \lambda_{ijk} L_i L_j \bar{E}_k + \lambda'_{ijk} L_i Q_j \bar{D}_k + \lambda''_{ijk} \bar{U}_i \bar{D}_j \bar{D}_k, \]
  all sparticles decay.
- But the Gravitino can still be long lived enough to be Dark Matter.
- The Decay Products might explain recent anomalies in Cosmic Rays measurements.
Outline

Introduction

Charged Particles
  Electrons and Positrons
  Antiprotons

Photons and the LHC
  Gamma Rays
  LHC
The PAMELA and Fermi/LAT Anomalies

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

Electrons and positrons, UDD-112, \( M_{\text{SUSY}} = 2 \text{ TeV} \), \( M_G = 1.8 \text{ TeV} \)

N.-E. Bomark, S. Lola, P. Osland, A. Raklev

Cosmic Ray Signatures from Decaying Gravitino Dark Matter
The PAMELA and Fermi/LAT Anomalies

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

Electrons and positrons, LQD-122, \( M_{\text{SUSY}} = 1 \text{ TeV}, M_{\tilde{G}} = 320 \text{ GeV} \)
The PAMELA and Fermi/LAT Anomalies

\[ \lambda_{ijk} L_i L_j E_k + \lambda'_{ijk} L_i Q_j \bar{D}_k + \lambda''_{ijk} \bar{U}_i \bar{D}_j \bar{D}_k \]

Electrons and positrons, LQD-133, \( M_{\text{SUSY}} = 2 \text{ TeV}, M_G = 1.8 \text{ TeV} \)

N.-E. Bomark, S. Lola, P. Osland, A. Raklev

Cosmic Ray Signatures from Decaying Gravitino Dark Matter
The PAMELA and Fermi/LAT Anomalies

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

Electrons and positrons, LLE-133, \( M_{\text{SUSY}} = 2 \text{ TeV}, M_G = 1.8 \text{ TeV} \)
The PAMELA and Fermi/LAT Anomalies

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

Electrons and positrons, LLE-233, \( M_{\text{SUSY}} = 6 \text{ TeV}, M_G = 3.7 \text{ TeV} \)

---

N.-E. Bomark, S. Lola, P. Osland, A. Raklev

Cosmic Ray Signatures from Decaying Gravitino Dark Matter
## The PAMELA and Fermi/LAT Anomalies

\[ \lambda_{ijk} L_i L_j \tilde{E}_k + \lambda'_{ijk} L_i Q_j \tilde{D}_k + \lambda''_{ijk} \tilde{U}_i \tilde{D}_j \tilde{D}_k \]

<table>
<thead>
<tr>
<th>(ijk)</th>
<th>(M_{\tilde{G}} = 1.8,\text{TeV})</th>
<th>(M_{\tilde{G}} = 2.5,\text{TeV})</th>
<th>(M_{\tilde{G}} = 3.7,\text{TeV})</th>
</tr>
</thead>
<tbody>
<tr>
<td>121</td>
<td>excluded</td>
<td>excluded</td>
<td></td>
</tr>
<tr>
<td>122</td>
<td>bad</td>
<td>bad</td>
<td></td>
</tr>
<tr>
<td>123</td>
<td>good</td>
<td>ok</td>
<td></td>
</tr>
<tr>
<td>131</td>
<td>excluded</td>
<td>excluded</td>
<td>excluded</td>
</tr>
<tr>
<td>132</td>
<td>good</td>
<td>ok</td>
<td></td>
</tr>
<tr>
<td>133</td>
<td>good</td>
<td>ok</td>
<td>bad</td>
</tr>
<tr>
<td>231</td>
<td>excluded</td>
<td>excluded</td>
<td></td>
</tr>
<tr>
<td>232</td>
<td>excluded</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>233</td>
<td>excluded</td>
<td>ok</td>
<td>good</td>
</tr>
</tbody>
</table>
The PAMELA and Fermi/LAT Anomalies

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

<table>
<thead>
<tr>
<th>( ijk )</th>
<th>( M_{\tilde{G}} = 1.8 \text{ TeV} )</th>
<th>( M_{\tilde{G}} = 2.5 \text{ TeV} )</th>
<th>( M_{\tilde{G}} = 3.7 \text{ TeV} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>121</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>122</td>
<td>bad</td>
<td>bad</td>
<td>–</td>
</tr>
<tr>
<td>123</td>
<td>good</td>
<td>ok</td>
<td>–</td>
</tr>
<tr>
<td>131</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>132</td>
<td>good</td>
<td>ok</td>
<td>–</td>
</tr>
<tr>
<td>133</td>
<td>good</td>
<td>ok</td>
<td>bad</td>
</tr>
<tr>
<td>231</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>232</td>
<td>excluded</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>233</td>
<td>excluded</td>
<td>ok</td>
<td>good</td>
</tr>
</tbody>
</table>
The PAMELA and Fermi/LAT Anomalies

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

<table>
<thead>
<tr>
<th>( ijk )</th>
<th>( M_{\tilde{G}} = 1.8 ) TeV</th>
<th>( M_{\tilde{G}} = 2.5 ) TeV</th>
<th>( M_{\tilde{G}} = 3.7 ) TeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>121</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>122</td>
<td>bad</td>
<td>bad</td>
<td>excluded</td>
</tr>
<tr>
<td>123</td>
<td>good</td>
<td>ok</td>
<td>–</td>
</tr>
<tr>
<td>131</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>132</td>
<td>good</td>
<td>ok</td>
<td>–</td>
</tr>
<tr>
<td>133</td>
<td>good</td>
<td>ok</td>
<td>bad</td>
</tr>
<tr>
<td>231</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>232</td>
<td>excluded</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>233</td>
<td>excluded</td>
<td>ok</td>
<td>good</td>
</tr>
</tbody>
</table>
The PAMELA and Fermi/LAT Anomalies

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

<table>
<thead>
<tr>
<th>( ijk )</th>
<th>( M_{\tilde{G}} = 1.8 \text{ TeV} )</th>
<th>( M_{\tilde{G}} = 2.5 \text{ TeV} )</th>
<th>( M_{\tilde{G}} = 3.7 \text{ TeV} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>121</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>122</td>
<td>bad</td>
<td>bad</td>
<td>–</td>
</tr>
<tr>
<td>123</td>
<td>good</td>
<td>ok</td>
<td>–</td>
</tr>
<tr>
<td>131</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>132</td>
<td>good</td>
<td>ok</td>
<td>–</td>
</tr>
<tr>
<td>133</td>
<td>good</td>
<td>ok</td>
<td>bad</td>
</tr>
<tr>
<td>231</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>232</td>
<td>excluded</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>233</td>
<td>excluded</td>
<td>ok</td>
<td>good</td>
</tr>
</tbody>
</table>
The PAMELA and Fermi/LAT Anomalies

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

<table>
<thead>
<tr>
<th>(ijk)</th>
<th>(M_{\tilde{G}} = 1.8) TeV</th>
<th>(M_{\tilde{G}} = 2.5) TeV</th>
<th>(M_{\tilde{G}} = 3.7) TeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>121</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>122</td>
<td>bad</td>
<td>bad</td>
<td>–</td>
</tr>
<tr>
<td>123</td>
<td>good</td>
<td>ok</td>
<td>bad</td>
</tr>
<tr>
<td>131</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>132</td>
<td>good</td>
<td>ok</td>
<td>–</td>
</tr>
<tr>
<td>133</td>
<td>good</td>
<td>ok</td>
<td>bad</td>
</tr>
<tr>
<td>231</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>232</td>
<td>excluded</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>233</td>
<td>excluded</td>
<td>ok</td>
<td>good</td>
</tr>
</tbody>
</table>
The PAMELA and Fermi/LAT Anomalies

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

<table>
<thead>
<tr>
<th>( ijk )</th>
<th>( M_{\tilde{G}} = 1.8 \text{ TeV} )</th>
<th>( M_{\tilde{G}} = 2.5 \text{ TeV} )</th>
<th>( M_{\tilde{G}} = 3.7 \text{ TeV} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>121</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>122</td>
<td>bad</td>
<td>bad</td>
<td>–</td>
</tr>
<tr>
<td>123</td>
<td>good</td>
<td>ok</td>
<td>–</td>
</tr>
<tr>
<td>131</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>132</td>
<td>good</td>
<td>ok</td>
<td>–</td>
</tr>
<tr>
<td>133</td>
<td>green</td>
<td>ok</td>
<td>bad</td>
</tr>
<tr>
<td>231</td>
<td>excluded</td>
<td>excluded</td>
<td>–</td>
</tr>
<tr>
<td>232</td>
<td>excluded</td>
<td>ok</td>
<td>–</td>
</tr>
<tr>
<td>233</td>
<td>excluded</td>
<td>ok</td>
<td>good</td>
</tr>
</tbody>
</table>
The PAMELA and Fermi/LAT Anomalies

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

Electrons and positrons, LLE-233 LLE-121, \( M_{\text{SUSY}} = 6 \text{ TeV}, M_G = 2.2 \text{ TeV} \)

Graphs showing electron and positron data, with energy on the x-axis and flux on the y-axis.
The PAMELA and ATIC Anomalies

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

Electrons and positrons, LLE-231, \( M_{\text{SUSY}} = 2 \text{ TeV} \), \( M_G = 1.8 \text{ TeV} \)
Outline

Introduction

Charged Particles
  Electrons and Positrons
  Antiprotons

Photons and the LHC
  Gamma Rays
  LHC
Constraints from the PAMELA $\bar{p}$ data

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

Antiprotons, UDD-112, LQD-133

N.-E. Bomark, S. Lola, P. Osland, A. Raklev

Cosmic Ray Signatures from Decaying Gravitino Dark Matter
Constraints from the PAMELA $\bar{p}$ data

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

Give no $\bar{p}$ at all!
Constraints from the PAMELA $\bar{p}$ data

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

Give no $\bar{p}$ at all!

Ideal for explaining the electron positron anomalies.
Constraints from the PAMELA $\bar{p}$ data

$$\lambda_{ijk} L_i L_j E_k + \lambda'_{ijk} L_i Q_j D_k + \lambda''_{ijk} U_i D_j D_k$$

Give no $\bar{p}$ at all!

Ideal for explaining the electron positron anomalies.

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

Introduction

Charged Particles
Electrons and Positrons
Antiprotons

Photons and the LHC
Gamma Rays
LHC
Gamma Ray Signals for Fermi/LAT

\[
\left( \frac{E^2 dJ}{dE} \right) \text{[GeV cm}^2\text{ str}^{-1}\text{s}^{-1]} \]

\[
\begin{array}{c}
\text{10}^{-5} \\
\text{10}^{-6} \\
\text{10}^{-7} \\
\text{10}^{-8} \\
\end{array}
\]

\[
\begin{array}{c}
\text{10}^{-1} \\
\text{1} \\
\text{10} \\
\text{10}^2 \\
\text{10}^3 \\
\end{array}\text{[GeV]}
\]
Outline

Introduction

Charged Particles
  Electrons and Positrons
  Antiprotons

Photons and the LHC
  Gamma Rays
  LHC
What can the LHC see?

- Neutralinos decay inside detector if $\lambda \gtrsim 10^{-6}$.
  \[ \rightarrow \text{We need } \lambda \approx 10^{-9} - 10^{-10}. \]

- A stau NLSP could decay faster through two-body decay.
  \[ \rightarrow \tau \text{ rich operators are favoured by the data.} \]

- SUSY production
  \[ \rightarrow M_{\tilde{G}} \gtrsim 1.8 \text{ TeV}, \text{ how heavy are the other sparticles?} \]
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.

- SUSY production
  $\rightarrow M_{\tilde{G}} \gtrsim 1.8$ TeV, how heavy are the other sparticles?
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.

- SUSY production
  $\rightarrow M_{\tilde{G}} \gtrsim 1.8$ TeV, how heavy are the other sparticles?
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.

- SUSY production
  $\rightarrow M_{\tilde{G}} \gtrsim 1.8$ TeV, how heavy are the other sparticles?
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.

- SUSY production  
  $\rightarrow M_{\tilde{G}} \gtrsim 1.8$ TeV, how heavy are the other sparticles?
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.

- SUSY production  
  $\rightarrow M_{\tilde{G}} \gtrsim 1.8$ TeV, how heavy are the other sparticles?
Summary

- **Gravitino Dark Matter** in R-Parity Violating Supersymmetric models can well explain the recent anomalies in cosmic ray electrons and positrons, seen by PAMELA, Fermi/LAT and ATIC.
- Fermi/LAT extragalactic diffuse gamma ray data will be important to strengthen/disprove this scenario.
- Prospects for SUSY at LHC not good in this scenario.
Gravitino Dark Matter in R-Parity Violating Supersymmetric models can well explain the recent anomalies in cosmic ray electrons and positrons, seen by PAMELA, Fermi/LAT and ATIC.

Fermi/LAT extragalactic diffuse gamma ray data will be important to strengthen/disprove this scenario.

Prospects for SUSY at LHC not good in this scenario.
Gravitino Dark Matter in R-Parity Violating Supersymmetric models can well explain the recent anomalies in cosmic ray electrons and positrons, seen by PAMELA, Fermi/LAT and ATIC.

Fermi/LAT extragalactic diffuse gamma ray data will be important to strengthen/disprove this scenario.

Prospects for SUSY at LHC not good in this scenario.