LINEAR COLLIDER SIGNALS OF ANOMALY MEDIATED
SUPERSYMMETRY BREAKING

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Diagnostic signals of the minimal model of anomaly mediated supersymmetry
breaking are discussed in the context of a $\sqrt{s} = 1$ TeV $e^+e^-$ linear collider.

1 Introduction

The idea of anomaly mediated supersymmetry breaking (AMSB)1,2, where
the SUSY breaking is conveyed to the observable sector by the super-Weyl
anomaly, has attracted a lot of attention in recent times. This can lead to
characteristically distinct and unique signatures in various collider experi-
ments3,4,5. In this work, we have concentrated on the signals of AMSB
which can be studied6,7 in a high energy $e^+e^-$ linear collider at a c.m. energy
$\sqrt{s} = 1$ TeV. Anomaly mediation is a special case of gravity mediation with no
tree-level couplings between the superfields of the hidden and the observable
sectors. This is realized, for instance, when the two sectors are localized on
two parallel but distinct 3-branes located in a higher dimensional bulk. This
scenario has several distinct and unique features with important phenomeno-
logical consequences. The gravitino is rather massive ($m_{3/2} \sim$ tens of TeV),
the lightest supersymmetric particle (LSP, $\tilde{\chi}_1^0$) is predominantly a Wino and
it is nearly mass-degenerate (mass-splitting $\Delta M < 1$ GeV) with the lighter
chargino ($\tilde{\chi}_1^\pm$) which is also a near-Wino. Such a chargino will be long lived
and is likely to leave a heavily ionizing charged track in the detector and/or a
associated soft pion from the decay $\tilde{\chi}_1^\pm \rightarrow \tilde{\chi}_0^0 + \pi^\pm$. The most glaring problem
of AMSB is that it predicts negative mass squares for the sleptons. In the
minimal AMSB model this problem is solved by adding a universal constant
term $m_0^2$ to the expressions for squared scalar masses. The set of parameters
which define the minimal AMSB model is \{$m_{3/2}, m_0, \text{sign}(\mu), \tan\beta$\}. The
AMSB sparticle mass spectrum can be broadly classified into two categories:

- Spectrum A: $\tilde{\chi}_1^0(\approx \tilde{\chi}_1^0) < \tilde{\nu} < \tilde{e}_R(\approx \tilde{e}_L) < \tilde{\chi}_2^0$
Table 1. Possible one or multilepton signal with one soft pion.

<table>
<thead>
<tr>
<th>Spectrum</th>
<th>Signals</th>
<th>Parent Channels</th>
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<tbody>
<tr>
<td>A</td>
<td>e π</td>
<td>ν̄ν̄, (%)</td>
</tr>
<tr>
<td></td>
<td>μ π</td>
<td>ν̄ν̄, (%)</td>
</tr>
<tr>
<td></td>
<td>e e ℓπ</td>
<td>ν̄ν̄, (%)</td>
</tr>
<tr>
<td></td>
<td>μ μ ℓπ</td>
<td>ν̄ν̄, (%)</td>
</tr>
<tr>
<td></td>
<td>ℓ1 ℓ2 ℓ3 π</td>
<td>ν̄ν̄, (%)</td>
</tr>
<tr>
<td>B</td>
<td>e π</td>
<td>ν̄ν̄, (%)</td>
</tr>
<tr>
<td></td>
<td>μ π</td>
<td>ν̄ν̄, (%)</td>
</tr>
<tr>
<td></td>
<td>e ℓ1 ℓ2 π</td>
<td>ν̄ν̄, (%)</td>
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<td>μ μ ℓπ</td>
<td>ν̄ν̄, (%)</td>
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<tr>
<td></td>
<td>e e ℓ1 ℓ2 π</td>
<td>ν̄ν̄, (%)</td>
</tr>
</tbody>
</table>

- Spectrum B: $\tilde{\chi}_1^0 (\approx \tilde{\chi}_2^0) < \tilde{\nu} < \tilde{e}_R (\approx \tilde{e}_L)$.

We discuss our signals for them separately.

2 Results

A list of all possible final states for both the spectra mentioned above, is given in Table 1 for one pion channels. The signals are always accompanied by missing energy. A similar list for two pion channels is given in Ref. 7. Cross sections for the various production processes have been calculated for two values of $\tan \beta$, namely 10 and 30 and for $\mu > 0$. In most of the allowed parameter space the signal cross sections are $\sim 10$-100 fb. For example, in the worst cases of the signal cross sections, assuming an integrated luminosity of 500 fb$^{-1}$, one would expect 13165 signal events from spectrum A, while 2910 signal events are predicted from spectrum B for the signal $e^\pm + \pi^\pm + E_T$. The kinematic distributions of the final state particles for the same signal have been studied for a sample point in the AMSB parameter space corresponding to Spectrum A. They are shown in Fig. 1. The chargino decay length distribution shows that a substantial number of events do have a large decay length so that the charged track can be seen. The signals analyzed here are essentially free of Standard Model background.

3 Conclusion

We have investigated possible signals of minimal AMSB model in a 1 TeV c.m. energy $e^+e^-$ linear collider. The model is characterized by nearly degenerate lightest neutralino ($\tilde{\chi}_1^0$) and the lighter chargino ($\tilde{\chi}_1^\pm$), resulting in a heavily
ionizing charged track and/or a detectable soft $\pi^\pm$ from the long-lived decay $\tilde{\chi}^\pm_1 \rightarrow \tilde{\chi}^0_1 + \text{soft } \pi^\pm$. The generated events triggered by fast charged leptons are large in number and the allowed region of the parameter space can be comprehensively probed.

Acknowledgments

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References