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SEARCH FOR CHARGINOS AND NEUTRALINOS USING TRILEPTONS

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We search for supersymmetry (SUSY) using trilepton events in $p\overline{p}$ collisions at $\sqrt{s} = 1.8$ TeV. In the Minimal Supersymmetric Standard Model (MSSM), trilepton events are expected from chargino-neutralino ($\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$) pair production, with subsequent decay into leptons. In all possible combinations of electron and muon channels in 100 pb^{-1} of data, we observe no events which pass our trilepton selection criteria. Assuming the GUT hypothesis within the framework of the MSSM, our preliminary analysis excludes $M(\tilde{\chi}_1^{\pm}) < 68$ GeV/c^2.

1 Introduction to Supersymmetry

The first indication of supersymmetric grand unification arose from precision measurements of the coupling constants α_1, α_2, and α_3 at the Z^0 pole [1]. Using the Standard Model (SM) assuming grand unification (GUT), there is no clear intersection of the coupling constants. However, they converge at the GUT scale when the Minimal Supersymmetric Standard Model (MSSM) [2] is employed. Hence SUSY can be used in grand unification schemes. Thus, a direct search for SUSY phenomena is clearly important.

2 Data Analysis

In our analysis, we assume R-parity (a multiplicative quantum number distiguishing particles from superparticles) to be conserved. Charginos and neutralinos ($\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$) can be pair produced in $p\overline{p}$ collisions via an s-channel virtual W yielding three isolated leptons and a stable LSP ($\tilde{\chi}_1^0$) (which causes missing energy [3]). Our data have been collected with the Collider Detector at

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Fermilab (CDF) [4] during the 1992-5 collider run. Our analysis begins by selecting the highest $p_T(\ell)$ >11 GeV/c electrons (muons) in the pseudorapidity range $|\eta^e| < 1.1$ ($|\eta^\mu| < 0.6$). The minimum p_T value for additional electons (muons) is 5 GeV/c (4 GeV/c); additional electrons (muons) are accepted in the pseudorapidity range $|\eta^e| < 2.4$ ($|\eta^\mu| < 1.0$). It is required that two of the three leptons are of opposite charge and same flavor. We look for events where $\not\!\!E_T$ >15 GeV. After all cuts, we are left with zero candidate events.

3 Backgrounds

The principal backgrounds to the SUSY trilepton analysis are from Drell-Yan plus fake leptons and diboson events. Events from diboson and Drell-Yan were generated by ISAJET [5] and run through our detector simulation. The rate of misidentified leptons is measured from data. The CDF measured cross-section for Drell-Yan was used [6]. The total SM background yield expected in 100 pb^{-1} of data is 0.4 ± 0.1 events, which is consistent with our observation of no events.

4 Excluded Regions of the MSSM

Our observation of zero trilepton events folded in with our statistical and systematic uncertainties determines an upper limit on $M(\tilde{\chi}_1^\pm)$. The total systematic uncertainty of 25% is convoluted (as a Gaussian smearing) with a Poisson distribution; we obtain a 95% C.L. upper limit of 3.35 events. The upper limit to $\sigma \cdot BR$ is:

$$\sigma \cdot BR(\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow 3\ell X) \quad < \quad \frac{3.35}{\int \mathcal{L} dt \cdot \epsilon^{tot}}$$

where $\int \mathcal{L} dt$ is the integrated luminosity for our data sample (100 pb^{-1}), ϵ^{tot} is the total detection efficiency, and $BR(\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow 3\ell X)$ is the branching ratio to three leptons (electrons or muons).

Figure 1 shows the 95% C.L. upper limit on $\sigma \cdot BR(\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow 3\ell X)$, plotted as a solid curve versus $M(\tilde{\chi}_1^\pm)$. We find that $M(\tilde{\chi}_1^\pm) < 68$ GeV/c^2 and $\sigma \cdot BR$ >0.66 pb are excluded by our analysis for the MSSM parameter values of $\mu = -600$ GeV/c^2, $\tan\beta = 2$, and $M_{\tilde{q}}/M_{\tilde{g}} = 1.0$.

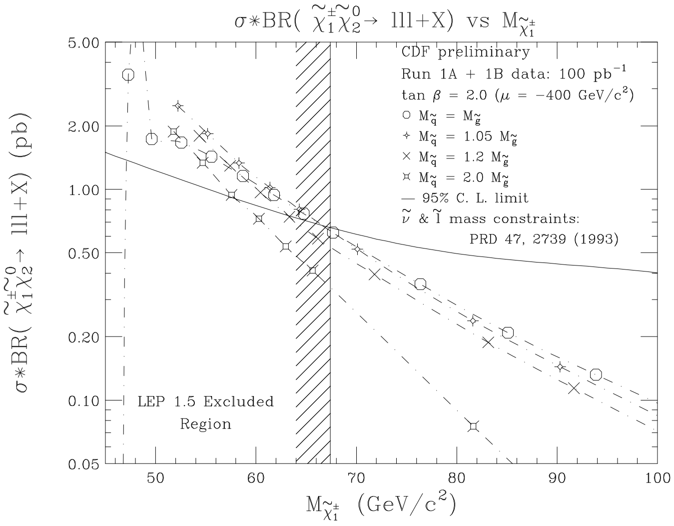

Figure 1: SUSY Mass Limits.

5 Conclusion

We searched for evidence of the production and decay of $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ pairs into trilepton events in 100 pb^{-1} of $\sqrt{s}$ = 1.8 TeV $p\overline{p}$ collision data at CDF. No candidates are observed. We set a preliminary limit of $M(\tilde{\chi}_1^{\pm}) > 68$ GeV/c^2 and $\sigma \cdot BR < 0.66$ pb at the 95 % C. L. for the MSSM parameters mentioned.

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