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FNAL/C--96/372-E

FERMILAB-Conf-96/372-E

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CONF-960812--29

Search for Squarks and Gluinos Using Dileptons

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P.O. Box 500, Batavia, Illinois 60510

October 1996

Published Proceedings of the *1996 Annual Divisional Meeting (DPF 96) of the Division of Particles and Fields of the American Physical Society*, Minneapolis, Minnesota, August 10-15, 1996.

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Operated by Universities Research Association Inc. under Contract No. DE-AC02-76CH03000 with the United States Department of Energy

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FERMILAB-CONF-96/372-E

CDF/ANAL/EXOTIC/CDFR/3832
September 30, 1996

SEARCH FOR SQUARKS AND GLUINOS USING DILEPTONS

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Gluinos and squarks can be produced in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TeV and decay via charginos and neutralinos to final states containing two (or more) leptons. There is no charge correlation between the leptons of charginos from gluino decays as gluinos are Majorana particles. The strategy of this analysis is to search for an excess of events containing two like-sign isolated leptons, missing energy, and jets. The analysis is based on 81 pb^{-1} of 1994-5 data recorded at CDF.

1 Introduction

Supersymmetry [1] is a promising theory that can allow for grand unification. The Minimal Supersymmetric Standard Model (MSSM)[2] is a supersymmetrized Standard Model (SM) with two Higgs doublets. Since the SUSY mass scale is expected to be of the order of the electroweak scale, data from the CDF[8] experiment can be used to search for SUSY.

2 SUSY Signature and Data Analysis

The assumption that R-parity (a multiplicative quantum number which differentiates particles from superparticles) is conserved implies: (1) SUSY objects are pair-produced and (2) a stable LSP exists. Cosmological constraints require that the LSP be the lightest neutralino ($\tilde{\chi}_1^0$) [4]. In our analysis, slepton and sneutrino masses are related to gaugino masses[3]. At hadron colliders, the dominant production mechanism for gluinos is $gg \rightarrow \tilde{g}\tilde{g}$ via s-channel gluon and t- and u-channel gluino exchange. For heavy gluinos, cascade decays into charginos ($\tilde{\chi}_1^{\pm}$) dominate (*e.g.,* $\tilde{g} \rightarrow q\overline{q'}\tilde{\chi}_1^{\pm}$)[5]. The charginos decay into leptons along with an LSP which carries away energy. Since the gluino is a Majorana fermion, it has the distinctive property of decaying with equal probability

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Published Proceedings 1996 Divisional Meeting of the Division of Particles and Fields, American Physical Society, Minneapolis, MN, August 10-15, 1996.

into fermions and antifermions. Since there are many SM processes which contribute opposite charge dileptons but very few that contribute those of the same sign, an excellent signature for pair production of gluinos results from events in which both gluinos decay to a chargino of the same sign, yielding like-sign dileptons in the final state [6,7]. We choose isolated dilepton (ee, $e\mu$, and $\mu\mu$) events from the 1994-5 Tevatron data recorded at CDF [8]. In order to choose leptons that passed our trigger with a high efficiency, we selected primary electons (muons) with $|\eta^e| <1.1$ ($|\eta^\mu| <0.6$) and $E_T^e >11$ GeV ($p_T^\mu >11$ GeV/c). We require additional electrons (muons) to be within $|\eta^e| <2.4$ ($|\eta^\mu| <1.0$) and $E_T^e >5$ GeV ($p_T^\mu >5$ GeV/c) as indicated by SUSY MC studies. We require these events to have two or more jets with $E_T >$ 15 GeV and $|\eta| <2.4$ but at least one with $|\eta| <1.1$. Jets and leptons are required to be well separated. A large missing energy cut ($\not{E}_T >25$ GeV) is made in order to identify LSPs in the gluino decay products. We then make our like-sign dilepton cut to reduce SM dilepton background. After all cuts, we observe two candidates.

3 Signal Simulation and Background Studies

We simulate the signal via ISAJET [11] using MSSM parameters: $\tan\beta =4$, $\mu = -400$ GeV/c^2, $A_t = -100$ GeV/c^2, and $m_A =500$ GeV/c^2. We take into account SUSY production via NLO cross-sections [9,10]. The trajectories and decays of these particles are evolved through our detector simulation. The main SM contributions to our analysis are due to $t\bar{t}$ and Drell-Yan. Cross-sections for these processes were taken from CDF measured values [12,13]. The total number of expected background is 1.3 ± 0.6 events.

4 Conclusion

After all cuts, we find two events consistent with expected background; hence there is no excess signal above background. We set limits at the 95 % C. L. on the mass of the gluino folding in a total systematic error of 35%. We set a preliminary limit for $m_{\tilde{g}} >$ 230 GeV/c^2 where $m_{\tilde{g}} \simeq m_{\tilde{q}}$ and a limit for $m_{\tilde{g}} >$ 180 GeV/c^2 independent of $m_{\tilde{q}}$ (see Figure 1).

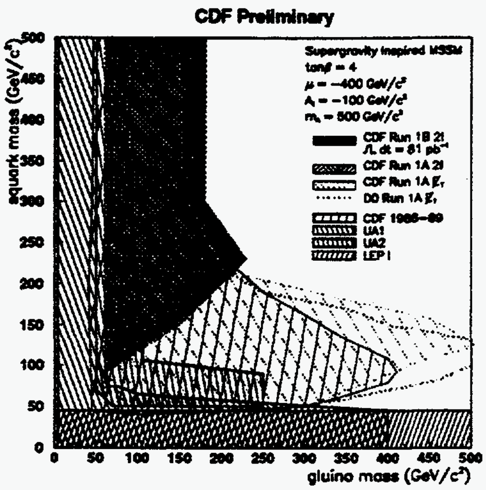

Figure 1: SUSY Mass Limits.

Acknowledgments

This work is supported by the U.S. Department of Energy and National Science Foundation; the Italian Instituto Nazionale di Fisica Nucleare; the Ministry of Education, Science and Culture of Japan; the Natural Sciences and Engineering Research Council of Canada; the National Science Council of the Republic of China; the A. P. Sloan Foundation; and the Alexander von Humboldt-Stiftung.

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