SEARCH FOR R-PARITY VIOLATION AT DØ

FRÉDÉRIC DÉLIOT
CEA-Saclay, DAPNIA/Service de Physique des Particules
91191 Gif sur Yvette Cedex, France
E-mail: deliot@hep.saclay.cea.fr

FOR THE DØ COLLABORATION

Using data collected by the DØ experiment during the Run I of the Fermilab Tevatron, searches for supersymmetric signatures have been performed in the framework of R-parity violation. No deviations from standard model predictions have been observed. Limits on supersymmetric parameters are presented focusing on recent results as well as discovery potential of Run II.

1 Introduction

Between 1992 and 1996, the DØ experiment[1] has accumulated an integrated luminosity of $\sim$ 120 pb^{-1} during the Run I of the Tevatron with proton-antiproton collisions at $\sqrt{s} = 1.8$ TeV. Searches for supersymmetric particles have been performed in the framework of the minimal supergravity model (mSUGRA) assuming that R-parity is violated ($\not{R}_p$) by one (dominant) λ or λ' coupling. Multilepton final states then provide golden plated signatures for supersymmetric signals. If the $\not{R}_p$ coupling is large enough, resonant supersymmetric particle production can occur[a]. Otherwise sparticles are produced in pairs; each of them further cascade-decay to the LSP[b], which is assumed to be the lightest neutralino χ_1^0. Then the LSP can decay according to the dominant $\not{R}_p$ coupling.

2 Pair Production

2.1 Previous Analyses

A R-parity conserved search for gaugino production ($\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$) with a trilepton signature[3] has been reinterpreted in the case where R-parity is violated by either a dominant $\lambda_{121}, \lambda_{122}$ or λ_{233} coupling[4]. With those couplings, the LSP decays into two charged leptons and a neutrino leading to a final state with

[a] Restricting the $\not{R}_p$ couplings within the range allowed by low energy measurements[2] still leads to a sizeable cross section for many $\not{R}_p$ scenarii.
[b] Lightest Supersymmetric Particle.

multilepton and missing transverse energy. A large domain of the mSUGRA parameter space can be excluded (for instance up to $m_0 = 250$ GeV/c^2 with λ_{121}) provided that the LSP decays within the detector (i.e. $\lambda_{121} \geq 10^{-4}$).

Assuming that one of the six $\lambda'_{1jk}(j = 1, 2; k = 1, 2, 3)$ dominates, the LSP decays into one electron and two jets. A search for final states with at least two electrons and at least two jets has been performed[5]. Squarks with mass below 243 GeV/c^2 and gluinos with mass below 227 GeV/c^2 have been excluded at the 95% confidence level for $A_0 = 0, \mu < 0$ and $\tan\beta = 2$. Based on a parametrization of the upgraded DØ detector, an estimated exclusion contour has been obtained for Run II ($2fb^{-1}$). If no excess of events is observed above the predicted background, squark masses up to 420 GeV/c^2 and gluino masses up to 500 GeV/c^2 are expected to be probed[6].

2.2 New Analysis: Dimuon Final State

For the case of sparticle pair production with a dominant λ'_{2jk}, a search in the dimuon + jets channel has been carried out[7] with a Run I data sample of 77.5 pb^{-1}. The standard model background for this signature is: Drell-Yan $\rightarrow \mu\mu$, $Z(\rightarrow \mu\mu)$ + 2 or more jets, $Z \rightarrow \tau\tau \rightarrow \mu\mu$, $t\bar{t} \rightarrow \mu\mu$ and $WW \rightarrow ll$. After the offline cuts[7], the total expected number of background events is: $0.18 \pm 0.03 \pm 0.02$. From the data events passing the trigger requirement (one muon with $p_T > 10$ GeV and one jet with $E_T > 15$ GeV and $|\eta| < 2.5$), none survive the offline criteria. An exclusion region in the mSUGRA plane $(m_0, m_{1/2})$ is determined for $A_0 = 0$, $\mu < 0$ and $tan\beta = 2$ or 6 (Fig. 1). It leads to a similar squark and gluino mass exclusion as for the dielectron analysis ($m_{\tilde{g}} > 227$ GeV/c^2 and $m_{\tilde{q}} > 243$ GeV/c^2). Discovery potential in Run II will be largely increased[6].

3 Resonant Production

R-Parity violation provides the possibility to produce scalar sparticles as resonances in the s-channel. Compared to pair production processes, larger sparticle masses can a priori be probed. Besides these processes allow an easy determination of the relevant $\not{R}_p$ coupling as well as sparticle mass reconstruction[8]. A resonant sparticle can be produced via λ'[c] leading to a singly produced chargino or neutralino. It is generally assumed that the resonant sparticle decays via R-parity conserving couplings followed by cascade decay to the

[c]Resonant production processes via a dominant λ'' coupling are also possible at hadronic colliders but provide multijet final states with high QCD background.

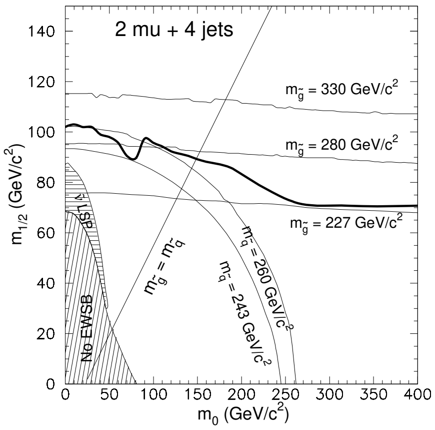

Figure 1. Exclusion contour in the $(m_0, m_{1/2})$ plane for $tan\beta = 2$, $\mu < 0$ $A_0 = 0$ and a dominant λ'_{222} coupling. The region below the bold line is excluded at the 95% C.L. The hatched region is excluded because no electroweak symmety breaking occurs or because the lightest neutralino is not the LSP.

LSP which finally decays within the detector. A search for resonant sneutrino or smuon production via λ'_{211} has been recently carried out by analyzing the final state with at least two muons and two jets[9]. The data used correspond to 94 ± 5 pb^{-1}. The main standard model background is similar to that in the dimuon final state in pair production (Sec. 2.2). A neural network is used to optimize the signal to background ratio[9]. The total expected background is 1.01 ± 0.02 compatible with two events observed in the data. The resulting exclusion contours are shown in Fig. 2 in the plane $(m_0, m_{1/2})$. This analysis excludes $m_{1/2}$ up to 260 GeV/c^2 for $\lambda'_{211} = 0.09$.

4 Conclusion

Various analyses assuming R-parity violation have been performed using Run I data. No sign of supersymmetry in this framework has been found. The discovery potential will be largely increased at Run II with 10% higher energy, improved detectors, and a twenty-fold increase in the integrated luminosity by 2003.

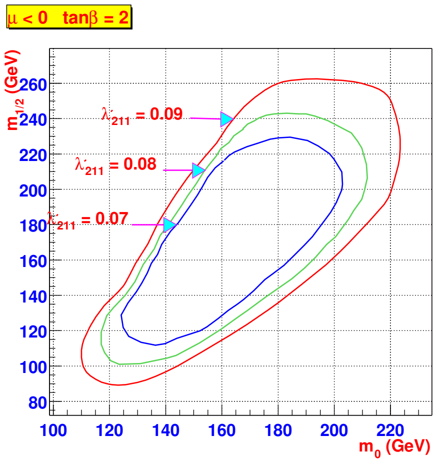

Figure 2. Exclusion contours at 95% C.L. in the $(m_0, m_{1/2})$ plane for $tan\beta = 2$, $\mu < 0$, $A_0 = 0$ and a dominant λ'_{211} coupling.

References

1. D0 Collaboration, S. Abachi *et al*, Nucl. Instr. and Meth. **A338**, 185 (1994).
2. F. Ledroit and G. Sajot, note GDR-S-008 (1998), http://qcd.th.u-psud.fr/GDR_SUSY/GDR_SUSY_PUBLIC/entete_note_publique
   B. Allanach *et al*, Phys. Rev. **D 60**, 75014 (1999).
3. D0 Collaboration, B. Abbott *et al*, Phys. Rev. Lett. **80**, 1591 (1998).
4. D0 Collaboration, B. Abbott *et al*, Phys. Rev. **D 62**, 071701 (2000).
5. D0 Collaboration, B. Abbott *et al*, Phys. Rev. Lett. **83**, 4476 (1999).
6. S.Banerjee, N.K.Mondal, V.S.Narasimham, N.Parua, "Search for R-parity Violation SUSY in Run 2 at DØ ",hep-ph/9904397.
7. D0 Collaboration, V. M. Abazov *et al*, to be published in Phys. Rev. Lett.
8. F. Déliot, G. Moreau and C. Royon, Eur. Phys. J. **C 19**, 155 (2001).
   F. Déliot *et al*, Phys. Lett. **B 475**, 184 (2000).
   H. Dreiner, P. Richardson and M. Seymour, Phys. Rev. **D 63**, 055008 (2001).
9. D0 Collaboration, V. M. Abazov *et al*, to be published in Phys. Rev. Lett.