Supersymmetry Searches in Final States with Three Leptons and Missing Transverse Momentum at ATLAS

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1 Introduction

Supersymmetry (SUSY) is an extension of the Standard Model (SM) which postulates that each SM field has a corresponding superpartner field whose spin differs by a half unit. SUSY provides elegant solutions to several open problems in the SM; these include the hierarchy problem, the identity of dark matter, and grand unification.

Signatures with multiple charged leptons can arise at the LHC through cascade decays of charginos ($\tilde{\chi}_i^{\pm}$) and neutralinos ($\tilde{\chi}_j^0$). These weak gauginos can either be produced directly or can result from decays of squarks and gluinos. The analysis presented here [1] consists of a search for direct production of weak gauginos in final states with three leptons and missing transverse momentum (MET) at $\sqrt{s} = 7$ TeV with integrated luminosity 2.06 fb^{-1} collected by the ATLAS [2] detector at the LHC.

Two classes of supersymmetric models were considered. In the first of these, the phenomenological minimal supersymmetric Standard Model (pMSSM), a series of simplifying assumptions reduces the 105 parameters of the R-parity conserving MSSM to 19. These assumptions include CP conservation (to remove phases) and degenerate 1st and 2nd generation sfermion masses. This analysis made further assumptions, *e.g.* $tan\beta = 6$ to ensure that the leptonic branching fraction is the same for each flavor, to reduce the number of parameters to 3: the $U(1)$ gaugino mass M_1, the $SU(2)$ gaugino mass M_2, and the Higgsino mass $|\mu|$.

The other class of SUSY models considered are the so-called simplified models. These are models which have been constructed with the minimal particle content necessary to produce multilepton SUSY-like events in pp collisions. They are parametrized directly in terms of the sparticle masses. This analysis focused on direct production of $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$.

2 Results and Interpretation

In addition to standard ATLAS event quality cuts, the baseline event selection requires 3 leptons (e, μ) with transverse momentum $p_T > 10$ GeV, MET > 50 GeV,

and at least one same flavor, opposite charge (SFOC) lepton pair. Two signal regions (SR) have been considered. SR1 is defined by requiring that the invariant mass of the SFOC pair be further than 10 GeV from the Z mass, and vetoing jets identified as originating from b quarks. Conversely, SR2 is defined by requiring the SFOC mass to be within 10 GeV of the Z mass.

SM background (BG) processes which produce the desired detector signature have been modeled with Monte Carlo (MC) simulated samples. BG processes which produce the desired signature via "fake" leptons (*i.e.* leptons in jets or from photon conversions) have been modeled with a data-driven matrix method. Good agreement was found between SM predictions and data in two orthogonal validation regions (Z+jets-dominated and $t\bar{t}$-dominated). The dominant background contributions in SR1 (SR2) were from WZ and $t\bar{t}$ (WZ) production.

In SR1 (SR2), 32 (95) events were seen in data. The total SM prediction was 26±5 (72±12) events. The BG-only p-value was found to be 19% (6%). The observed excesses are not significant, so 95% confidence level (CL) limits have been set on the parameter spaces of both SUSY scenarios. These limits have been computed using the modified frequentist CL_s prescription [3] and are shown in Figure 1. An upper bound of 9.9 fb (23.8 fb) at 95% CL has been placed on the visible cross section in SR1 (SR2).

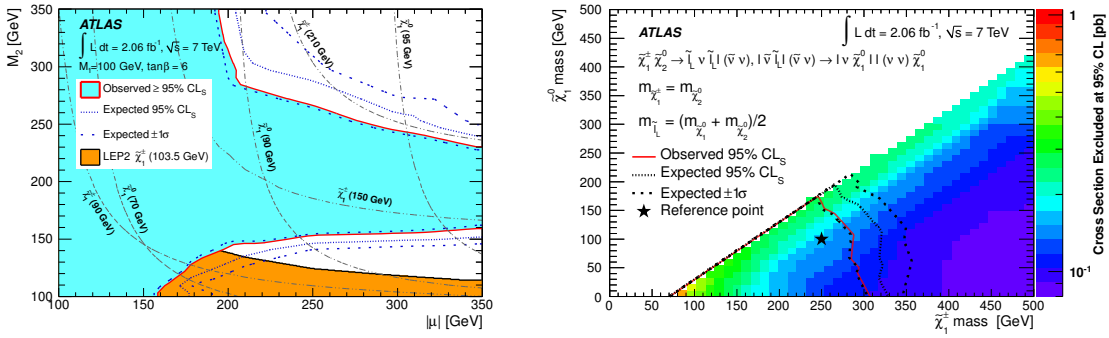

Figure 1: 95% CL limits on the parameter spaces of pMSSM (left) and simplified model (right) scenarios. Both limits are set in SR1. [1]

References

[1] ATLAS collaboration, Phys. Rev. Lett. 108 (2012) 261804.

[2] ATLAS collaboration, JINST 3 (2008) S08003.

[3] A.L. Read, J. Phys. G28 (2002) 2693