SUSY signatures in the GNMSSM with monojets and single photons

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Abstract

No signs of Supersymmetry (SUSY) have be found at the LHC7,8. This puts strong lower bounds on the squark masses. The 125 GeV Higgs mass imposes severe constraints (high fine tuning, large stop masses) on simple models like the MSSM. Extended models can relax these conditions. We look at a promising parameter region within the GNMSSM and try to predict if it's within the sensitivity of the LHC14. We compare two different signal topologies: monojet + Missing Transverse Energy (MET) and single photons + MET.

The Model

The Generalized Next-to-Minimal Supersymmetric Standard Model (GNMSSM) contains an additional singlet superfield. The gaugino masses do not have to unify at a high scale.

$$M_1 = am_{3/2}, M_2 = bm_{3/2}, M_3 = cm_{3/2} \text{ at } M_{\mathrm{GUT}}$$

Superpotential

$$\mathcal{W} = \mathcal{W}_{\mathrm{MSSM}} + \tfrac{1}{3}\kappa S^3 + \lambda S H_u H_d + \xi S + \tfrac{1}{2}\mu_s S^2$$

Soft breaking parameters:

$$m_S^2, A_\kappa, A_\lambda, L_\xi, B_{\mu_s} \qquad \xi = 0 \text{ by redefinition}$$

The model can accomodate LHC7,8 SUSY and Higgs bounds, dark matter abundance and low-fine tuning, which often results in compressed spectra, see e.g. G. Ross, K. Schmidt-Hoberg, A. Kaminska, arXiv:1308.4168.

Example (plots)

Masses in units of GeV

$$m(\tilde{g}) = 1114, m(\tilde{u}_L) = m(\tilde{d}_L) = 1528$$

$$m(\tilde{d}_R) = 1014, m(\tilde{u}_R) = 1283, m(\chi_1^0) = 687$$

Produced final state: $\tilde{q}\tilde{q} \;+\; \tilde{q}\tilde{q}j$

Generated with MadGraph5 / Pythia6 with MLM matching, used Delphes for ATLAS detector simulation. All plots show jet rapidity η (eta).

Jet tags applied using MC information

Very large amount of decay jets vs. Matrix Element (ME) jets

Typical jet multiplicities per event: ME (0-1), ISR(0-2), decay+FSR (1-8)

Signatures

We consider two final state topologies.

- monojet + Missing Transverse Energy (MET)
- single photon + MET

While monojet events are more frequent because of the strong coupling, the single photon signal is cleaner and has less background.

The photon signal is probably more effective at high ET, since the background drops off quicker than in the jet case.

Procedure

We generate events with $\tilde{q}\tilde{q}$ final state with up to 1 jet or photon (also $\tilde{q}\tilde{g}$, $\tilde{g}\tilde{g}$).

Hard jets have to be filtered out by the analysis and compared to the background. In the given example, this is difficult due to the large overlapping amount of decay jets (blue).

This part can be simplified by the use of CheckMATE, a tool that performs automated detector simulation and several analyses.

Goals:

- Exclude or allow the parameter space with LHC14
- which signal (photon / monojet) has higher sensitivity ?