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Search for electroweak production of supersymmetric particles at LHC Run 2 with the ATLAS detector

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Summary. — Searches for supersymmetric particles performed with the ATLAS detector 2015–2016 data will be presented. The physical processes considered are the electroweak production of charginos, neutralinos and sleptons, with final states with leptons and missing transverse energy. No excess above the Standard Model expectations was observed. Exclusion limits at 95% confidence level are reported.

1. – Introduction

Supersymmetry searches based on 36 fb^{-1} of LHC collision data collected by the ATLAS detector [1] in 2015–2016 at $\sqrt{s} = 13\,\mathrm{TeV}$ will be presented.

The Standard Model (SM) does not provide an explanation to many questions, like the nature of Dark Matter and the Higgs boson hierarchy problem. Supersymmetry (SUSY) is a SM extension, that provides a solution to these problems by introducing supersymmetric partners of the known particles. The production of supersymmetric particles depends on the type of interaction involved and on the masses of the particles themselves. The superpartners of quarks and gluons (squarks and gluinos) would be produced in strong interaction with significantly larger production cross-section than the partners of leptons (sleptons) and SM Higgs and gauge bosons (charginos and neutralinos). The direct electroweak production can dominate SUSY production at the LHC if the masses of the gluinos and the squarks are significantly larger. The current exclusion limits on squark and gluino masses extend to up to approximately 2 TeV, making electroweak production an increasingly promising probe for SUSY signals at the LHC.

2. – SUSY searches

Results obtained by various SUSY searches performed by the ATLAS Collaboration will be summarized in the following. Only electroweak production of sleptons, neutralinos and charginos is considered. The final-state signatures that are considered consist of

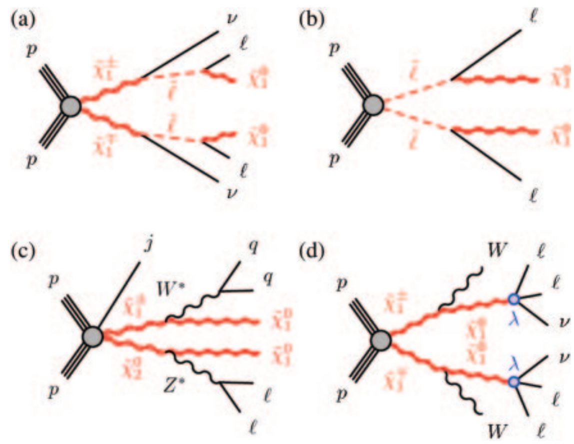

Fig. 1. – SUSY production diagrams for various processes considered in this contribution.

leptons (electrons, muons or taus) and missing transverse energy, due to SM neutrinos or SUSY neutralinos. The neutralino is supposed to be stable and weakly interacting, so it escapes the detector.

2˙1. *2- or 3-leptons signature.* – Three different final states are addressed in the paper [2]: 2 leptons and no jets, 2 leptons and jets or 3 leptons, depending on the decay chain. Only electrons and muons are considered, since the tau kinematic is different.

The production diagrams for the 2 leptons and no jets final state are shown in fig. 1: (a) charginos ($\tilde{\chi}_1^{\pm}$) pair production, decaying to a neutralino ($\tilde{\chi}_1^0$) through sleptons and (b) sleptons direct production, decaying to neutralinos and leptons. Large m_{T2} [3] and large leptons invariant mass are required in order to select signal regions.

In all the considered signal regions no excess above the SM expectations was observed, exclusion limits at 95% confidence level were placed on the SUSY particles masses involved. Exclusion plots referring to the final state with 2 leptons and no jets are reported in fig. 2. The plot on the left considers charginos direct production (supposed to be a pure wino status): chargino mass is excluded up to 740 GeV; the right plot shows the exclusion limits for sleptons direct production, decaying to neutralinos: sleptons are excluded up to 500 GeV.

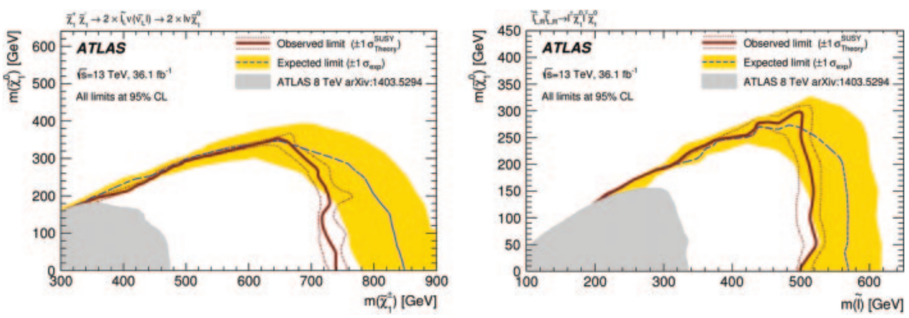

Fig. 2. – Exclusion plots at 95% CL for 2 leptons and no jets final state for charginos production (left) and sleptons production (right) [2].

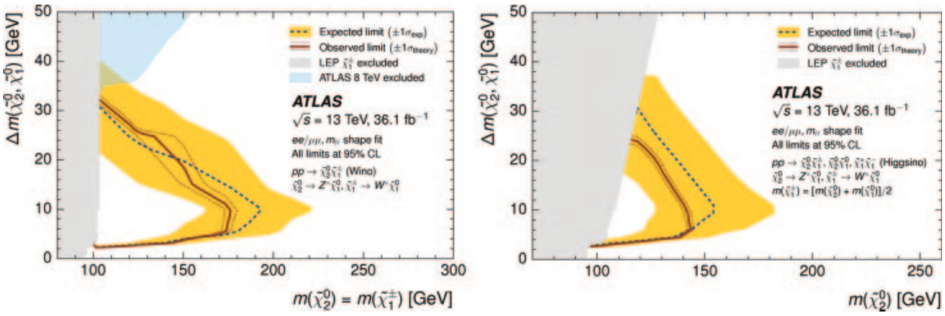

Fig. 3. – Exclusion plots at 95% CL for final state with soft leptons, for wino cross-section (left) and higgsino cross-section (right) [4].

2˙2. *Soft-leptons signature*. – Production of chargino-neutralino ($\tilde{\chi}_1^{\pm}$-$\tilde{\chi}_2^0$) is considered. Chargino and neutralino can be a pure wino-bino status or a pure higgsino status, in the latter case the production cross-section is smaller, making the process detection more difficult. Chargino and neutalino decay to real or virtual W and Z bosons and a small mass difference between SUSY particles is considered, giving low momentum leptons in the final state (fig. 1(c)). Low leptons invariant mass is used to select signal regions.

No significant fluctuation from SM background was observed. In the wino-bino case, the neutralino was excluded up to 140 GeV, considering the higgsino case chargino-neutralino are excluded up to 180 GeV (fig. 3).

2˙3. *Tau-leptons signature*. – The search targets a final state with at least two tau leptons [5]. The production diagram is the same reported in fig. 1(a), but in this case only the tau slepton is considered. The main discriminating variable for the signal region selection is m_{T2}. Charginos were excluded up to 620 GeV.

2˙4. *4-leptons signature*. – Charginos pair production is considered, decaying in the W boson and neutralino [6]. The neutralino is not supposed to be a stable particles, but it can decay in 2 leptons and neutrino violating the leptonic number conservation: the final state is at least 4 leptons (electrons or muons) and missing transverse energy from the neutrinos. The production diagram is reported in fig. 1(c). No significant excess was observed in the signal region, charginos were excluded up to 1100 GeV with 95% CL.

3. – Conclusion

A brief summary of the searches for SUSY particles with electroweak production performed by the ATLAS Collaboration was presented. No significant fluctuations from SM prediction were observed, exclusion limits were placed on the SUSY particles masses, providing a large improvement of the results obtained at LHC Run 1.

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