IL NUOVO CIMENTO **42 C** (2019) 200
DOI 10.1393/ncc/i2019-19200-1

Colloquia: IFAE 2018

Searches for supersymmetric higgsinos with the ATLAS detector

L. Rossini(1)(2) on behalf of the ATLAS Collaboration

(1) *INFN, Sezione di Milano - Milano, Italy*
(2) *Dipartimento di Fisica, Università di Milano - Milano, Italy*

received 31 January 2019

Summary. — A search for supersymmetric partners of the Higgs and gauge bosons (charginos and neutralinos) is presented in this work, using the data from the ATLAS experiment. Considerations on the naturalness of the Higgs boson mass suggest that the two lightest neutralinos might be a mix of the partners of the Higgs and could have a similar mass. Using this scenario as reference, in the analysis we are searching for final states with pairs of electrons and muons with low transverse momentum coming from the decay of the second lightest neutralinos, high missing transverse momentum generated by lightest neutralinos which are non-detectable, and an energetic jet coming from QCD initial-state radiation. Results are shown for the analysis obtained with 36 fb^{-1}, and limits are set on the mass parameter of the higgsinos.

Supersymmetry (SUSY) predicts that for each Standard Model particle there exists a new state that differs by half a unit of spin. The superpartners of the gauge bosons mix together to give mass eigenstates called neutralinos, $\tilde{\chi}^0_{1,2,3,4}$, and charginos, $\tilde{\chi}^{\pm}_{1,2}$ (where the subscripts indicate the increasing mass), or collectively electroweakinos. If the two lightest neutralinos and the lightest chargino are mainly composed of higgsinos, and the mass parameters of the Wino and Bino are large, they form a triplet of states with few GeV of difference in mass and close in mass to the higgsino mass parameter μ [1]. The decay products of $\tilde{\chi}^0_2$ are therefore very soft.

The analysis presented here [2] uses data taken from the events collected by the ATLAS detector [3] during 2015 and 2016. The signal is the direct production of a pair of electroweakinos ($\tilde{\chi}^0_2\, \tilde{\chi}^0_1$ and $\tilde{\chi}^0_2\, \tilde{\chi}^{\pm}_1$), where the $\tilde{\chi}^0_2$ decays into a $\tilde{\chi}^0_1$ and (through a virtual Z^0) two very soft opposite-sign same-flavour leptons, bounded in m_{ll} to the difference in mass of the two neutralinos. The leading lepton must have $p_T > 5\,\mathrm{GeV}$ while the subleading lepton $p_T > 4.5$ (4) GeV if electron (muon). The signal has large missing transverse energy (denoted E_T^{miss}, used to trigger and required to be larger than 200 GeV) due to the two neutralinos boosted against a very energetic jet from initial

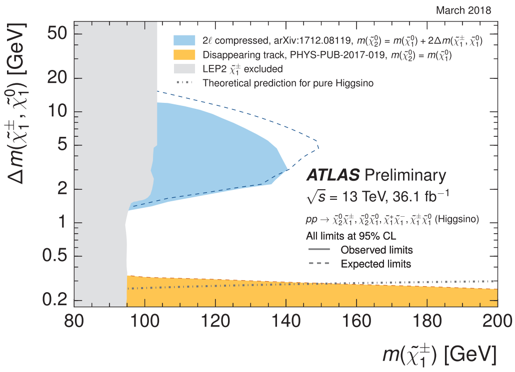

Fig. 1. – Exclusion limits at 95% CL for higgsino pair production. The production cross-section is for pure higgsinos (from [4]).

state radiation which must be at least one and with $p_T > 100\,\text{GeV}$. Sensitivity is further enhanced by asking $\frac{E_T^{miss}}{p_T^{lep1}+p_T^{lep2}} > \max(5, 15 - \frac{m_{ll}}{1\text{GeV}})$. Since the invariant mass (m_{ll}) of the two leptons is bounded to the difference in mass of the two neutralinos, the strategy is to shape fit in the region between 1 and 60 GeV of m_{ll}.

These cuts are optimized to reduce the main sources of background: non-prompt lepton (fakes) and instrumental E_T^{miss}. The main background Monte Carlo processes are normalized to data in Control Regions, while fakes are estimated with a data-driven method. A shape fit between 1 and 60 GeV of m_{ll} has been performed, but no statistical significant excess has been observed and, therefore, only limits on the particles masses have been set. The exclusion limits at 95% Confidence level in the hypothesis of electroweakinos composed of mainly higgsinos is shown as the blue contour in fig. 1. These are the first ATLAS limits on this hypothesis. The LEP limits are also shown in the grey area, while the orange region represents the limits from another ATLAS analysis using the "disappearing track" [5].

REFERENCES

[1] Papucci M., Ruderman J. T. and Weiler A., *JHEP*, **09** (2012) 035 (arXiv:1110.6926 [hep-ph]).
[2] ATLAS Collaboration, *Phys. Rev. D*, **97** (2018) 052010.
[3] ATLAS Collaboration, *JINST*, **3** (2008) S08003.
[4] `https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CombinedSummaryPlots/SUSY/`.
[5] ATLAS Collaboration, *JHEP*, **06** (2018) 022.