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Search for electroweak production of charginos and sleptons decaying into final states with two leptons and missing transverse momentum in $\sqrt{s} = 13$ TeV pp collisions using the ATLAS detector

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Summary. — A search for the electroweak production of charginos and sleptons decaying into final states with two electrons or muons is presented. The analysis is based on 139 fb^{-1} of proton-proton collision data recorded by the ATLAS experiment at the Large Hadron Collider (LHC) at $\sqrt{s} = 13$ TeV. Three scenarios are considered: the production of chargino pairs with decays via either W bosons or sleptons and the direct production of slepton pairs. No significant deviations from the Standard Model expectations are observed and limits at 95% confidence level (CL) are set on the masses of relevant supersymmetric particles in each of these scenarios.

1. – Introduction

Supersymmetry (SUSY) is a theoretical extension of the Standard Model (SM) that, if realised in nature, would solve the hierarchy problem by introducing supersymmetric partners (sparticles) of the particles in the SM. The superpartners of the SM Higgs boson and the electroweak gauge bosons (electroweakinos) mix to form chargino ($\tilde{\chi}_i^{\pm}$, $i = 1, 2$) and neutralino ($\tilde{\chi}_j^0$, $j = 1, 2, 3, 4$) mass eigenstates, ordered by increasing mass. Direct electroweakino production would dominate SUSY production at the LHC if gluinos and squarks were much heavier than low-mass electroweakinos.

This proceeding [1] presents a search for the electroweak production of charginos and sleptons ($\tilde{\ell}$ or $\tilde{\nu}$) decaying into final states with two opposite charged leptons (electrons and/or muons) and significant $\mathbf{p}_{\mathrm{T}}^{\mathrm{miss}}$ ($E_{\mathrm{T}}^{\mathrm{miss}}$ as the magnitude) using 139 fb^{-1} of proton-proton collision data recorded by the ATLAS [2] detector at the LHC at $\sqrt{s} = 13$ TeV.

Three scenarios are presented, based on simplified models [3]. The analysis strategy is optimised to i) search for the direct production of $\tilde{\chi}_1^+\tilde{\chi}_1^-$ where each $\tilde{\chi}_1^{\pm}$ decays into the $\tilde{\chi}_1^0$ and an on-shell W boson, then applied to the others two: ii) the search for the direct production of $\tilde{\chi}_1^+\tilde{\chi}_1^-$, where each $\tilde{\chi}_1^\pm$ decays into a $\tilde{\ell}$ via the emission of a lepton and the $\tilde{\ell}$ itself decays into a lepton and the $\tilde{\chi}_1^0$; iii) the direct pair production of $\tilde{\ell}$, where each $\tilde{\ell}$ decays into a lepton and the $\tilde{\chi}_1^0$.

2. – Analysis strategy and results

Events are required to have exactly two oppositely charged leptons, both with $p_T > 25\,\mathrm{GeV}$. To remove contributions from low-mass resonances and to ensure a good SM background modelling, the invariant mass of the two leptons must be $m_{\ell_1\ell_2} > 100\,\mathrm{GeV}$. Events are further required to have no reconstructed b-jets, to suppress contributions from processes with top quarks. Selected events must also satisfy $E_\mathrm{T}^\mathrm{miss} > 110\,\mathrm{GeV}$ and $E_\mathrm{T}^\mathrm{miss}$ significance >10. Events are separated into "Different Flavour" and "Same Flavour" events, the latter requiring to have a dilepton invariant mass far from the Z peak, $m_{\ell_1\ell_2} > 121.2\,\mathrm{GeV}$ to reduce dibosons and Z+jets background. Events are further classified by the multiplicity of non–b-tagged jets. Following the classification of the events, two sets of signal regions (SRs) are defined, a set of exclusive SRs, to maximise model-dependent search sensitivity, and a set of inclusive SRs, to be used for model-independent results, both defined by specific ranges of the m_{T2} variable [4].

The main irreducible backgrounds come from SM diboson (WW, WZ, ZZ) and top-quark ($t\bar{t}$ and Wt) productions. These are estimated from simulated events, normalised using a simultaneous likelihood fit to data in dedicated control regions (CRs). Three CRs are used: the first one targeting WW production; the second one targeting WZ and ZZ production and the last one targeting $t\bar{t}$ and single-top-quark production. The normalisations of the relevant backgrounds are then validated in a set of validation regions (VRs), which are not used to constrain the fit, but are used to verify that the data and predictions agree within uncertainties in regions of the parameter space kinematically close to the SRs. All relevant sources of experimental and theoretical systematic uncertainty are included in the likelihood fit. The background coming from fake or non-prompt leptons is estimated using a data-driven technique, known as Matrix Method [5]. No significant deviations from the SM expectations are observed in any of the SRs considered. Exclusion limits at 95% CL are set on the masses of the sparticles considered, as shown in fig. 1, as well as model-independent upper limits at 95% CL on the visible signal cross-section of processes beyond the SM.

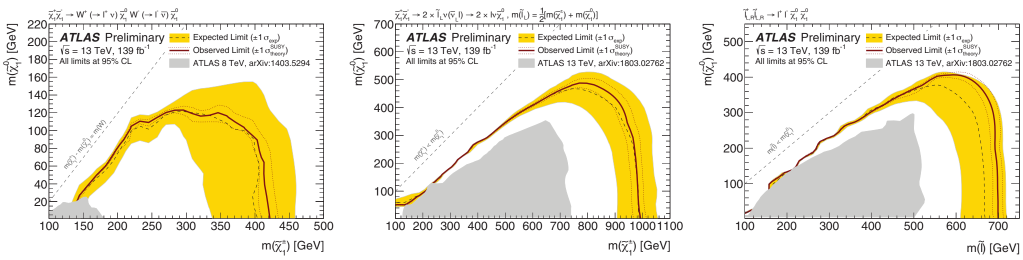

Fig. 1. – Observed and expected exclusion limits on SUSY simplified models for chargino-pair production with (left) W-boson–mediated decays, (center) slepton/sneutrino-mediated decays and for (right) slepton-pair direct production. All limits are computed at 95% CL.

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