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, arXiv:1908.08215

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1 Summary

This is a CheckMATE implementation of a search [1] for the electroweak production of charginos and sleptons. It targets the final states with two leptons (electrons and/or muons). The analysis uses 139 fb^{-1}of proton-proton collision data recorded by the ATLAS experiment at $\sqrt{s} = 13$ TeV from 2015 to 2018. Three R-parity-conserving scenarios where the lightest neutralino is the lightest supersymmetric particle are considered: the production of chargino pairs with decays via either W bosons or sleptons, and the direct production of slepton pairs. The results are in agreement with the Standard Model expectation and therefore 95% confidence level limits are set on the masses of charginos and sleptons. Under assumptions of the massless lightest neutralino, the chargino masses up to 420 GeV are excluded for scenarios with W boson mediated chargino decays, while the limit of 1 TeV is obtained when slepton mediated decays are assumed. This is a CheckMATE implementation validated for version 2 [2, 3].

2 Validation

1. **Chargino production with W mediated decays**

   Process: $pp \to \tilde{\chi}_1^+ \tilde{\chi}_1^- \to \tilde{\chi}_1^0 W^+ \tilde{\chi}_1^0 W^-$
   $m_{\tilde{\chi}_1^\pm} = 300$ GeV, $m_{\tilde{\chi}_1^0} = 50$ GeV
   Events generated with `MG5_aMC 2.6.6` [4] interfaced to `Pythia8` [5] with up to two extra partons. 100000 MC events weighted to 139 fb^{-1}.

Selection	ATLAS	CheckMATE
Total weighted events	26432	26433
Trigger	793	1058
OS signal leptons	661	777
$p_T^{\ell_1,\ell_2} > 25$ GeV	565	608.7
$m_{\ell_1,\ell_2} > 25$ GeV	559	600
number of b-jets	526	568
SR-DF-0J		
different flavour and number of light jets $= 0$	122.7	141
$m_{\ell_1,\ell_2} > 100$ GeV	94.2	107
$E_T^{\text{miss}} > 110$ GeV	46.5	53
E_T^{miss} significance > 10	42.2	52
$m_{T2} > 100$ GeV	26.4	28.6 ± 3.1
SR-DF-1J		
different flavour and number of light jets $= 1$	81.9	91
$m_{\ell_1,\ell_2} > 100$ GeV	62.3	68
$E_T^{\text{miss}} > 110$ GeV	33.8	41
E_T^{miss} significance > 10	27.2	38
$m_{T2} > 100$ GeV	15.3	19.1 ± 2.5
SR-SF-0J		
different flavour and number of light jets $= 0$	138.7	155
$m_{\ell_1,\ell_2} > 121.2$ GeV	92.4	98
$E_T^{\text{miss}} > 110$ GeV	47.1	55
E_T^{miss} significance > 10	42.9	54
$m_{T2} > 100$ GeV	25.4	27.2 ± 3.0
SR-SF-1J		
different flavour and number of light jets $= 1$	88.8	90
$m_{\ell_1,\ell_2} > 121.2$ GeV	58.9	59
$E_T^{\text{miss}} > 110$ GeV	32.6	33
E_T^{miss} significance > 10	26.9	30
$m_{T2} > 100$ GeV	14.0	17.3 ± 2.4

2. **Chargino production with $\tilde{\ell}$ mediated decays (3 flavours)**

Process: $pp \to \tilde{\chi}_1^+ \tilde{\chi}_1^-$ followed by decays (3 flavours included)
$\tilde{\chi}_1^+ \to \tilde{\ell}^+ \nu_\ell \to \tilde{\chi}_1^0 \ell \nu_\ell \qquad \tilde{\chi}_1^+ \to \tilde{\nu}_\ell \ell \to \tilde{\chi}_1^0 \ell \nu_\ell$
$m_{\tilde{\chi}_1^\pm} = 600$ GeV, $m_{\tilde{\ell}^\pm} = 300$ GeV, $m_{\tilde{\chi}_1^0} = 1$ GeV
Events generated with `MG5_aMC 2.6.6` [4] interfaced to `Pythia8` [5] with up to two extra partons. 10000 MC events weighted to 139 fb^{-1}.

Selection	ATLAS	CheckMATE
Total weighted events	1320	1320
Trigger	516	637
OS signal leptons	439	479
$p_T^{\ell_1,\ell_2} > 25$ GeV	430	461
$m_{\ell_1,\ell_2} > 25$ GeV	429	460
number of b-jets	401	431
SR-DF-0J		
different flavour and number of light jets $= 0$	82.8	103
$m_{\ell_1,\ell_2} > 100$ GeV	77.8	96
$E_T^{\text{miss}} > 110$ GeV	66.8	82
E_T^{miss} significance > 10	62.9	78
$m_{T2} > 100$ GeV	53.8	66.2 ± 3.1
SR-DF-1J		
different flavour and number of light jets $= 1$	66.3	68
$m_{\ell_1,\ell_2} > 100$ GeV	61.3	62
$E_T^{\text{miss}} > 110$ GeV	53.4	53
E_T^{miss} significance > 10	48.6	50
$m_{T2} > 100$ GeV	40.7	39.4 ± 2.5
SR-SF-0J		
different flavour and number of light jets $= 0$	89.8	102
$m_{\ell_1,\ell_2} > 121.2$ GeV	82.2	93
$E_T^{\text{miss}} > 110$ GeV	68.7	82
E_T^{miss} significance > 10	63.5	76
$m_{T2} > 100$ GeV	56.0	63.2 ± 3.1
SR-SF-1J		
different flavour and number of light jets $= 1$	74.0	60
$m_{\ell_1,\ell_2} > 121.2$ GeV	65.5	55
$E_T^{\text{miss}} > 110$ GeV	55.9	50
E_T^{miss} significance > 10	49.7	45
$m_{T2} > 100$ GeV	41.7	37.1 ± 2.4

3. **Selectron/smuon production**

Process: $pp \to \tilde{\ell}^+\tilde{\ell}^- \to \tilde{\chi}_1^0\ell^+\tilde{\chi}_1^0\ell^-$
$m_{\tilde{\ell}^\pm} = 400$ GeV, $m_{\tilde{\chi}_1^0} = 200$ GeV
Events generated with `MG5_aMC 2.6.6` [4] interfaced to `Pythia8` [5] with up to two extra partons. 5000 MC events weighted to 139 fb^{-1}.

Selection	ATLAS	CheckMATE
Total weighted events	503	503
Trigger	352	415
OS signal leptons	318	314
$p_T^{\ell_1,\ell_2} > 25$ GeV	316	310
$m_{\ell_1,\ell_2} > 25$ GeV	315	309
number of b-jets	298	288
SR-SF-0J		
different flavour and number of light jets $= 0$	136.0	138
$m_{\ell_1,\ell_2} > 121.2$ GeV	123.5	123.6
$E_T^{\text{miss}} > 110$ GeV	97.5	93.3
E_T^{miss} significance > 10	88.5	85.3
$m_{T2} > 100$ GeV	75.1	71.0 ± 2.7
SR-SF-1J		
different flavour and number of light jets $= 1$	99.2	87.5
$m_{\ell_1,\ell_2} > 121.2$ GeV	90.3	78.4
$E_T^{\text{miss}} > 110$ GeV	71.8	62.5
E_T^{miss} significance > 10	61.3	52.8
$m_{T2} > 100$ GeV	51.1	42.8 ± 2.1

References

[1] G. Aad *et al.* [ATLAS Collaboration], "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," arXiv:1908.08215 [hep-ex].

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