Search for electroweak production of charginos and neutralinos in multileptonic final states with the ATLAS experiment

Marco Aparo
University of Sussex, UK
On behalf of the ATLAS Collaboration

Electroweak SUSY: the physics case

- Supersymmetry (SUSY) introduces a fermion-boson symmetry (As = 1/2) in the Standard Model (SM) [1]
- R-Parity
  \[ P_R = (-1)^{3B + 2L + 2S} \]
- If R-Parity is conserved
  \[ \tilde{\chi}^0_1 \text{ is stable and a good dark matter candidate} \]
- Mass of strongly interacting \( \tilde{q}/\tilde{g} \) excluded up to \( \sigma(\text{TeV}) \) scale
  \[ \tilde{\chi}^0_1, \tilde{\chi}^0_2 \text{ may be the dominant SUSY process} \]
- Charginos, \( \tilde{\chi}^{\pm}_1 \text{ (i=1,2), and neutralinos, } \tilde{\chi}^0_i \text{ (i=1,2,3,4),} \) produced and studied via their electroweak interaction
- \( \tilde{\chi}^+_1/\tilde{\chi}^0_1 \rightarrow WZ/h \rightarrow 2/3 \text{ leptons are key analyses to search for SUSY} \)
- Full Run 2 analysis recently released [4]
  - No significant deviation from SM observed \( \rightarrow \) upper limits on \( m(\tilde{\chi}^+_1/\tilde{\chi}^0_1) \) and \( m(\tilde{\chi}^0_i) \) using the CLs prescription

\[ \tilde{\chi}^{\pm}_1, \tilde{\chi}^0_1 \rightarrow WZ/h \rightarrow 3\ell \text{ search} \]

Comparison of the observed data and expected SM background yields in the SRs for \( WZ \) (left) and \( Wh \) (right) models [4]

- SIGNAL SEARCH STRATEGY
  - Same flavour opposite sign (SFOS) lepton pair \( \rightarrow \) + 1 extra lepton
  - Same flavour same sign (SFSS) lepton pair
  - Different flavour opposite sign (DFOS) lepton pair

Simplified models assumptions:
- R-Parity conserving
- \( \tilde{\chi}^{\pm}_1/\tilde{\chi}^0_1 \rightarrow \text{Wino-like}; \tilde{\chi}^0_1 \rightarrow \text{Bino-like} \)
- \( m(\tilde{\chi}^+_1) = m(\tilde{\chi}^0_1) > m(\tilde{\chi}^0_2) \)
- On-shell decays to \( W/Z/h \), with 100% BR

3 isolated e or \( \mu + E_T^{miss} + \) light (not b-tagged) jets

- TARGET
  - 1 Same flavour Opposite Sign (SFOS) lepton pair
  - \( m(\tilde{\chi}^{\pm}_1) > m(\tilde{\chi}^0_1) \)
  - \( m(\tilde{\chi}^{\pm}_1) < m(\tilde{\chi}^0_1) \)
  - 1 Same flavour Opposite Sign (SFOS)
  - 1 Same flavour Same Sign (SFSS) lepton pairs

- Production of \( \tilde{\chi}^+_1, \tilde{\chi}^0_1 \) decaying to 3 \( \ell \) via \( WZ \) (left) or \( Wh \) (right)

Induced backgrounds (e.g. prompt leptons from SM \( W/Z \) or dijet or dijet-like backgrounds with data-driven techniques)

- \( \tilde{\chi}^{\pm}_1, \tilde{\chi}^0_1 \) decaying to \( 2 \) \( \ell \) same-sign via \( Wh \)

- Full Run 2 analysis recently released [4]
- No significant deviation from SM observed \( \rightarrow \) upper limits on \( m(\tilde{\chi}^+_1/\tilde{\chi}^0_1) \) and \( m(\tilde{\chi}^0_i) \) using the CLs prescription

\[ \tilde{\chi}^{\pm}_1, \tilde{\chi}^0_1 \rightarrow Wh \rightarrow 2\ell \text{ same-sign search} \]

Limits at 95% CL for \( WZ \) (left) and \( Wh \) (right) models in the \( 3\ell \) channel [4]

- 2 isolated same-sign (SS) e or \( \mu + E_T^{miss} + \) light (not b-tagged) jets

- Simplified model with same assumptions as \( 3\ell \) case
- \( 2\ell \)-SS search is complementary to \( 3\ell \) search \( \rightarrow \) facilitate statistical combination of multileptonic searches
- Analysis strategy similar to \( 3\ell \) case (orthogonal SRs/CRs/VRs)
- Some of the expected backgrounds include SM \( WZ \) (irreducible with prompt leptons) and lepton charge mis-reconstruction, or \( \text{charge-flip} \) (reducible)
- Early Run 2 results show good agreement with the SM prediction [5]
  - Upper limits on \( m(\tilde{\chi}^+_1/\tilde{\chi}^0_1) \) and \( m(\tilde{\chi}^0_i) \) using the CLs prescription
- Stay tuned for more exciting ATLAS SUSY results!

Limits at 95% CL for the \( Wh \) model in \( 2\ell \)-SS channel [5]

References: