Search for new particles in events with one lepton and missing transverse momentum in $pp$ collisions at $\sqrt{s} = 8$ TeV

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**Introduction**

A search for new particles in events with one lepton (electron or muon) and missing transverse momentum using 20.3 fb$^{-1}$ of proton-proton collision data at $\sqrt{s} = 8$ TeV recorded by the ATLAS experiment(1).

Many models predict the existence of heavy gauge bosons. The first new physics scenario that is investigated is the Sequential Standard Model (SSM), the extended gauge model of ref. [2]. This model proposes the existence of additional heavy gauge bosons, of which the charged ones are commonly denoted as $W'$. The $W$ has the same couplings to fermions as the SM W boson and a width that increases linearly with the $W'$ mass.

The second new physics scenario that is investigated originates from ref. [3] and proposes the existence of charged partners, denoted $W'$, of the chiral boson excitations described in ref. [4]. The anomalous (magnetic moment-type) coupling of the $W'$ leads to kinematic distributions significantly different from those of the $W$.

The analysis is also sensitive to dark matter pair production in association with a leptonically decaying $W$ boson, see [6].

**Search Strategy**

Search for high mass states that decay into a lepton and missing transverse momentum $m_T = \sqrt{\sum p_T^2 (1-\cos \phi_{p_T})}$

The observable is transverse mass:

$$m_T = \sqrt{2 p_T^* E_T^* (1 - \cos \phi_{p_T})}$$

An event counting experiment is performed, and the probability of a significant excess above background expectations is investigated. If no excess is observed, set limit on the $W'$.

To choose the optimal $m_T$ threshold for a particular mass point in the $W'$ search, the $m_T$ threshold bins are scanned for the threshold that gives the smallest expected limit.

**Background**

- $W'\rightarrow l\nu$ (Irreducible and the dominant one)
- $Z'\rightarrow l_1l_2$ (One of the leptons is not reconstructed)
- Diboson ($WW, WZ, ZZ, W\gamma$)
- Top quarks ($t\bar{t}$ and $t\mu$)
- Multijet + QCD (Events with unidentified leptons and mismeasured jets - Data estimated)

**Candidate selection**

- Primary Vertex = pp collision
  - at least 3 tracks, $|z|<200$ mm
- Impact Parameter = cosmic rays rejection
  - $d\eta/d<0.2$ mm
  - $L_2<1$ mm
- Jet Cleaning = avoid events with spurious $E_T^{miss}$
  - $E_T^{miss} > 125$ GeV ($\ell$) or 45 GeV ($\mu$) – enhancement of associated neutrino production

**Electron**

- Central electrons
  - $E_T > 125$ GeV
  - $|\eta| < 2.47$
- Medium electron identification
  - ID hits
  - Trigger matching
  - Reconstructed electron with trigger track
  - Isolation
  - QCD rejection

**Muon**

- Combined muons
  - $p_T > 45$ GeV
- Combined = ID + MS tracks loosely matched
  - ID and MS hits
  - Trigger matching
  - Reconstructed muon with trigger track
  - Isolation
  - QCD rejection
  - ID-MS momentum
- Remove muons with mismeasured momentum

**Results**

Select a high-$p_T$ lepton

Require $E_T^{miss}$ that balances the lepton $p_T$

Search the $m_T$ distributions for excesses

Relative uncertainties on the selection efficiency $E_{sel}$ and expected number of background events $N_{bg}$ for a $W'$ and $W''$ with a mass of 2000 GeV.

**Conclusions - Limits**

No significant excess beyond Standard Model expectations is observed. A $W'$ with SSM couplings is excluded at the 95% confidence level for masses up to 3.24 TeV. Excited chiral bosons ($W''$) with equivalent coupling strengths are excluded up to a mass of 3.21 TeV [8].

One of the highest $m_T$ events in the electron channel. The electron has a $p_T$ of 525 GeV and $\eta=0.37$. The event has $E_T^{miss}=525$ GeV and $m_T=1050$ GeV.

One of the highest $m_T$ events in the muon channel. The muon has a $p_T$ of 902 GeV and $\eta=0.78$. The event has $E_T^{miss}=259$ GeV and $m_T=966$ GeV.

**References**

[1] ATLAS Collaboration, B-Phase: A 1000 TeV detector

**Acknowledgments**