Search for new resonant phenomena in the high-mass dilepton final states using Run 2 data from ATLAS

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LHCC Poster Session, 19 Feb 2020

Outline

The search for new resonant production in dielectron and dimuon final states in TeV scale is presented. The data, corresponding to an integrated luminosity of 139 fb^{-1}, were recorded by the ATLAS experiment in proton–proton collisions at a centre-of-mass energy of sqrt(s) = 13 TeV during Run 2 of the Large Hadron Collider. The search covers dielectron invariant masses from 250 GeV to 6 TeV. The background models are a functional form fit to the data, and generic signal shapes are used to represent various models with different resonant widths and masses. No significant deviation from the expected background is observed and 95% confidence level upper limits are set on the fiducial cross-section times branching ratio for several models. For benchmark models, limits are converted to lower limits on the resonance mass and reach 4.5 TeV for the E_8 motivated Z' boson.

ATLAS Detector

The ATLAS detector is a multiple purpose particle detector located at the LHC. The detector covers nearly the entire solid angle around the collision point. It consists of:

- An inner tracking detector (ID) surrounded by a thin superconducting solenoid
- Electromagnetic and hadronic calorimeters
- A muon spectrometer (MS) incorporating three large superconducting toroid magnets

The MS comprises separate trigger and high-precision tracking chambers. Muons are reconstructed by a combination of tracks from the ID and MS. Electrons are reconstructed from energy deposits in the electromagnetic calorimeter and tracks in the ID.

Analysis Details

Object Definitions

The primary objects used in this analysis are muons and electrons. Candidate objects must pass these cuts:

- Selection criteria:
  - E_T > 30 GeV
  - p_T > 30 GeV

- Impact parameter:
  - |d_0| < 0.003 mm

- Vertex requirements (for ee channels):
  - d_V < 3.0 mm

- Visible mass (mVV)

Event Selection

Events are required to contain at least two same-flavor leptons. Dimuons are required to be oppositely charged. In events with both dielectron and dimuon pairs, the dilepton pair is preferred due to the higher efficiency.

M_{ll} Spectra

Mass distributions in the ee and μμ channels. The solid red line shows the background fit, while the dotted red lines show generic Z' signals.

Limits

Upper limits on the fiducial σ × BR for the dilepton combination are shown in this plot. Model predictions are superimposed on top of the limits for aSSM, ψ, and Z' bosons. Masses below the intersection of the model prediction and the observed limit are considered excluded. The observed and expected lower limits are shown in the table. This result improves upon the previous exclusion by 500-800 GeV.

<table>
<thead>
<tr>
<th>Model</th>
<th>Lower limits on m_{Z'} [TeV]</th>
<th>ee</th>
<th>μμ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z'</td>
<td>4.1</td>
<td>4.4</td>
<td>4.0</td>
</tr>
<tr>
<td>SSM</td>
<td>4.6</td>
<td>4.6</td>
<td>4.2</td>
</tr>
<tr>
<td>Z'_{SM}</td>
<td>4.9</td>
<td>4.9</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Summary

Comparison of this result (black) with previous ATLAS results.