The Dijet+ISR Analysis in ATLAS: SEARCHING FOR LOW-MASS DARK MATTER MEDIATOR

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Abstract

The WIMP model in the simplified form used as a benchmark by LHC experiments predicts dark matter mediator particles, $Z'$, which would interact as $Z$- or $\gamma$ searches.

With a larger number of high energy proton-proton collision events than ever in history, ATLAS is now able to probe decay channels that could not previously be studied. By requiring initial state radiation (ISR) in the standard $Z' \rightarrow j j$ dijet channel, we are able to go beyond previous experimental trigger constraints and push the searchable $Z'$ mass limit down to 100 GeV. This poster displays the latest ATLAS jet and dijet analysis results for resolved jets topology in 2016 data. A newly studied experiment technique using a machine learning method to estimate the background shape will also be discussed.

Why Dark Matter?

Standard model of particle physics failed to explain various astronomical observation in the last couple of decades.

- Red: Ordinary matter collides and heats up to emit light
- Blue: Dark matter passes through the other cluster of galaxies with no visible interaction

1. Bullet clusters collisions
2. Cosmic microwave background matter composition
3. Rotational velocity curves of galaxies

- Dark matter, a particle that has mass but does not interact with light is hypothesized to explain all of these phenomena.

Why Di-jet ISR?

The simplified WIMP model considered here predicts $Z'$ DM mediator.

The $Z'$ decay to DM can lead to a "Mono-X" final state if produced along ISR; the $Z'$ could also decay to standard model dijet or dilepton final states.

DM Mediator Search

Theoretical calculation of the thermal freeze out of a particle with a mass near the weak scale could lead to the observed relic abundance of dark matter if it is weakly interacting.

Resolved Di-jet ISR

Model-independent check for discrepancies from SM does not find any significant excess.

Boosted Di-jet ISR

Event Selection: Large R jet (2 resonance jets) $R=1.0$, $|\eta_j| < 2.6$, $E_T^j < 50$ GeV and $m_{jj} > 1.5$ Channel specific:
- ISR jet: $E_T^j > 60$ GeV, $R=0.4$, from primary vertex
- ISR photon: $|\eta| < 2.37, E_T^j > 150$ GeV

Boosted: The resonance jets fall into 1 jet cone of $\Delta R=1.0$

Mass decorrelated jet tagging substructure as a selector to increase sensitivity for the trijet channel.

Result comparison

- Dijet ISR is able to push $Z'$ mass limit to 100-920 GeV
- $Z'$ reinterpreted limit for axial-vector-mediated DM
- $Z'$ reinterpreted limit for vector-mediated DM

Possible Improvements

- Background estimation with Gaussian process
- Pseudo Toy data show good fitting result.
- G.P shows better performance in high luminosity

References