Efficiency of ML Anomaly Detection Triggers for Emerging Jets

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Emerging Jets (EMJs)
- Astronomical observations (e.g. galaxy rotation curves) indicate the existence of dark matter.
- Hidden Valley models propose a dark QCD-like sector that couples to the SM through a mediator particle [1]
  - EMJ: Phenomenological model where long-lived dark mesons decay into SM quarks, producing sub-jets with displaced vertices.
  - No significant deviation from the SM was observed.
- In this work we focus on the s-channel and on how novel AD triggers could help find this signal.

Anomaly Detection (AD) Triggers
- Traditional triggers are based on prior knowledge of the signal, or on kinematic cuts.
- AD ML techniques find signals which are different from typical events, independent of a model.
- AD triggers are trained on typical events, so they fail to reconstruct rare or beyond SM signals.
- Two AD Triggers:
  - CICADA: Convolutional Autoencoder [3]
  - AXOL1TL: Variational Autoencoder [4]

Work So Far
- Development of s-channel Pythia MC production code.
- Production of s-channel samples for mass values ranging from 100 GeV to 2000 GeV.
- Substantial improvement in trigger efficiency observed when including AD triggers for lower Z' mass, but negligible improvements for higher mass.
- Study of how jet kinematic distributions are impacted by cuts on the AD scores.
- Derived ROC curves from AD scores and observed good discrimination of EMJ events against typical events.

Future Work
- Study background mass sculpting due to AD triggers.
- Include novel LLP triggers in trigger efficiency study.
- Study LLP and AD trigger efficiencies as a function of the lifetime of the long-lived dark mesons.

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Bibliography

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