Tau Identification and Leptoquarks at ATLAS

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Leptoquark Overview

What is a LQ?

- BSM particle with baryon and lepton quantum numbers
- Link between the similar structure between quark and lepton families



- General class of BSM models predict the existence of LQs:
- Lepton flavour universality potentially observed at LHCb in
- ➢ g-2 discrepancy
- Neutrino masses



Searching for new physics:

- Better tau and flavour tagging at ATLAS
- Improved modelling
- ➤ Concentrate on high-pT region → less background and challenge is to deal with lower statistics
- More data, improved multivariate techniques and background estimations

Leptoquark Signal Sample Generation

 Vector LQ Model (Massive spin-1)

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Possible to probe this through spin correlations



- Angular observables defined to study these effects
- $\geq \frac{E_{had}}{E_{tau}}$ represents energy of hadronic component of tau/ energy of tau
- L.H tau the neutrino carries away more energy
- Implemented into the new signal samples



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Leptoquark Invariant Mass

- We want to reconstruct the invariant mass of the LQ system
- Neutrinos are missing transverse energy in the detector





 $au_{had} au_{had}$ channel



Collinear Mass Approximation:

- ► LQ is heavy s.t the decay products are considerably boosted → tau and neutrino are collinear.
- Assume all MET is from neutrinos only



What is Tau Identification?



- T- lepton decays hadronically (66%)
- Reconstructed as jets inside the ATLAS detector
- ➤ Two main categories: 1/3 prong → number of charged mesons in decay



- Major background are QCD Dijets
- Tau Identification refers to this classification challenge



 Currently an RNN based architecture is used for the classification

Graph Neural Network for Tau Identification



Ongoing Studies Work with Tau Identification



Future Work and Outlook

Leptoquarks:

- Studies on background (ttbar, single top, etc)
- Sensitivity studies
- Fake modelling
- Thesis on Run 2+3/ Aiming for a paper Tau Identification:
- Complete write-up of QT and become ATLAS author
- Studies on additional input features comparing GNN models
- Studies on inclusive vs exclusive prongness impact
- Additional signal processes

Thank you for listening!

Any questions?



Backup: Current Experimental Limits from ATLAS



LQ(qµ)