Contribution ID: **6** Type: **Contributed talk**

Integrating Energy Flow Networks with Jet Substructure Observables for Enhanced Jet Quenching Studies

Wednesday 21 May 2025 16:30 (20 minutes)

The phenomena of Jet Quenching, a key signature of the Quark-Gluon Plasma (QGP) formed in Heavy-Ion (HI) collisions, provides a window of insight into the properties of the primordial liquid. In this study, we evaluate the discriminating power of Energy Flow Networks (EFNs), enhanced with substructure observables, in distinguishing between jets stemming from proton-proton (pp) and jets stemming from HI collisions. This work is a crucial step towards separating HI jets that were quenched from those with little or no modification by the interaction with the QGP on a jet-by-jet basis. We trained simple Energy Flow Networks (EFNs) and further enhanced them by incorporating jet observables such as N-Subjettiness and Energy Flow Polynomials (EFPs). Our primary objective is to assess the effectiveness of these approaches in the context of Jet Quenching, exploring new phenomenological avenues by combining these models with various encodings of jet information. Initial evaluations using Linear Discriminant Analysis (LDA) set a performance baseline, which is significantly enhanced through simple Deep Neural Networks (DNNs), capable of capturing non-linear relations expected in the data. Integrating both EFPs and N-Subjettiness observables into EFNs results in the most performant model over this task, achieving state-of-the-art ROC AUC values of approximately 0.84. This significant performance is noteworthy given that both medium response and underlying event contamination effects on the jet are taken into account. These results underscore the potential of combining EFNs with jet substructure observables to advance Jet Quenching studies and adjacent areas, paving the way for deeper insights into the properties of the QGP. Results on a variation of EFNs, Moment EFNs (MEFNs), which can achieve comparable performance with a more manageable and, in turn interpretable, latent space, will be presented.

Would you like to be considered for an oral presentation?

Yes

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Session Classification: Contributed Talks

Track Classification: 2 ML for analysis: Event classification, statistical analysis and inference, anomaly detection