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

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 this primordial liquid. In this study, we rigorously 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 yet another step towards separating significantly quenched jets from relatively unmodified ones on a per-jet basis, which would enable increasingly more precise measurements of QGP properties. We have analyzed simple Energy Flow Networks (EFNs) and subsequently augmented them with global features such as N-Subjettiness observables and Energy Flow Polynomials (EFPs). Our primary objective is to gauge the power of these approaches in the context of Jet Quenching. Initial evaluations using Linear Discriminant Analysis (LDA) set a performance baseline, which is further enhanced through simple Deep Neural Networks (DNNs), capable of capturing non-linear relations in the data. Integrating 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, a very considerable value given that both medium response and underlying event contamination effects are taken into account.

Primary Field of Research

Particle Physics

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