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Exploring perturbative QCD splittings in heavy-ion collisions

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We propose a novel approach to investigate the evolution of jets in heavy-ion collisions by employing a combination of jet substructure measurements. Our method focuses on isolating the perturbative regime of jet evolution. As a proof of concept, we analyze the distribution of the hardest splitting above a transverse momentum scale, $k_{t,cut}$, in high-p_t jets. For a $k_{t,cut}$ that is significantly greater than any medium scale, the observable is determined by vacuum-like emissions. Therefore, it serves as a unique baseline independent of the medium modeling. Furthermore, a moderate $k_{t,cut}$ enhances the sensitivity to energy loss, specifically highlighting the presence of a critical resolution angle. Finally, at low $k_{t,cut}$, the observable becomes sensitive to induced emissions and medium response. We validate the generality of our findings using various heavy-ion event generators, including Hybrid, JetMed, Jewel, and Matter+LBT/MARTINI models. Consequently, these substructure measurements can serve as a valuable guideline for future model developments, effectively disentangling different medium contributions. Our study paves the way for the definition of jet observables that can be calculated from first principles, dominated by perturbative QCD, and within the experimental reach of Run3 at the LHC.

Category

Theory

Collaboration (if applicable)

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