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Exploring QCD dynamics using the jet invariant mass

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Systematic studies of jet substructure offer precision tests of quantum chromodynamics (QCD) in vacuum as well as at the large particle densities and high temperatures of the quark-gluon plasma (QGP) produced in heavy-ion collisions. The jet invariant mass is a canonical jet substructure observable which has been broadly studied for decades, both experimentally and theoretically, to qualify the shape of jets and to identify boosted particles. A proxy for the virtuality Q of the initiating parton, the jet invariant mass is a perturbatively calculable probe of an uncontrolled variable in scattering experiments, though it is also dominated by nonperturbative corrections at small values, presenting an excellent test of QCD dynamics across a broad range of Q^2. The jet invariant mass can be combined with jet grooming procedures such as soft drop to remove soft, wide-angle radiation, both enhancing the predictive strength of perturbative calculations and reducing experimental systematic uncertainties. First-principles calculations are essential to estimate QCD backgrounds in particle searches in combination with Monte Carlo generators, which have surprisingly produced jet mass distributions in tension with one another. The jet invariant mass has also presented mysteries in heavy-ion collisions, where observed quenching modifications are in apparent disagreement with those observed for theoretically related jet angularities.

This talk presents an overview of recent jet invariant mass measurements from the Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC) in both pp and heavy-ion collisions. These measurements provide tests of QCD in vacuum and of jet quenching models, providing new critical information on nonperturbative dependence and QCD medium evolution. Comparing measurements from RHIC and the LHC provides insight on QGP dynamics at different energy scales. This talk furthermore looks forward to future precision measurements of the heavy-flavor tagged jet invariant mass, which will offer a unique frontier to disentangle the QCD dead cone from Casimir color effects, while also testing novel flavor tagging algorithms and perturbative QCD with a nonzero quark mass.

session

G. Heavy Ion Physics

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