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Identifying jet observables which can see the short-length structure of QGP

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Quark-gluon plasma, which is a strongly coupled liquid at its natural length scales, must at the same time feature weakly coupled quark and gluon quasiparticles that appear only in hard processes that can resolve its short-length structure. In particular, high-energy partons in a jet shower can scatter off, and kick, the quark and gluon quasiparticles within a droplet of QGP when these Moliere scattering processes occur with a large enough momentum transfer. Here, we implement this physics within the hybrid strong/weak coupling model for jets in heavy ion collisions.

Throughout its evolution within the expanding cooling droplet of QGP, the shower of jet and recoil partons inject energy and momentum into the QGP, producing wakes. The large impact of the wakes generated by the hydrodynamic response of the medium on jet observables makes finding distinctive signatures of scattering off QGP quasiparticles challenging.

The hybrid model is particularly valuable for identifying observables that are more/less sensitive to consequences of scattering off quasiparticles and less/more sensitive to consequences of wakes in the QGP because when we turn Moliere scattering off the model contains no effects of scattering —energy loss in the model arises from strongly coupled physics, not from scattering.

We show that jet shapes and fragmentation functions are more sensitive to the contribution of the wake to the reconstructed, and identify various groomed jet observables (eg soft drop splitting angle, leading k_T, and girth) that are insensitive to this contribution and that show reasonable sensitivity to scattering off quasiparticles, with those in gamma-jet events of particular interest. We also investigate Z-hadron correlation observables and Z-jet acoplanarity observables constructed with the winner-take-all definition of the jet direction. We construct several promising observables from inclusive subjets within jets, and show that Moliere scattering increases the number of subjets and yields subjets which are more widely distributed and more widely separated. These observables are unaffected by the wake; they are directly sensitive to "sprouting a new subjet", the intrinsic feature of Moliere scattering which makes its effects different from those of the wake.

Category

Theory

Collaboration (if applicable)

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