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Modification of jet substructure in heavy ion collisions as a probe of the resolution length of quark-gluon plasma

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In this work we present an analysis of the role that the quark-gluon plasma resolution length, the minimal distance by which two nearby colored charges in a jet must be separated such that they engage with the plasma independently, plays in the understanding of modifications of jet substructure modification due to interaction with QGP. The shorter the resolution length of QGP is the better the resolving power of this medium. We identify a set of observables that are very sensitive to whether jets are quenched as if they are single energetic colored objects or whether the medium has the ability to resolve the internal structure of the jet instead. Using the hybrid strong/weak coupling model, we find that although the ungroomed jet mass is not suitable for this purpose because it is very sensitive to effects of the particles coming from medium response, groomed observables such as the number of Soft Drop splittings, the momentum sharing fraction, or the groomed mass are particularly well suited to discriminate the degree to which the medium resolves substructure within the jet. In order to find the optimal grooming configuration, we explore different cuts on the Lund plane that allow for a clear identification of the regions of phase space that enhance the difference in jet substructure between vacuum and quenched jets. Comparison with present data seems to disfavor an "infinite resolution length", which is to say it disfavors the hypothesis that the medium interacts with the jet as if it were a single energetic colored object. Our analysis indicates that as the precision of experimental measurements of jet substructure observables and the control over uncertainties in their calculation improves, it will become possible to use comparisons like this to constrain the value of the resolution length of quark-gluon plasma as well as to see how the substructure of jets is modified via their passage through it.

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