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Jet Substructure for heavy ion collisions

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We develop an Effective Field Theory (EFT) framework to compute jet substructure observables for heavy ion collision experiments.
We consider dijet events that accompany the formation of a Quark Gluon Plasma medium in a heavy ion collision and look at the simultaneous measurement of jet mass along with the transverse momentum imbalance between the jets accounting for both vacuum and medium evolution.
The jets are groomed using a soft drop grooming algorithm in order to mitigate effects of soft contamination from Multi-parton interactions as well as the QGP medium. Treating the energetic jet as an open quantum system interacting with a QGP bath, we write down a factorization formula within the SCET(Soft Collinear Effective Theory) framework, including the recent addition accounting for the forward scattering regime. This leads us to a Lindblad type master equation for the evolution of the reduced density matrix of the jet in the Markovian approximation. The resulting solution allows us to resum large logarithms that arise due to the final state measurements imposed while simultaneously summing over multiple interactions of the jet with the medium. We find that the the decoherence between the hard interaction that creates the jet and the subsequent medium interactions lead to *physical* Infra-Red(IR) collinear divergences that are otherwise absent in pure vacuum evolution. We show that these IR divergences are completely regulated by the medium induced gluon mass and highlight the need to develop a multi-scale EFT approach in the future to resum the new logarithms that arise from these divergences.

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