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Exploring the equilibration time of the QGP with jet quenching

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Heavy-ion collisions produce a quark-gluon plasma that undergoes rapid expansion and cooling, which presents a challenge for calculating jet quenching observables. Current approaches rely on analytical results for static cases, introducing theoretical uncertainties and biases in our understanding of the pre-equilibrated medium. To address this issue, we employ analytical re-summation schemes to incorporate multiple scattering in a class of expanding backgrounds. By introducing a new length scale related to the equilibration time of the QGP, we investigate the range of validity of Bethe-Heitler emissions, LPM interference effects, and higher-twist contributions to the emitted gluon spectrum. We also discuss methods to mitigate the non-local nature of the emission spectrum. Our analysis shows that strong jet quenching is only possible when the equilibration time of the medium is longer than its mean free path, highlighting the importance of medium modifications of jets in the earliest stages of heavy-ion collisions. By accounting for the expansion of the medium, our approach reduces the uncertainties in model predictions for jet quenching observables, providing insights into the nature of the pre-equilibrated medium. This work lays the foundation for further investigations into the dynamics of the QGP and the interplay between jets and the expanding medium.

Category

Theory

Collaboration (if applicable)

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