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Nonlinear dynamics of jet quenching

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We develop a comprehensive analytic framework for jet quenching in QCD media, based on a medium-induced parton cascade sourced by collinear virtual splittings. We show that the energy flow out of the jet cone, driven by turbulent gluon cascades, is governed by a non-linear rate equation that resums gluon splittings at arbitrary angles and is enhanced by the medium length, L. The solution of this equation sets the initial condition for a non-linear DGLAP-like evolution equation, which describes the collinear early vacuum cascade resolved by the medium at angles exceeding the medium resolution angle, θ_c. For asymptotic jet energies, the medium-induced cascade displays an exponential behavior that generalizes the Poisson-like distribution of parton energy loss. This formulation enables the resummation of leading contributions in $\ln(1/R)$, and $\ln(R/\theta_c)$, and powers of L. We briefly explore the limit of strong quenching, where analytic treatments are feasible, offering insights into the impact of parton cascades on jet quenching. These results provide guidance for future numerical simulations and analytical investigations.

Category

Theory

Collaboration (if applicable)

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