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Calculating hard probe radiative energy loss beyond soft-gluon approximation: how valid is the approximation?

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One of the most common assumptions when calculating radiative energy loss of high $p_\perp$ particles in quark-gluon plasma is the soft-gluon approximation, which considers that initial parton losses only a small amount of its energy via gluon's bremsstrahlung. Despite its convenience, the approximation sustainability was questioned by the reported notable radiative energy loss within different theoretical models.

To address this issue, we relax the soft-gluon approximation within DGLV formalism [1]. The obtained analytic expression beyond soft-gluon approximation is significantly more involved than its soft-gluon counterpart. Unexpectedly, however, the numerical results lead to similar predictions for the fractional radiative energy loss and the number of radiated gluons. Furthermore, the effect on these two variables is of an opposite sign, and results in nearly overlapping suppression predictions with and without soft-gluon approximation. We also show that this surprising result can be understood by the interplay of initial parton's $p_\perp$ distribution and its energy loss probability. Consequently, the results presented here provide confidence that, despite the concerns mentioned above, the soft-gluon approximation remains adequate within DGLV formalism. Finally, we also discuss generalizing this relaxation in the dynamical QCD medium, which suggests a more general applicability of the conclusions obtained here.

[1] B. Blagojevic, M. Djordjevic and M. Djordjevic, Phys. Rev. C **99**, no. 2, 024901 (2019).

Collaboration name

Track

Strangeness and Light Flavour

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