The soft-gluon approximation, which assumes that radiated gluon carries away a small fraction of initial parton's energy, is widely used in calculating radiative energy loss of high momentum partons traversing QGP created at RHIC and LHC. Regardless of its convenience, different theoretical approaches reported significant radiative energy loss of high pT partons, which raised the doubts of its validity. To address this issue, we relaxed the soft-gluon approximation within DGLV formalism. Although the obtained analytical expressions are quite distinct compared to the soft-gluon case, numerically both cases lead to very similar predictions for the first order in opacity fractional energy loss. The predicted number of radiated gluons is also barely affected. Additionally, the effects on these two variables run in opposite directions, which when superposed results in nearly overlapping suppression predictions. Consequently, our results imply that, regardless of the skepticism, the soft-gluon approximation in practice works surprisingly well in DGLV formalism. We also refer to generalizing this relaxation to the dynamic QCD medium, which suggests a broader validity of the conclusions obtained here.

We relaxed the approximation for high pT gluon, by calculating corresponding 11 Feynman diagrams within DGLV, under the following assumptions:

- Initial gluon propagates along the longitudinal axis
- The soft-scattering (elkonia) approximation
- The first order in opacity approximation

The obtained analytical expression for single gluon radiation spectrum \(dE_{\text{gluon}}^2/dx\) beyond soft-gluon approximation (log):

- Is more complicated than in soft-gluon (sg) case.
- Recover sg result for \(x < 1\).
- Is symmetric under the exchange of radiated (k) and final gluon (p).

Finally, we compared \(\text{bag} and \text{sg} numerical predictions for fractional radiative energy loss \(dE_{\text{gluon}}^2/E\), number of radiated gluons, \(N_{\text{gluon}}\), differential energy loss \(dE_{\text{gluon}}^2/dx\), single gluon radiation spectrum and suppression \(R_{AA}\), to assess the effect of relaxation.

CONCLUSIONS AND OUTLOOK

- Few theoretical models reported considerably radiative energy loss, imposing a question: is the soft-gluon approximation well-founded?
- Static scattering centers, so the interactions with medium constituents are modeled by Debye colored-screened Yukawa potential.
- Gluons, in finite temperature QGP, as massive transversely polarized fields.
- Why is \(R_{AA}\) barely affected by this relaxation?
- Why does the differential variables discrepancies at \(x \geq 0.4\) do not influence \(R_{AA}\)?

REFERENCES


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