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One-loop Factorization for Inclusive Hadron Production in pA Collisions in the Saturation Formalism

We demonstrate the QCD factorization for inclusive hadron production in pA collisions in the saturation formalism at one-loop order. We explicitly calculate both real and virtual gluon radiation diagrams and show explicitly that, the collinear divergences associated with the incoming parton distribution of the nucleon and the outgoing fragmentation function of the final state hadron, as well as the rapidity divergence with small-x dipole gluon distribution of the nucleus factorize into the splittings of the associated parton distribution and fragmentation functions and the energy (non-linear) evolution of the dipole gluon distribution function. The hard coefficient function is evaluated at one-loop order and contains no divergence.

Summary

We carried out the single-inclusive hadron production in pA collision at one loop level. The proton is treated as a diluted system which, using collinear factorization, emits a quark or a gluon that eventually scatters off a dense target like a large nucleus. Here, the collinear factorization and the rapidity factorization enter on the same footing. It is then important to show that indeed the cross section can be written as a factorization of two pieces where each of them follows a different factorization scheme: one piece follows the normal collinear QCD factorization while the other one follows the small-x rapidity-factorization. This result represents a QCD factorization for hard processes in the saturation formalism at one loop.

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