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Next to eikonal corrections to the shock wave in QCD

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In the high energy limit, scattering processes can be described within the eikonal approximation, neglecting contributions which are power-suppressed at high energy. In the case of processes involving a large nuclear target, like pA or AA collisions, the Color Glass Condensate effective theory (CGC) is one of the most convenient formalisms based on the eikonal approximation. So far, the phenomenological studies at LHC and RHIC have been focused on particle production of large albeit finite energies. So it is not clear to what extent the eikonal approximation is completely reliable. We develop a method to expand the gluon propagator in a strong background field beyond the eikonal approximation and study the next-to-eikonal contributions due to finite length of the target (or due to the large but finite energy of the projectile). This allows one to calculate the power-suppressed corrections with respect to the CGC which are enhanced by the width of the target. As a first example, we apply this expansion to single inclusive gluon production as well as the single transverse spin asymmetry in pA collisions to study these observables at next-to-eikonal accuracy. We find that the first corrections (linear in the width of the target) vanish for the unpolarized single inclusive gluon cross-section, making the CGC more reliable than expected, but dominate in the case of some single-transverse-spin asymmetries.

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