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Forward particle production in proton-nucleus collisions at next-to-leading order: solving the running-coupling puzzle

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Reaching next-to-leading order (NLO) accuracy in perturbative calculations of particle production in QCD at high energy is essential for reliable phenomenological applications. In recent years, the Color Glass Condensate effective theory (the natural framework for such calculations) has indeed been promoted to NLO accuracy. However, the first NLO calculations met with unexpected difficulties, among which a huge scheme-dependence with respect to the scale choice in the running of the coupling. The NLO correction to the cross-section for single inclusive particle production in pA collisions at forward rapidities was found to vary by up to two orders of magnitude and also to change sign, when replacing the momentum-space prescription for the running of the coupling (as natural in the calculation of the NLO impact factor) by a coordinate-space prescription (as generally used when solving the Balitsky-Kovchegov equation).

Recently we have found out that the origin of this puzzle lies in the interplay between the Fourier transform from coordinate space to momentum space and the asymptotic freedom of QCD [1]. We present a new coordinate space prescription which avoids this problem and leads to results consistent with the momentum-space prescription ones. The NLO corrections are negative and reduce the LO result by 40% to 50%. We argue that the scheme-dependence could be further reduced by using the momentum-space representation throughout the whole NLO calculation, that is, for both the impact factor and the solution to the BK equation.

[1] "On the use of a running coupling in the NLO calculation of forward hadron production", to appear.

Content type

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