Contribution ID: **134** Type: **Parallel talk**

Analytic Solution for the Revised Helicity Evolution at Small x and Large N_c: New Resummed Gluon-Gluon Polarized Anomalous Dimension and Intercept

Tuesday, 28 March 2023 16:50 (20 minutes)

We consider the novel small-x helicity evolution equations previously derived using the light-cone operator treatment (LCOT) [1,2]. In the double logarithmic approximation (summing powers of $\alpha_s \ln^2(1/x)$) and in the large-N_c limit, the evolution yields a closed system of equations for which we construct an analytic solution. This solution can then provide small-x, large-N_c expressions for the flavor-singlet quark and gluon helicity PDFs and TMDs along with the g_1 structure function, with their leading small-x asymptotics given by
\begin{align}
\Delta \Sigma (x, Q^2) \sim \Delta G (x, Q^2)
\sim g_1 (x, Q^2) \sim \left(\frac{1}{x} \right)^{\alpha_h} , \notag
\end{align}
where the exact analytic expression we obtain for the intercept α_h can be approximated by $\alpha_h = 3.66074 \sqrt{\frac{\alpha_s N_c}{2\pi}}$.
Our solution also yields an all-order (in α_s) resummed small-x anomalous dimension $\Delta\gamma_{GG}(\omega)$ which agrees with the fixed-order calculations to the existing three-loop order. Notably, our anomalous dimension slightly disagrees at 4 loops with that obtained in the infrared evolution equation framework by Bartels, Ermolaev, and Ryskin (BER) [3] (the latter also agrees with the existing 3-loop calculations).
Despite the previously reported agreement at the two decimal points [2], the intercepts of our large-N_c helicity evolution and that of BER disagree beyond that precision, with the BER intercept at large N_c being equal to $\alpha_h^{BER} = 3.66394 \sqrt{\frac{\alpha_s N_c}{2\pi}}$. We speculate on the origin of this disagreement.

[1] Y. V. Kovchegov, D. Pitonyak and M. D. Sievert, Helicity Evolution at Small-x, JHEP 01 (2016) 072, [1511.06737].
[2] F. Cougoulic, Y. V. Kovchegov, A. Tarasov and Y. Tawabutr, Quark and gluon helicity evolution at small x: revised and updated, JHEP 07 (2022) 095, [2204.11898]
[3] J. Bartels, B. I. Ermolaev and M. G. Ryskin, Flavor singlet contribution to the structure function G(1) at small x, Z. Phys. C 72 (1996) 627–635, [hep-ph/9603204].

Submitted on behalf of a Collaboration?

No

Participate in poster competition?

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Session Classification: WG2

Track Classification: WG2: Small-x, Diffraction and Vector Mesons