1-Jettiness as a probe of nuclear dynamics

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Event shapes in deep inelastic scattering (DIS) at the future EIC could play an important role in studying QCD dynamics. 1-jettiness (τ_1) [1, 2, 3, 4] is a global event shape variable that provides a quantitative measure of the hadronic activity or the pattern of radiation between the proton beam and leading jet direction in electron-proton collisions. The DIS τ_1-distribution has now been computed with high precision, next-to-next-to-leading logarithmic level (NNLL) [2, 3] and (NNLL+NLO) [4], and can be systematically improved to even higher order. This opens the door for using 1-jettiness as a precision probe for the extraction of fundamental QCD parameters, notably the strong coupling constant.

Equally importantly, studies of the τ_1-distribution for a range of nuclear targets and at different kinematics can probe various aspects of nuclear dynamics. In [1, 2], we propose the use of the τ_1-distribution in $e + A$ collisions which can be compared to $e + p$ collisions to constrain nuclear parton distribution functions (PDFs). The top panel in Fig. 1 shows the τ_1-distribution at the NNLL level of accuracy in e+Au (red) and in $e + p$ (grey) collisions and the bottom panel gives the usual nuclear modification factor $R_{\rm Au} = d\sigma_{e+{\rm Au}}/d\sigma_{e+p}$. Fig. 1 corresponds to $\sqrt{s} = 90$ GeV and leading jet transverse momentum and rapidity of $P_{J_T} = 20$ GeV and $y_J = 0$, respectively, corresponding to the EMC region of the nuclear PDFs. The clear deviation

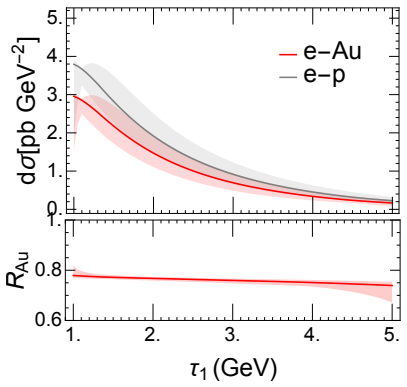

Figure 1: The 1-jettiness distribution for $e + p$ (grey) and e+Au (red) collisions (top panel) and the corresponding nuclear modification factor (bottom panel) at the NNLL level of accuracy.

of $R_{\rm Au}$ from unity demonstrates the sensitivity of the 1-jettiness distribution to nuclear PDFs.

Within this theoretical framework, one could further study how the final-state interactions between the propagating jet and the nuclear target modify the size and shape of the τ_1-distribution. The resummation region, $\tau_1 \ll P_{JT}$, should be very sensitive to the corresponding nuclear dynamics. We propose a detailed measurement for 1-jettiness in both $e+p$ and $e+A$ collisions at the EIC.

References

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