XXVIII International Workshop on Deep Inelastic Scattering and Related Subjects

Contribution ID: **253** Type: **Contributed Talk**

Angular de-correlation of forward di-hadrons: on the optimal pt range to probe gluon saturation

Wednesday, 25 March 2020 17:24 (18 minutes)

An important phenomenological consequence of the phenomenon of gluon saturation is the suppression of back-to-back hadron and jet pairs produced in the forward region of pA collisions. We present a new calculation of this process within the dilute-dense formalism of the color glass condensate (CGC) effective theory. Following Ref. [1], we collide a large-x, dilute probe, described in terms of parton distribution functions, off a dense target, described in terms of transverse momentum dependent (TMD) gluon distributions, whose small-x evolution we calculate using rcBK evolution. We then couple this cross section with the formalism introduced in Ref. [2] to implement in an analytically-controlled way the radiation of soft gluons (Sudakov resummation) from the initial and the final state.

We first apply this CGC+Sudakov framework to the production of forward di-jets at high-p_t in pp and pA collisions. We use the same kinematic cuts and collision energy as in a recent analysis by the ATLAS collaboration [3]. We find that the suppression of the di-jet yield at $\Delta\phi = \pi$, predicted by gluon saturation, is essentially washed out by a strong effect of broadening induced by the radiation of soft gluons. Compatibly with ATLAS data, we find that the nuclear modification factor for forward high-p_t dijets is at best of order $R_{pA} \approx 0.9$.

Motivated by this result, we propose to study the production of forward dihadrons (pions) at lower, though moderate, p_t(≈10 GeV). We find that, in this case, the suppression of back-to-back pairs genuinely predicted by gluon saturation survives the broadening due to the Sudakov resummation. We indeed obtain $R_{pA} \approx 0.75$ at $\Delta\phi = \pi$ using kinematic cuts compatible with the proposed FoCal upgrade of the ALICE detector. We conclude that forward dihadrons at high p_t provide a sensitive probe of gluon saturation at LHC.

[1] J. L. Albacete, G. Giacalone, C. Marquet and M. Matas, https://arxiv.org/abs/1805.05711

[2] A. Stasto, S-Y. Wei, B-W. Xiao, and F. Yuan https://arxiv.org/abs/1805.05712

[3] ATLAS Collaboration https://arxiv.org/abs/1901.10440

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Session Classification: Small-x, Diffraction and Vector Mesons

Track Classification: Small-x, Diffraction and Vector Mesons