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Imaging nuclear modifications on parton distributions with triple-differential dijet cross sections in pA collisions

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Dijet production in proton-nucleus (pA) collisions at the LHC provides invaluable information on the underlying parton distributions in nuclei, especially the gluon distributions. Triple-differential dijet cross sections enable a detailed kinematic scan (over momentum fraction x and probing scale Q^2) of the nuclear parton distribution functions (nPDFs), i.e., $f_i^{\rm A}(x, Q^2)$.

In this work, we study several types of triple-differential cross sections for dijet production in proton-proton (pp) and proton-lead (pPb) collisions at the LHC, to next-to-leading order within the framework of perturbative quantum chromodynamics (pQCD). Four sets of nPDF parametrizations, EPPS16, nCTEQ15, TUJU19, and nIMParton16 are employed in the calculations for pPb collisions. For the first time, we show that the observable nuclear modification factor $R_{p\rm Pb}$ of triple-differential cross sections can serve as a nice image of the nuclear modifications on parton distributions, quantified by the ratio $r_i^{\rm A}(x, Q^2) = f_i^{\rm A,proton}(x, Q^2)/f_i^{\rm proton}(x, Q^2)$. Considerable differences among the $R_{p\rm Pb}$ predicted by the four nPDF sets can be observed and well interpreted.

Future measurements of such observables are expected to not only constrain the nPDF parametrizations, but also help confirm various nuclear effects, e.g., shadowing, anti-shadowing, EMC, and Fermi motion at different values of x and their variation with probing scale Q^2.

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