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Imaging nuclear modifications on parton distributions at the LHC and EicC/EIC

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Nuclear modifications to parton distribution functions provide an essential baseline for disentangling final-state nuclear matter effects in high-energy nuclear collisions. However, determining the explicit form of the modification factors $r_i^{\mathrm{A}}(x, Q^2)$ through global analyses remains challenging, partly due to their complex relationships with observables. In this talk, we introduce a series of novel observables in pA collisions at the LHC, designed to establish an approximate mapping to the underlying nuclear modification factors $r_i^{\mathrm{A}}(x, Q^2)$. Specifically, by combining the reorganized cross sections of multiple processes, we separately purify signals from light-quark, gluon, and heavy-flavor (charm) distributions in nuclei. This approach allows us to effectively image the $r_i^{\mathrm{A}}(x, Q^2)$ for specific parton species, serving as an analogy to the measurement of nuclear modifications on structure functions in DIS. Such imaging observables are expected to significantly enhance the impact of LHC data by providing more direct constraints on designing the parametrization forms of flavor-separated nuclear modifications. Importantly, this approach can help establish a framework for analysis of the commonalities and distinctions in nuclear modification effects across diverse processes, spanning from LHC to EicC/EIC.

Primary authors: 茹, 🄵 (South China Normal University); YANG, Meng-Quan (Central China Normal University); ZHANG, Ben-Wei (Central China Normal University)

Presenters: 茹, 🄵 (South China Normal University); YANG, Meng-Quan (Central China Normal University)

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