Contribution ID: **95** Type: **Oral**

Multi-scale Imaging of Nuclear and Proton Geometries

Wednesday 6 September 2023 15:40 (20 minutes)

Determining the structure of protons and nuclei at high energy is one of central goals of the heavy-ion collisions and the future Electron-Ion Collider (EIC). We first use Bayesian inference within the color glass condensate framework to extract the proton shape fluctuations from HERA exclusive vector meson production data at $x = 10^{-3}$. With this input, we employ the JIMWLK evolution for the proton and nucleus geometry from HERA to LHC energies. We then do the hydrodynamic simulations to quantify the various hydrodynamic observables obtained using this setup with evolved geometry parameters with full JIMWLK evolution. We find the multiplicity distributions and $v_n - p_T$ correlations are sensitive to the JIMWLK evolution. These help us to understand the energy evolution of nuclear geometry in the future.
For electron+nucleus collisions, we find out that the nuclear geometric deformations and fluctuations affect diffractive vector meson productions, and that multi-pole deformations at different length scales manifest themselves at different regions of transverse momentum transfer. Further more, the JIMWLK evolution doesn' t wash out this effects. We systematically study the deformations effects of Uranium (U), Gold (Au), Oxygen-16 (^{16}O), and Neon (^{20}Ne) on the diffractive J/Ψ productions. Our work demonstrate that the future EIC diffractive data can provide direct information on the nuclear structure at small x and the complementary constraints for the nuclear geometric shape for the traditional hydrodynamic simulations in heavy-ion collisions.

Category

Theory

Collaboration (if applicable)

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Session Classification: Initial State

Track Classification: Initial state