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Proton structure fluctuations: constraints from diffraction and applications to p+A collisions

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Exclusive vector meson production can be used to directly probe the gluon density of a hadron. Measuring the cross section differentially in transverse momentum transfer makes it possible to determine the transverse density profile (via coherent diffraction) and density fluctuations (incoherent diffraction) of the target hadron. This knowledge about the geometric fluctuations of the proton is particularly important for understanding collective phenomena observed in proton-nucleus collisions.

We calculate coherent and incoherent diffractive vector meson production in photon-proton scattering at high energy. We demonstrate that incoherent gamma-p scattering is sensitive to sub-nucleon scale fluctuations, and show that the effect of geometric fluctuations can be disentangled from saturation scale fluctuations.

The Bjorken-x (or energy) evolution of the fluctuations is studied by solving the JIMWLK evolution equation. In particular, we study the energy evolution of the diffractive cross section. This is particularly interesting, as the ALICE collaboration has recently observed the disappearance of the incoherent contribution to the diffractive cross section in ultraperipheral p+A collisions at high energies, which suggests that the proton gets smoother at small x.

The fluctuating proton, constrained by the HERA data, is then used as input for hydrodynamic calculations of azimuthal anisotropy coefficients in proton-nucleus collisions, which we show to be sensitive to initial state geometric fluctuations.

References:
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Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

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