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Proton structure fluctuations: from HERA to the LHC

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One of the striking results of the LHC has been the observation of collective behavior in high-multiplicity proton-proton and proton-nucleus collisions. These signals are similar to those that have been previously seen in collisions of heavy nuclei, and have been interpreted as a result of the hydrodynamic evolution of the produced QCD matter.

Initial state geometry is a necessary input to hydrodynamical simulations. The knowledge of the proton density profile, and its event-by-event fluctuations, is then crucial for properly interpreting the experimental pA and pp results.

We discuss how exclusive vector meson production measured at HERA can be used to constrain proton shape and the shape fluctuations. In particular, we show that incoherent diffractive vector meson production data suggest that there are large eventy-by-event fluctuations in the proton shape. This information is then applied to proton-nucleus collisions, where we show that with hydrodynamical simulations it is possible to obtain a good description of the flow harmonics measured in high multiplicity proton-nucleus collisions.

Ultraperipheral pA collisions at the LHC, being dominantly photon-proton scatterings, provide access to the exclusive vector meson production at much higher energies than what was accessible at HERA. This makes it possible to study the Bjorken-x evolution of the geometric shape of the proton. The x evolution can be calculated by solving the small-x JIMWLK evolution equation. We present results for diffractive cross sections at the LHC energies and discuss how the ultraperipheral pA collisions can constrain the proton shape at very small x.

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