Contribution ID: **91** Type: **Parallel talk**

Bayesian inference of the fluctuating proton shape

Wednesday 4 May 2022 15:40 (20 minutes)

Determining the multi dimensional structure of protons and nuclei at high energy is one central goal of the future Electron-Ion Collider. This fundamental information is a crucial input for models describing the initial state of heavy ion collisions. In particular the event-by-event fluctuating proton geometry should have a strong effect on the flow and multiplicity distribution in high multiplicity proton-proton and proton-nucleus collisions [1], assuming that a strongly interacting medium is formed in these events. Understanding the subnucleon structure to a high degree of precision is thus a prerequisite of determining whether quark gluon plasma is created in small system collisions.

In order to extract the proton shape fluctuations (see [2]) from HERA exclusive vector meson production data in a statistically rigorous manner, we apply Bayesian inference[3]. This approach enables us to extract likelihood distributions for the non-perturbative parameters describing the proton fluctuating profile, including their correlations. The resulting posterior distributions allow for a systematic propagation of uncertainties when simulating for example high-multiplicity proton-proton and proton-nucleus collisions.

We determine how accurately the HERA data can constrain the proton fluctuating shape, and illustrate how the determined parametrizations can be used to propagate uncertainties to modeling of high-multiplicity proton-proton and proton-nucleus collisions.

[1] H. Mäntysaari, B. Schenke, C. Shen, Phys. Lett. B 772 (2017) 681-686, arXiv:1705.03177 [nucl-th]
[2] H. Mäntysaari, B. Schenke, Phys. Rev. Lett. 117 (2016) 052301, arXiv:1603.04349 [hep-ph], H. Mäntysaari, Rep. Prog. Phys. 83 (2020), 082201, arXiv:2001.10705 [hep-ph]
[3] H. Mäntysaari, B. Schenke, C. Shen, W. Zhao, arXiv:2201.01998 [hep-ph]

Submitted on behalf of a Collaboration?

No

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Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Track Classification: WG2: Small-x, Diffraction and Vector Mesons