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Hot spots in a proton

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We explore consequences of the existence of gluonic hot spots inside the proton for the initial eccentricities in a proton-nucleus collision [1], and the constraints on the parameters describing these hot spots from coherent and incoherent exclusive vector meson production cross sections in deep inelastic scattering [2].

The eccentricities are calculated by calculating correlation functions of the energy density field of the glasma immediately after the collision event at proper time t=0+. We separately consider the effects of color charge and geometrical hot spot fluctuations, analytically performing the averages over both in a dilute-dense limit. We show that geometric fluctuations of hot spots inside the proton are the dominant source of eccentricity whereas color charge fluctuations only give a negligible correction. The size and number of hot spots are the most important parameters characterizing the eccentricities.

By employing a nonrelativistic vector meson wave function and working in the dilute limit of the Color Glass Condensate framework we are able to analytically calculate cross sections for vector meson production in our hot spot model. We find that the coherent cross section is sensitive to both the size of the target and the structure of the probe. The incoherent cross section is dominated by color fluctuations at small transverse momentum transfer (t), by proton and hot spot sizes as well as the structure of the probe at medium t and again by color fluctuations at large t. While the t-dependence of the cross section is well reproduced in our model, the relative normalization between the coherent and the incoherent cross sections points to the need for additional fluctuations in the proton.

[1] S. Demirci, T. Lappi and S. Schlichting, "Hot spots and gluon field fluctuations as causes of eccentricity in small systems," Phys. Rev. D **103** (2021) no.9, 094025, [arXiv:2101.03791 [hep-ph]].

[2] S. Demirci, T. Lappi and S. Schlichting, "Proton hot spots and exclusive vector meson production," Phys. Rev. D **106** (2022) no.7, 074025, [arXiv:2206.05207 [hep-ph]].

Category

Theory

Collaboration (if applicable)

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