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Accessing saturation and subnuclear structure with multiplicity dependent J/ψ production in p+p and p+Pb collisions

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We compute the production of J/ψ mesons in different rapidity bins as a function of event activity in p+p and p+Pb collisions at LHC energies within the color glass condensate framework combined with non-relativistic QCD (NRQCD) or an Improved Color Evaporation model (ICEM) to describe the J/ψ hadronization. We demonstrate that deviations from a linear increase of J/ψ multiplicity with increasing charged hadron multiplicity is sensitive to gluon saturation and the details of sub-nucleonic fluctuations in the proton and nucleus. We find that saturation effects are paramount to accurately describe experimental data in p+Pb collisions from the ALICE Collaboration for both forward and backward going J/ψ. The parameters we find for the model of the nucleon structure are consistent with those obtained from fits to diffractive vector meson production in e+p collisions at HERA. In addition, the observables studied here are better suited to distinguish whether size fluctuations or density fluctuations contribute more to the fluctuations of hadron multiplicities. This suggests a strong potential for a combined global analysis of HERA (and future EIC) and LHC data to constrain (sub-)nucleon structure at high energies.

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