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Recent PHENIX results probing gluon dynamics in proton-proton and highly asymmetric nuclear collisions at $\sqrt{s_{NN}}$ = 200 and 510 GeV

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The dynamics of gluons in high energy proton and nuclei interactions remain an elusive process. Gluon interactions can be accessed via both light and heavy flavor hadron production at the PHENIX experiment at RHIC. In particular, via systematically measuring the nuclear modification in light hadron production in p+A and light-ion-A collisions at $\sqrt{s_{NN}} = 200$ GeV, we observed a distinct pattern emerging across large pseudorapidity (-2 – 2) and transverse momentum ranges (1 – 20 GeV/c), which can be used to constrain nuclear PDFs and models of parton energy loss in the cold nuclear matter. In addition, the heavy flavor (HF) quarks can be produced in nuclear collisions via various mechanisms that originate from gluons. Recently, the PHENIX collaboration carried out a systematic study of HF production cross sections in p+p collisions at $\sqrt{s}$ = 200 GeV and 510 GeV via the production channels of non-prompt J/Ψs, single and di-muons production at forward rapidities ($1.2 < y < 2.2$). These favor the upper limit of the HF cross section uncertainty band of the FONLL calculations. The recent PHENIX results on these measurements and their implications will be discussed in this talk.

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