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Glimpse on fluctuations in proton structure through heavy ion reactions[1]

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Hadronic and Heavy Ion collisions at relativistic energies provide a unique opportunity to explore the landscape of quantum chromodynamics (QCD) as a function of resolution scale and parton density. An interesting yet largely unexplored regime within this landscape is the regime of high-density saturated gluon matter that dominates the early stages of relativistic heavy ion (A+A) collisions. The dense gluonic matter eventually forms a medium that behaves hydrodynamically, expands, undergoes hadronization and forms detectable particles that have characteristic azimuthally anisotropic distributions, strongly correlated with the initial spatial geometry of the collision. Recently, precision data from the RHIC and LHC reveal striking similarities between the observed azimuthal anisotropies of particle production in high multiplicity light-heavy ion collisions (p+A) and heavy ion collisions. Such observations have provided hints that, at sufficiently high multiplicities, the system formed in p+A collisions can also behave hydrodynamically. In this talk, I discuss how the sub-nucleon scale fluctuations in the proton projectile, that lead to highly irregular collision regions, are essential to describe the observables in p+A collisions at the LHC. More specifically, a combined classical Yang-Mills and viscous fluid dynamic simulation shows that the experimental data on the azimuthal anisotropy of produced particles are sensitive to the hot-spots of initial energy density generated, for example, by the distribution of the three valence quarks inside a proton.

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