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Towards the discovery of primordial momentum anisotropies in nuclear collisions

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Momentum anisotropy, quantified by the coefficients of anisotropic flow, v_n, is observed in the final states of both small and large nuclear collision systems. In large A-A systems, anisotropy is of geometric origin, and determined by a hydrodynamic response to the initial spatial anisotropy of the system. In smaller systems, such as p-A, d-A or peripheral A-A collisions, a range of theoretical work suggests that the observed anisotropy also receives an important contribution from the momentum anisotropy present in the earliest stages of the collision. Such anisotropy is for example predicted by the color glass condensate effective theory of QCD. Until now, there has not been a clear way to obtain experimental evidence of this contribution to the observed anisotropy in small systems.

We show that a promising way to obtain such experimental evidence is by studying the correlation between v_2 and the average hadron transverse momentum, $\langle p_t \rangle$. We make clear predictions for phenomenological manifestations of the initial-state momentum anisotropy to be observed in future measurements. By means of a hybrid IP-GLASMA+MUSIC+UrQMD framework, we predict that in small systems, such as p-A or d-A, the correlation between v_2 and $\langle p_t \rangle$ decreases as a function of multiplicity, presenting a sign change from positive to negative. We further predict a qualitative change of the correlator in A-A collisions, as the collision energy is changed from top RHIC to LHC energies.

The experimental verification of these qualitative features will provide striking evidence of the presence and importance of the primordial momentum anisotropy predicted by the CGC.

Based on:
G. Giacalone, B. Schenke, C. Shen, https://arxiv.org/pdf/2006.15721.pdf

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