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Bayesian analysis of flow in small and large QGP droplets: the role of subnucleonic structure

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Recent measurements of azimuthal particle correlations in small collision systems show striking simularities to flow signatures observed in gold-gold and lead-lead collisions, leading many to question if the origin of small system correlations is hydrodynamic in nature. The ensuing effort to construct a unified hydrodynamic model for small and large collision systems revealed new tension in the QGP initial conditions: heavy-ion collisions appear to prefer saturation based initial conditions [1209.6330, 1505.02677], while small system collectivity is currently best described using a Monte Carlo Glauber model [1502.04745].

It has since been suggested that adding subnucleonic structure to the QGP initial conditions could strongly affect flow in small collision systems and may explain apparent model discrepancies [1405.3605v1]. While practical implementations of subnucleonic structure are relatively straightforward—one simply replaces smooth protons with lumpy protons—there exist large theoretical uncertainties regarding the fluctuated shape of the proton, and corresponding theory predictions are highly model dependent.

In this work, we extend previous efforts to parametrize and constrain the QGP initial conditions using systematic Bayesian analysis and study the effects of subnucleonic structure predicted by a simple constituent parton model. We vary both subnucleonic degrees of freedom, e.g. the constituent parton number and effective parton width, as well as typical transport parameters such as the hydrodynamic starting time and QGP viscosity. The initial conditions are then embedded in an event-by-event hydrodynamic model and calibrated to simultaneously fit charged particle yields, flows and mean p_T for light-heavy and heavy-heavy collisions at RHIC. We finally apply Bayesian parameter estimation methods to extract posterior distributions for the optimal initial condition parameters and comment on the implied viability of related theoretical frameworks.

Preferred Track

QCD in small systems

Collaboration

Not applicable

Primary author: MORELAND, Scott (Duke University)

Presenter: MORELAND, Scott (Duke University)

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