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Dynamical Evolution of Stochastic Fluctuations

Develops a theoretical framework to study stochastic fluctuations in relativistic heavy-ion collisions, with a focus on their evolution near the QCD critical point. We begin by introducing thermal and critical fluctuations and their impact on the hydrodynamic evolution of the system. The "Hydro+" formulation is explored as a means of incorporating critical fluctuations into hydrodynamic simulations. Various critical models are compared, including Models A, B, and H, to assess their influence on fluctuation dynamics.
We utilize a realistic QCD equation of state (EOS) from the BEST collaboration, which incorporates a tunable critical point, to analyze the impact of critical behavior on the system's evolution. Bjorken (1+1)D simulations provide insights into the effects of different critical models, while (3+1)D simulations track the fireball's phase diagram trajectory and the full 3D evolution of the two-point function C_(sˆsˆ) (Q). Additionally, we examine out-of-equilibrium corrections to entropy, highlighting the significant deviations from equilibrium in regions near the critical point.
Our findings provide theoretical guidance for experimental efforts to locate the QCD critical point in the RHIC Beam Energy Scan program. The results illustrate the importance of including stochastic fluctuations in hydrodynamic modeling and set the stage for future studies on nonequilibrium dynamics in high-energy nuclear collisions.

Author: ALZHRANI, Sahr (Jazan University)

Presenter: ALZHRANI, Sahr (Jazan University)

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