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Stochastic baryon charge transport in relativistic hydrodynamics

We utilize 3+1-d stochastic hydrodynamics to study correlations and fluctuations of baryon charge in high-energy heavy-ion collisions. The baryon charge fluctuations are important observables to probe the QCD phase diagram, while a dynamical description through stochastic hydrodynamics remains challenging due to numerical instabilities and high computation demands. In this work, we employ a linearized approach, allowing us to separately simulate the background energy-momentum evolution of a charge-neutral fluid and the stochastic baryon fluctuation/diffusion processes, which largely reduces computation cost while maintaining sufficient precision.

We implement this linearized stochastic charge evolution in the viscous hydrodynamic code MUSIC, and find that it nicely describes the two-point correlation of 1+1-d analytical solutions for various EoS and transport coefficients. In particular, the hydrodynamic calculations demonstrate how different rapidity separations probe charge fluctuations originating at different times of the evolution, which is valuable for extracting critical signals with sizeable initial state fluctuations. We also investigate the net baryon correlations after the Cooper-Frye freeze-out, which show good consistency with the analytical calculations and indicate that this fluctuation-induced correlations are sensitive to the baryon diffusion coefficient.

Category

Theory

Collaboration (if applicable)

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