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Hydrodynamic fluctuations and dissipation in an integrated dynamical model

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Thermal fluctuations arising during hydrodynamic evolution of the system (a.k.a., *hydrodynamic fluctuations*) [1] play an important role in event-by-event hydrodynamic simulations. For example, entropy production fluctuates during the expansion even if we start from a common initial condition in a macroscopic sense [2]. On the other hand, the effect of the fluctuations must be significant in small colliding systems such as p-p, p-A and peripheral A-A collisions [2]. Stability of thermal equilibrium systems is a consequence of an interplay between thermal fluctuations and dissipation. Thus it is indispensable to take the hydrodynamic fluctuations into account in causal dissipative hydrodynamic simulations.

In this study, we develop a new (next-generation) integrated dynamical model to investigate the effects of the hydrodynamic fluctuations on observables in high-energy nuclear collisions. We implement the hydrodynamic fluctuations in a fully 3-D dynamical model consisting of the hydrodynamic initialization models such as Monte-Carlo Kharzeev-Levin-Nardi model and Monte-Carlo Glauber model, causal dissipative hydrodynamics, and the subsequent hadronic cascades. By analyzing the hadron distributions obtained by massive event-by-event simulations with both of the hydrodynamic fluctuations and the initial-state fluctuations, we discuss the effects of the hydrodynamic fluctuations on the flow harmonics, v_n, and their fluctuations. This sheds a new light on extracting transport coefficients from observables.

1 K. Murase and T. Hirano, arXiv:1304.3243 [nucl-th].

2 T. Hirano, R. Kurita, K. Murase and K. Nagai, Nucl. Phys. A **931** (2014) 831.

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