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Hydrodynamic fluctuations and fluctuation theorem in heavy-ion collisions

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Recently the effects of hydrodynamic fluctuations, i.e., the thermal fluctuations of relativistic hydrodynamics, on flow observables in high-energy nuclear collisions are analyzed in event-by-event simulations by dynamical models. The statistics of the hydrodynamic fluctuations is usually determined by the fluctuation-dissipation theorem obtained in the global equilibrium. However, in expanding systems such as matter created in the experiments, the fluctuation-dissipation theorem is non-trivial. Fluctuation theorem is more general theorem that describes the probability distribution of the entropy production and is applicable to any non-equilibrium systems. We discuss the fluctuation-dissipation relation in expanding systems and its relation to the fluctuation theorem by performing the numerical simulations of non-linear relativistic fluctuating hydrodynamics assuming the Bjorken flow.

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