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Longitudinal flow decorrelation by hydrodynamic fluctuations and event-shape engineering in Xe+Xe collisions

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In this talk, we analyze the factorization ratio $r_n(\eta_p^a, \eta_p^b)$ in Xe+Xe and Pb+Pb collisions [1] using event-shape engineering within the integrated dynamical model [2,3] constructed of the Monte-Carlo Glauber model for the initialization, rfh for 3+1D relativistic fluctuating hydrodynamics with hydrodynamic fluctuations [2], and JAM for hadronic cascades [4]. We also address recent topics of the fluctuating hydrodynamic about the correction of the fluctuation-dissipation relation [5] and the renormalization of the equation of state.

To precisely determine the properties of the matter created in heavy-ion collisions—such as the viscosity and diffusion coefficients, and the finite-μ_B equation of state—, it is important to constrain the model uncertainties that affect the collective dynamics such as the initialization models and the hydrodynamic fluctuations. The comprehensive description of collective flows and their correlations, including the factorization ratios, mixed correlations, and symmetric and asymmetric cumulants, is the key to constraining the model parameters.

We here focus on the longitudinal factorization ratio $r_n(\eta_p^a, \eta_p^b)$ [6] which is a useful tool to understand and constrain the longitudinal fluctuations generated by initialization models and hydrodynamic fluctuations. We have shown that both the hydrodynamic fluctuations and the initial longitudinal fluctuations are needed to explain the centrality dependence of $r_2(\eta_p^a, \eta_p^b)$ in our previous study [7]. To discern the effect of the hydrodynamic fluctuations more clearly from that of the other fluctuations, it is a great opportunity to investigate the longitudinal decorrelation observed in the Xe+Xe collisions [1], where the deformation of the colliding nuclei plays a non-trivial role. We first analyze the eccentricities ε_n and initial decorrelations $r_n^\varepsilon(\eta_s^a, \eta_s^b)$ calculated from initial entropy densities for Xe+Xe collisions with/without deformation and for Pb+Pb collisions. We find the effect of the deformation on the decorrelations r_n^ε in the central collisions and further analyze them by classifying the events by ε_n. We then perform the event-by-event simulations with and without hydrodynamic fluctuations and calculate $r_n(\eta_p^a, \eta_p^b)$. We discuss the effects of the hydrodynamic fluctuations by classifying the events by the magnitude of flow vectors q_n.

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