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Dynamics of the conserved charge fluctuations in an expanding medium

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A non-monotonic net-proton kurtosis as a function of the collision energy for very central collisions has been suggested and may be confirmed by recent BES-II program results advocating the existence of the QCD critical point. Fluctuations at the origin of this peculiar behavior are produced in the highly dynamic environment of ultra-relativistic collisions. Especially, the violent longitudinal expansion and the associated temperature cooling may have a non-trivial impact on how we interpret the experimental data. The in- or out-of equilibrium nature of the fluctuations during this expansion is a crucial question in discriminating between critical contributions and purely dynamical features.
Here, we inspect the diffusive dynamics of the conserved charges net density fluctuations in a Bjorken-type 1+1D expanding system. Between the initial time of the collision and the chemical freeze-out, the equilibrium thermodynamics is described by a potential derived from a Ginzburg-Landau free-energy functional parametrized by its second and fourth-order susceptibilities. In the scaling region, the susceptibilities are mapped from the 3D Ising model and at muB = 0 MeV, from lattice QCD calculations. Between the chemical freeze-out and the kinetic freeze-out, the thermodynamics is determined by the hadron resonance gas of the 19 lightest species at first order in the chemical potentials. The non-trivial interplay between the diffusive properties of the constituents and the longitudinal expansion of the medium allows us to study the critical fluctuations in the dynamically expanding medium as well as their survival in the hadronic phase until kinetic freeze-out.
We demonstrate the enhancement of the critical fluctuations for trajectories passing near the critical point. The signal is shown to be largely dependent on the diffusive properties of the medium and the chemical freeze-out temperature. After chemical freeze-out, we observe that the diffusion in the hadronic medium has a huge impact on the amplitude of the critical fluctuations. We conclude that the signal survives longer in sectors related to the electric charge.

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