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Critical point fluctuations in heavy-ion collisions within molecular dynamics with expansion

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We analyze particle number fluctuations in the crossover region near the critical endpoint of a first-order phase transition in baryon-rich matter by utilizing microscopic molecular dynamics simulations of the classical non-relativistic Lennard-Jones fluid. We extend out previous studies by incorporating longitudinal collective flow to model the expansion dynamics in heavy-ion collisions.

In heavy-ion experiments it is possible to observe fluctuations in the momentum space only, so we are concentrating our current research around this topic. Using as a beginning result of our previous article about the momentum space fluctuations without the collective flow, where the scaled variance appears to be close to the ideal gas without interaction, we apply shift in one of the space directions to the thermal momentum of the particles.

The scaled variance of particle number distribution inside different coordinate and momentum space acceptances is computed through ensemble averaging and found to agree with earlier results obtained using time averaging, validating the ergodic hypothesis for fluctuation observables in considered system. The presence of a sizable collective flow is found to be essential for observing large fluctuations from the critical point in momentum space acceptances. We find that the enhancement of baryon number fluctuations due to critical point is visible at collision energies between 3 and 10 GeV in realistic rapidity space acceptances. We discuss our findings in the context of the ongoing measurements of proton number cumulants in heavy-ion collisions.

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