

Probing Baryon-rich QCD Matter with Deuteron Cumulants and Proton–deuteron Mixed Cumulants in Au+Au Collisions at STAR

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Abstract

The deuteron carries baryon number two and is copiously produced in the baryon-rich matter of heavy-ion collisions. Its number fluctuations give insight into the QCD phase diagram at high baryon density and might be sensitive to the critical-point physics [1]. Since deuterons are built from nucleons, their fluctuations are tied to baryon-density fluctuations and can complement conserved-charge cumulants [2,3,4]. Their dependence on the rapidity acceptance may further probe the range of the underlying correlations [5]. In addition, deuteron cumulants and proton–deuteron correlations may provide further insight into the production mechanisms of light nuclei in heavy-ion collisions.

We report the measurement of cumulants (up to fourth order), factorial cumulants and their ratios of deuteron number distributions and proton-deuteron mixed cumulants in Au+Au collisions at $\sqrt{s_{NN}} = 3.0$ GeV (FXT) to 7.7 GeV (BES-II collider) at STAR, reaching the high μ_B region at RHIC. Deuterons are identified with the Time Projection Chamber (TPC) and Time-of-Flight (TOF) detectors within $0.8 < p_T$ (GeV/ c) < 4.0 . Centrality and rapidity-acceptance dependence of deuteron cumulants and proton-deuteron mixed cumulants, will be presented, corrected for detector efficiency and centrality bin-width effects. The measurements will be compared with thermal and coalescence model calculations, and the implications on baryon-number dynamics and the QCD phase diagram at high baryon density will be discussed.

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