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Transport model study of net-baryon number fluctuations in QCD matter

Higher-order moments of conserved charge fluctuations, such as net-charge, net-baryon, and net-strangeness, are sensitive experimental probes for investigating the critical fluctuations in relativistic heavy-ion collisions. We calculate the cumulants and correlation functions of proton, antiproton, and net-proton multiplicity distributions in Au + Au collisions at √sNN = 7.7 GeV using a multiphase transport model (AMPT). The AMPT model can basically describe the trends of cumulants, cumulant ratios, (normalized) correlation functions of the proton and net-proton measured by the STAR experiment. The multiproton (baryon) correlations in the AMPT model are consistent with the expectation from baryon number conservation. Since the physics of the QCD critical fluctuations is not included in the AMPT model, our results are expected to only provide a baseline for searching for the possible critical behaviors at the CEP in relativistic heavy-ion collisions[1]. Then, we incorporate critical fluctuations from the functional renormalization group (FRG) into the AMPT model in order to reveal the important effect of hadronic rescatterings on critical fluctuations. We observed apparent influences of hadronic rescatterings on the cumulant ratios of the net-baryon number fluctuations. The results demonstrate that hadronic rescatterings decrease C4/C2 in central collisions and increase C4/C2 in peripheral collisions, thereby bringing the model results with FRG closer to the STAR measurements. The effect of hadronic rescatterings is more significant for critical fluctuations than dynamical fluctuations. Those study establishes a foundation for incorporating the fundamental dynamics of critical fluctuation into the framework of the AMPT model[2].

[1] Qian Chen and Guo-Liang Ma. Dynamical development of proton cumulants and correlation functions in Au+Au collisions at √(S_NN)=7.7 GeV from a multiphase transport model. Phys. Rev. C, 2022, 106(1): 014907.
[2] Qian Chen, Rui Wen, Shi Yin, Wei-jie Fu, Zi-Wei Lin, and Guo-Liang Ma. The influence of hadronic rescatterings on the net-baryon number fluctuations. arXiv:2402.12823.

Category

Theory

Collaboration (if applicable)

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