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Baryon number fluctuations and search for the CEP of QCD

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Fluctuations of conserved charges, in particular the baryon number fluctuations, are thought of as experimental observables which are sensitive to the QCD critical end point (CEP), where the singular part of thermodynamic functions plays a dominant role. Indeed, in the past several years significant fluctuation measurements have been performed in the Beam Energy Scan program at RHIC, and an amount of relevant data are available. However, how can the experimental data be used to extract the information of CEP, e.g., the existence or location of CEP in the QCD phase diagram? This question could be answered through the combination of efforts from both experiments and theories.

In this talk, first of all, I would like to discuss recent progress in the theoretical studies of baryon number fluctuations in the functional approach [1]. We compute the baryon number fluctuations up to tenth order at finite temperature and density. We show that a non-monotonic energy dependence of baryon number fluctuations can arise in the non-critical crossover region of the phase diagram. Our results compare well with recent experimental measurements of the kurtosis and the sixth-order cumulant of the net-proton distribution from the STAR collaboration. Then, I would like to discuss the influence of different locations of CEP in the QCD phase diagram on the collision-energy dependence of the observed cumulants, which could help us to constrain the regime of CEP based on the experimental data [2], especially in the region of interest, $\mu_B \sim (450-650)$ MeV, where the location of CEP is predicted by recent first-principle functional QCD [3].

Reference:

- [1] Wei-jie Fu, Xiaofeng Luo, Jan M. Pawłowski, Fabian Rennecke, Rui Wen, Shi Yin, Phys. Rev. D 104, 094047, 2021 (DOI: <https://doi.org/10.1103/PhysRevD.104.094047>, Editors' Suggestion), arXiv: 2101.06035 [hep-ph].
- [2] Wei-jie Fu, Xiaofeng Luo, Jan M. Pawłowski, Fabian Rennecke, Rui Wen, Shi Yin, in preparation.
- [3] Wei-jie Fu, Jan M. Pawłowski, Fabian Rennecke, Phys. Rev. D 101, 054032, 2020, arXiv: 1909.02991 [hep-ph]; Fei Gao and Jan M. Pawłowski, Phys.Lett.B 820, 136584, 2021, arXiv: 2010.13705 [hep-ph].

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