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Systematics of higher order net-baryon number fluctuations at small values of the baryon chemical potential: A comparison of lattice QCD and beam energy scan results

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Fluctuations of and correlations among conserved charges of strong interactions have long been considered sensitive observables for the exploration of the structure of the phase diagram of QCD. Cumulants of conserved charge fluctuations are the most promising experimental observables in the search for a critical point in the phase diagram of QCD performed in the beam energy scan (BES) at RHIC. The published data on cumulants of net-proton number fluctuations and, in particular, the still preliminary data set on net-proton fluctuations which covers a larger transverse momentum range show obvious deviations from the thermodynamics of a hadron resonance gas (HRG). This naturally raises the question whether ratios of cumulants of net-proton number fluctuations, and the relation between them and net electric charge cumulants measured by STAR and PHENIX can be understood in terms of equilibrium thermodynamics obtained from lattice QCD calculations.

We present results for cumulants of net-baryon number and net electric charge fluctuations calculated in a next-to-leading order (NLO) Taylor series in the baryon chemical potential (μ_B). We discuss the resulting pattern of ratios of cumulants, e.g. $\kappa_B\sigma_B^2 \equiv \chi_4^B/\chi_2^B$ and $S_B\sigma_B^3/M_B \equiv \chi_3^B/\chi_1^B$. We note that both quantities are identical at $\mu_B = 0$ and that the curvature of the latter is about three times larger than the former. Comparing this generic structure with STAR results on net-proton number fluctuations we conclude that current BES results at energies $\sqrt{s} \geq 19.6$˜GeV are compatible with QCD thermodynamics and can be understood in a NLO Taylor expansion. We also discuss changes of freeze-out parameters that arise from the new, preliminary STAR data on net-proton fluctuations compared to the published data and the recent PHENIX data on electric charge fluctuations.

On behalf of collaboration:

[Other]

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