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Higher order net-baryon number cumulants and baryon-strangeness correlations: Comparing QCD results on the pseudo-critical line with RHIC-BES II results on the freeze-out line

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Non-monotonic behavior in the RHIC net proton number fluctuation data could signal the presence of a QCD critical point if they probe thermal conditions at the time of freeze-out. However, the connection between higher-order baryon number cumulants calculated in equilibrium QCD thermodynamics and higher-order net proton number cumulants may not be straightforward. Moreover, correlations between conserved net baryon number and net strangeness number have been suggested as sensitive probes for detecting changes in the degrees of freedom that carry strangeness at low temperatures (hadrons) and high temperatures (quarks) [1]. A non-interacting hadron resonance gas (HRG) model can explain baryon-strangeness correlations calculated in QCD at low temperatures and small chemical potentials, especially when additional strange hadrons are included (QMHRG2020).

In this presentation, we will show the ratio of first-order to second-order baryon number fluctuations and compare them with the RHIC BES-II results for proton number fluctuations. We will argue that a simple non-interacting HRG model cannot explain the RHIC BES-II results at higher densities, particularly at lower beam energies. Additionally, we will compare higher-order baryon number fluctuations with lattice QCD results and argue that these results rule out the possibility of a QCD critical point in the BES-II collider mode. We will also discuss the potential influence of corrections arising from global charge conservation in heavy-ion collisions [2]. Finally, we will compare our results on correlations between conserved net baryon number and net strangeness number at finite chemical potential [3] with preliminary results from RHIC BES-II.

[1] V. Koch et al, Baryon-strangeness correlations: a diagnostic of strongly interacting matter, Phys. Rev. Lett. 95, 2005, 182301

[2] V. Vovchenko et al, Connecting fluctuation measurements in heavy-ion collisions with the grand-canonical susceptibilities, Phys.Lett.B 811 (2020) 135868

[3] D. Bollweg et al, Strangeness-correlations on the pseudocritical line in (2+1)-flavor QCD, Phys.Rev.D 110 (2024), 054519

Category

Theory

Collaboration (if applicable)

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