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Skewness and kurtosis of net-strangeness, net-baryon number and net-electric charge distributions at non-zero μ_B.

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Using recent results on higher order cumulants of conserved charge fluctuations from lattice QCD, we construct mean, variance, skewness and kurtosis of net-strangeness, net-baryon number and net-electric charge distributions at next-to-leading order in μ_B. For the strangeness neutral case ($\mu_S = 0$) at fixed ratio of electric charge to baryon number density ($\frac{n_Q}{n_B} = 0.4$), which is appropriate for a comparison with heavy ion collisions, we present results for $\kappa_X \sigma_X^2$ and $S_X \sigma_X$ and $S_X \sigma_X^3 / M_X$, $(X = B, Q, S)$ on the crossover line for the chiral transition ($T_{pc}(\mu_B)$). Continuum extrapolations for this pseudo-critical transition line have recently been reported by HotQCD up to baryon chemical potentials $\mu_B \simeq 300$ MeV (arXiv:1812.08235). These cumulant ratios thus are of direct relevance for comparisons with corresponding ratios measured by STAR in the BES-I and II runs at beam energies $\sqrt{s_{NN}} \geq 20$ GeV. In particular, we point out that recent high statistics results on skewness and kurtosis of net-baryon number distributions obtained by STAR at $\sqrt{s_{NN}} = 54.4$ GeV put strong constraints on freeze-out parameters and are consistent with predictions from thermal QCD. Additionally, we show that, unlike in the case of net-baryon number fluctuations, the kurtosis ratios for strangeness and electric charge are only weakly dependent on μ_B.

Furthermore, we also construct Taylor series for baryon-strangeness and baryon-charge correlations up to $\mathcal{O}(\mu_B^4)$ and present results for these observables on the crossover transition line. We point out that these correlations are dominated by correlations in the baryon sector of QCD, which is consistent with recent findings of the STAR collaboration (arXiv:1903.05370). Correlations of proton fluctuations with kaon or pion fluctuations, respectively, thus are poor proxies for studying such correlations on the freeze-out line in heavy ion collisions.

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