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Recent results on cumulant ratios at nonzero temperature and density from lattice QCD

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We present recent results on the distributions of conserved charge fluctuations. In particular, we discuss ratios of the shape parameters mean, variance, skewness and kurtosis of the net baryon- number, electric charge and strangeness distributions. For the net baryon-number fluctuations we find –using a next-to-leading order Taylor expansion –that qualitative features of these ratios closely resemble the corresponding experimentally measured cumulants ratios of net proton-number fluctuations for beam energies down to collision energies of 19.6 GeV. We show that the observed difference in cumulant ratios for the mean net baryon-number and the normalized skewness arises naturally in QCD thermodynamics. Moreover, we establish a close relation between skewness and kurtosis ratios, at small values of the baryon chemical potential. In the case of electric charge and strangeness fluctuations we show that these ratios are sensitive to the presence of multiple charged particles.
The calculations are based on lattice QCD simulations with physical quark masses and a highly improved staggered quark (HISQ) action. The lattice size is $N_\sigma^3 \times N_\tau$, with an aspect ratio $N_\sigma/N_\tau = 4$ and three different lattice spacings, corresponding to the number of temporal sites $N_\tau = 8, 12$ and 16. Continuum extrapolations have been performed for most of our observables.

1. A. Bazavov *et al.* [HotQCD Collaboration], "Skewness and kurtosis of net baryon-number distributions at small values of the baryon chemical potential,"Phys. Rev. D 96 (2017), 074510 [arXiv:1708.04897].
2. A. Bazavov *et al.*, "The QCD Equation of State to $\mathcal{O}(\mu_B^6)$ from Lattice QCD,"Phys. Rev. D 95 (2017), 054504 [arXiv:1701.04325].

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