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The equation of state of (2+1)-flavor QCD: An update based on high precision Taylor expansion results

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Compared to the earlier calculation of the equation of state of QCD with physical light and strange quark masses, performed in 2017, the HotQCD collaboration has accumulated an order of magnitude larger statistics for up to 8th order cumulants on lattices with temporal extent Nt=8 and 12 and added results for Nt=16 that were not available previously. We use these high statistics results on Taylor expansion coefficients for an updated calculation of the equation of state in (2+1)-flavor QCD at non-zero net baryon-number density. We show that previously observed ‘’wiggles” in the Taylor series for e.g. the net baryon-number, smoothen out with increasing statistics, confirming that there is no hint of a breakdown of the Taylor expansion up to baryon chemical potential $\mu_B/T = 2.5$.

We compare calculations for pressure, energy and entropy densities as well as net baryon-number densities with HRG model calculations based on the recently constructed QMHRG2020 hadron list, which in addition to the hadronic resonances listed by the Particle Data Group, also includes resonances calculated in relativistic quark models. We discuss the sensitivity of the QCD equation of state to the choice of the hadron spectrum. We also provide an update for the speed-of-sound and use lattice QCD results for (2+1)-flavor QCD to discuss the sensitivity of the dip in the speed-of-sound to the occurrence of a chiral phase transition in the universality class of O(N) spin models.

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