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The QCD equation of state at nonzero temperature and density from lattice QCD

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We present results from a calculation of the QCD equation of state to next-to-leading order ($\mathcal{O}(\mu_B^4)$) in the baryon, strangeness and electric charge chemical potentials [1,2]. We approximate the conditions met in heavy ion collision by enforcing strangeness neutrality and a constant baryon number to electric charge ratio. We show that the fourth-order equation
of state is suitable for the modeling of dense matter created in heavy ion collisions with center-of-mass energies down to
$\sqrt{s_{NN}} \sim 20$ GeV. Sixth-order results for Taylor expansion coefficients are used to estimate truncation errors of the fourth-order expansion. We will further discuss lines of constant pressure and energy density in comparison to the
freeze-out and chiral critical lines.

The presented results will be close to final, *i.e.*, many of the quantities will be continuum extrapolated, based on lattice calculations performed with the Highly Improved Staggered Quark action (HISQ) in the temperature range 140 MeV < T < 330 MeV, with lattice sizes $24^3 \times 6$, $32^3 \times 8$ and $48^3 \times 12$. The strange quark mass is tuned to its physical value
and we use a strange to light quark mass ratio $m_s/m_l = 20$, which in the continuum limit corresponds to a pion mass of about
160 MeV.

References

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2. A. Bazavov, H. T. Ding, P. Hegde, O. Kaczmarek, F. Karsch, E. Laermann, S. Mukherjee and P. Petreczky, C. Schmidt, D. Smith, W. Soeldner and M. Wagner, "*Freeze-out Conditions in Heavy Ion Collisions from QCD Thermodynamics,*" Phys. Rev. Lett. **109** (2012) 192302 [arXiv:1208.1220 [hep-lat]].

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