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A new 4D lattice QCD equation of state: extended density coverage from a generalized T'-expansion

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Although calculations of QCD thermodynamics from first-principle lattice simulations are limited to zero net-density due to the fermion sign problem, it is possible to extend the equation of state (EoS) to finite values of the μ_B, μ_Q, μ_S chemical potentials via expansions around zero chemical potentials. Thanks to a new method based on a T'-expansion scheme, it was possible to extrapolate in the (T, μ_B) plane up to a baryo-chemical potential around $\mu_B/T = 3.5$, further than the range currently accessible by the Taylor expansion ($\mu_B/T < 2.5 \sim 3$) [1]. We present here a generalization of this scheme in which all three chemical potentials can be varied independently. We base our construction on continuum-estimated susceptibilities, obtained with the 4stout action on lattices with up to $N_\tau = 16$, 20 and 24 time slices, depending on the quantity considered [2]. As a result, we are able to offer a substantially larger coverage of the four dimensional QCD phase diagram compared to extrapolations based on the Taylor expansion, which we discuss based on stability and causality criteria.
[1] S. Borsanyi et al., Phys. Rev. Lett. 126 (2021) 23, 232001.
[2] A. Abuali et al., Phys.Rev.D 112 (2025) 5, 054502.

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