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A lattice-based equation of state to study QCD matter at the Beam Energy Scan II.

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With current and future heavy-ion experiments focusing on understanding the baryon-rich QCD (Quantum Chromodynamic) matter produced at low collisional energies, first-principle knowledge of the equation of state in such regions is essential for analyzing experimental data in terms of transport simulations and to constrain effective models of QCD.

We construct a novel equation of state (EoS) describing QCD matter at finite temperature T and baryon B, electric Q and strangeness S chemical potentials by utilizing the alternate expansion scheme from recent lattice QCD results [1]. This procedure allows to reliably estimate the baryon and strangeness densities at larger values of the baryon chemical potential μ_B compared to the usual Taylor expansion in terms of susceptibilities. We use the latter only to incorporate the μ_Q and μ_S dependence into thermodynamic quantities, which is sufficient for studying the matter as produced in relativistic heavy-ion collisions. Our simple parametrization provides reliable results for all temperatures since it interpolates between the confined phase at low T described by the Hadron-Resonance Gas (HRG) model, lattice QCD results around and above the transition temperature $T_c(\mu_B)$, and $\mathcal{O}(g^5)$ perturbative QCD results in the high-T regime.

[1] S. Borsányi, Z. Fodor, J.N. Guenther, R. Kara, S.D. Katz, P. Parotto, A. Pásztor, C. Ratti, K.K. Szabó. Lattice QCD equation of state at finite chemical potential from an alternative expansion scheme. Phys.Rev.Lett. 126 (2021) 23, 232001.

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