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Phase and equation of state of finite density QC_2D at lower temperature

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We investigate the phase structure and the equation of state (EoS) for dense two-color QCD (QC2D) at low temperature (T=40 MeV, 32^4 lattice) for the purpose of extending our previous works at T=80 MeV (16^4 lattice). Indeed, a rich phase structure below the pseudo-critical temperature Tc as a function of quark chemical potential μ has been revealed, but finite volume effects in a high-density regime sometimes cause a wrong understanding. Therefore, it is important to investigate the temperature dependence down to zero temperature with large-volume simulations. By performing 32^4 simulations, we obtain essentially similar results to the previous ones, but we are now allowed to get a fine understanding of the phase structure via the temperature dependence. Most importantly, we find that the hadronic-matter phase, which is composed of thermally excited hadrons, shrinks with decreasing temperature and that the diquark condensate scales as $\langle qq \rangle \propto ^2$ in the BCS phase, a property missing at T=80 MeV. From careful analyses, furthermore, we confirm a tentative conclusion that the topological susceptibility is independent of μ. We also show the temperature dependence of the pressure, internal energy, and sound velocity as a function of μ. The pressure increases around the hadronic-superfluid phase transition more rapidly at the lower temperature, while the temperature dependence of the sound velocity is invisible. Breaking of the conformal bound is also confirmed thanks to the smaller statistical error.
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