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Chemical potential dependence of the endpoint of the first-order phase transition in the heavy-quark region of finite-temperature lattice QCD

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We determine the location of the critical point where the first-order deconfining transition in the heavy-quark region turns into a crossover in finite-temperature and density QCD with 2+1 flavors. Combining a hopping parameter expansion of the quark determinant with a reweighting method, we evaluate the chemical potential dependence of the critical point. By systematically calculating the coefficients of the hopping parameter expansion up to the higher order terms, it is found that the higher order terms are strongly correlated with the Polyakov loop, which is the first-order term, at each configuration. Furthermore, we find that the complex phase, which is important at finite density, is also strongly correlated with the complex phase of the Polyakov loop. Using this property, we develop a method for estimating the results incorporating high-order terms from calculations with only low-order terms. We report that the first-order phase transition region in the heavy-quark regime becomes exponentially narrower with increasing chemical potential. Since the hopping parameter at the critical point decreases exponentially with increasing density, the sign problem does not become too serious as the density increases, and the critical point can be evaluated up to a high density.

Topical area

QCD at Non-zero Density

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