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Quark mass dependence of the nature of QCD phase transition at high temperature and density by a histogram method

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We study the phase structure of QCD at high temperature and density by lattice QCD simulations focusing on the probability distribution function (histogram).
First, we investigate the quark mass and chemical potential dependence of the probability distribution functions as functions of appropriate physical quantities when all quark masses are sufficiently large.
Through the shape of the distribution, the critical surface, which separates the first order transition and crossover regions in the heavy quark region, is determined for the 2+1-flavor case.
Next, we study the phase structure of (2+Nf)-flavor QCD, where two light flavors and Nf massive flavors exist.
Applying the reweighting method, the probability distribution function of the plaquette is calculated in (2+Nf)-flavor QCD.
From the distribution, we determine the critical mass of heavy flavors terminating the first order region, and find it to become larger with Nf.
Moreover, the first order region is found to become wider as increasing the chemical potential at finite density and the light-quark mass dependence of the critical mass seems to be small.
From the results of (2+Nf)-flavor QCD, we discuss the properties of 2-flavor QCD and (2+1)-flavor QCD at finite temperature and density.

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