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Critical endpoint of 4-flavor QCD on the lattice

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At vanishing chemical potential the chiral phase transition in QCD with three degenerate quark flavors is expected to be of first order in the massless limit. As increasing the quark mass, a region of the first-order phase transition should terminate at a second-order critical endpoint before a crossover region appears. However, lattice studies with staggered-type quarks have shown that the region of the first-order phase transition keeps shrinking by decreasing the lattice spacing and with more improved actions, which may indicate possibility of no first-order phase transition at any finite quark mass. Results with Wilson-type quarks also have the same trend but they are still quantitatively different from those with staggered-type quarks. To understand these puzzling results we studied the nature of phase transition in 4-flavor QCD at vanishing chemical potential on the lattice with $O(a)$-improved Wilson quarks. An advantage of studying 4-flavor QCD is that there is expected to be a stronger first-order phase transition and accordingly, a larger critical quark mass than in 3-flavor, which allows more detailed investigations with numerically less expensive costs. Another advantage is that one can make a better comparison between staggered-type and Wilson-type quarks as there is no issue of rooting. In this talk we determine the critical endpoint from an intersection point of kurtosis of the chiral condensate with three different volumes on lattices with temporal size of 4, 6 and 8. Then, we discuss a location of the critical endpoint in the continuum limit.

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