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Exploration of the Phase Diagram of (2+1)-Flavor QCD through the Study of Fluctuations of Conserved Charges with Domain Wall fermions

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In this presentation, we explore the phase diagram of (2+1)-flavor Quantum Chromodynamics (QCD) through the study of fluctuations of conserved charges using Domain Wall Fermions (DWF). DWF are known for their better control over chiral symmetry, closely matching the symmetries of continuum QCD. This implies that studies of QCD phase transitions using DWF fall within the same universality class as those in continuum QCD, making DWF a natural choice for studying QCD phase transitions at finite temperature, chemical potential, and quark masses.

We will present our ongoing calculations of chiral observables, quark number susceptibilities, and conserved charge fluctuations for two pion masses, approximately 220 MeV and 135 MeV, using Mobius Domain Wall fermions for aspect ratios of lattices $LT = 2$ and $LT = 3$, respectively. We will demonstrate that the second-order conserved charge fluctuations, while following expected features obtained using staggered fermion discretization schemes, can differ quantitatively at lower temperatures. Furthermore, we argue that these differences, particularly for the second-order electric charge fluctuations, are a consequence of the pion spectrum distortion in the staggered fermion formalism. We will also present the first calculations of the kurtosis ratio of electric charge cumulants as well as various fourth-order cumulants calculated using Mobius Domain Wall fermions.

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