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Universal scaling near the chiral phase transition in (2+1)-flavor QCD

The chiral phase transition in (2+1)-flavor QCD is expected to be of second order if the breaking of axial anomaly remains sufficiently strong at the chiral phase transition temperature T_c [1]. This is supported by lattice QCD calculations [2]. However, FRG model calculations suggest that the scaling window, in which universal scaling relations hold, may be small [3]. Furthermore, whether or not the $U_A(1)$ symmetry gets effectively restored at T_c remains to be controversial. This suggest that a more detailed analysis of universal critical behavior close to T_c , as well as a direct determination of the relevant universality class for the chiral phase transition [1,4] in (2+1)-flavor QCD are needed.

In this talk we present new results from a study of the scaling behavior
of an improved order parameter $M = M_\ell - H\chi_\ell$ for chiral symmetry restoration in the light 2-flavor sector of (2+1)-flavor QCD. Here M_ℓ and χ_ℓ are multiplicatively renormalized light quark chiral condensate and chiral susceptibility, respectively. Furthermore, $H = m_l/m_s$ is the light-to-strange quark mass ratio.

We construct ratios of M for two different values of the light quark mass, m_l (or H equivalently), and T close to T_c . In the scaling region we find a unique intersection point for these ratios at $T = T_c$, which allows us to determine T_c and the underlying universality class of the chiral phase transition, from the knowledge of critical exponent δ.

The approach followed here will allow to further constrain the influence of axial anomaly on universal critical behavior in (2+1)-flavor QCD. It also provides a new way of determining the chiral phase transition temperature T_c , which strengthens the upper bound on the temperature range within which a critical end point in QCD for non-vanishing values of chemical potential can possibly be found in heavy ion experiments.

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Category

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