Contribution ID: **71** Type: **Parallel Session**

The fate of U(1)A and topological features of QCD at finite temperature

Wednesday 9 August 2017 16:00 (30 minutes)

The nature of chiral phase transition for QCD with two light quark flavors is not yet completely resolved. This is primarily because
one has to understand whether or not the anomalous U(1) symmetry in the flavor sector is effectively restored along with the chiral symmetry.
Since the physics near the chiral phase transition is essentially
non-perturbative, we employ first principles lattice techniques to address this issue. We use overlap fermions, which have exact chiral symmetry on the lattice, to probe the anomalous U(1) symmetry violation of 2+1 flavor dynamical QCD configurations with domain wall fermions. The latter also optimally preserves chiral and flavor symmetries on the lattice. We observe that the anomalous U(1) is not effectively
restored in the chiral crossover region. We perform a systematic study of the finite size and cut-off effects since the signals of U(1) violation are sensitive to it. For the same reasons we also compare our results from the continuum extrapolated results of the QCD Dirac spectrum obtained from a different lattice discretization called Highly Improved Staggered Quarks. Our studies also provide a glimpse of the microscopic topological structures of the QCD medium that are responsible for the strongly interacting nature of the quark gluon plasma phase and related to the physics of confinement and chiral symmetry breaking.

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Session Classification: Parallel 3

Track Classification: Parallel Session