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The topological structures in strongly coupled QGP with chiral fermions on the lattice

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The nature of chiral phase transition for two flavour QCD is an interesting but unresolved problem. One of the most intriguing issues is
whether or not the anomalous U(1) symmetry in the flavour sector is effectively restored along with the chiral symmetry.
This may determine the universality class of the chiral phase transition. 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 flavour dynamical QCD configurations with domain wall fermions. The
latter also optimally preserves chiral and flavour symmetries on the lattice, since it is known that the remnant chiral symmetry of the light
quarks influences the scaling of the chiral condensate [1] in the crossover
transition region. We observe that the anomalous U(1) is not effectively
restored in the chiral crossover region. This effectively means that the eta' excitations remains distinct from the pion excitations well into
the QGP medium. We perform a systematic study of the finite size and cut-off effects since the signals of U(1) violation are sensitive to it.
We 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. We study the effect of these microscopic constituents through our first calculations for the topological susceptibility of QCD at finite temperature, which could be a crucial input for the equation of state with a finite chiral chemical potential.

Reference:
[1] S. Ejiri et. al., Phys. Rev. D 80, 094505 (2009).

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