QUARK MATTER 2015
Sep. 27 – Oct. 3, 2015 Kobe, Japan

Contribution ID: **231** Type: **Poster**

Deconfinement and chiral crossover with Dirac-mode expansion in QCD

Tuesday 29 September 2015 16:30 (2 hours)

We discuss the relation between confinement and chiral symmetry breaking using Dirac-mode expansion in finite-temperature lattice QCD.

The ratios of the real, imaginary and modulus of the Polyakov loop fluctuations are sensitive probes for quark deconfinement even in the presence of dynamical quarks [1].

We focus on the correlations of these Polyakov loop fluctuations with eigenmodes of the lattice Dirac operator. Their analytic relations are rigorously derived on the temporally odd-number size lattice with a non-twisted periodic boundary condition for the link-variables [2,3].

We show that the low-lying Dirac modes, which are essential for chiral symmetry breaking, yield negligible contributions to the Polyakov loop fluctuations. This property is confirmed in confined and deconfined phases by numerical simulations in quenched QCD. Our results indicate that there is no direct, one-to-one correspondence between confinement and chiral symmetry breaking in the context of different properties of the Polyakov loop fluctuations and their ratios.

[1] P.M. Lo, B. Friman, O. Kaczmarek, K. Redlich and C. Sasaki, Phys. Rev. D88, 074502 (2013).
[2] T. M. Doi, H. Suganuma, T. Iritani, Phys. Rev. D90, 094505 (2014).
[3] T. M. Doi, K. Redlich, C. Sasaki, H. Suganuma, arXiv:1505.05752 [hep-lat].

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Session Classification: Poster Session

Track Classification: QCD at High Temperature