Unquenched finite temperature lattice Landau gauge QCD

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The color diagonal and color antisymmetric ghost propagators of finite temperature $N_f = 2$ MILC $24^3 \times 12$ lattices(MILC$_{ft}$)[1] are measured and compared with zero temperature unquenched $N_f = 2+1$ MILC$_c$ $20^3 \times 64$ and MILC$_f$ $28^3 \times 96$ lattices and zero temperature quenched 56^4 $\beta = 6.4, 6.45$ lattices [2, 3].

The configurations of the MILC$_{ft}$ consists of three different β values and their temperature were assigned by the corresponding ρ meson mass. The critical temperature T_c that the cross over to the deconfinement occurs was assigned to be about 140MeV from the data of chiral susceptibility. This temperature is lower than that of the recent simulation with Asqtad action that suggests $T_c \sim 170$MeV and that of the $N_f = 2$ improved Kogut-Susskind (KS) fermion $T_c \sim 173 \pm 8$MeV [4]. The stout-link improved KS fermion simulation[5] suggests that the T_c measured by the chiral susceptibility is about 25 MeV lower than that measured by the Polyakov loop. We leave accurate assignment of the temperature scale of the MILC$_{ft}$ to a future study and assign the $\beta = 5.65, 5.725$ and 5.85 data by $T/T_c = 1.02, 1.23$ and 1.32, respectively.

The expectation value of the color antisymmetric ghost propagator $\phi^c(q)$ is zero but its Binder cumulant, which is consistent with that of $N_c^2 - 1$ dimensional Gaussian distribution below T_c, becomes smaller above T_c as shown in Figure 1. We study l^1 norm of $\phi^c(q)$ which could contain information on the ghost condensate parameter v. We observed that the color diagonal ghost propagator is temperature independent, but the l^1 norm of the color antisymmetric ghost propagator is temperature dependent. The ghost condensate and the A^2 condensatein $T > T_c$ are consistent with 0[6].

We measure also magnetic and electric gluon screening masses slightly above T_c[7, 8, 9]. The running coupling at 0 momentum near T_c are almost constant but the magnetic gluon screening mass has temperature dependence as shown in Figure 2. It implies strong non-perturbative effects in the magnetic screening mass of the gluon near T_c.

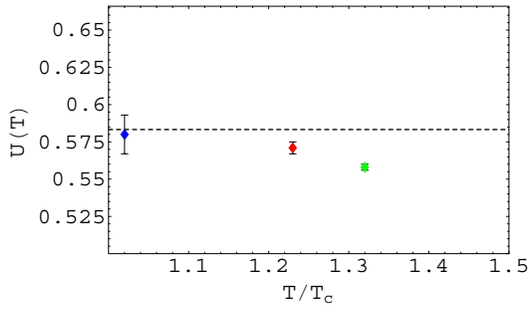

Figure 1: Averages over momenta excluding the lowest momentum point of the Binder cumulants of MILC finite temperature configurations. $T/T_c = 1.02$(blue diamonds), $T/T_c = 1.23$(red stars) and $T/T_c = 1.32$(green triangles).

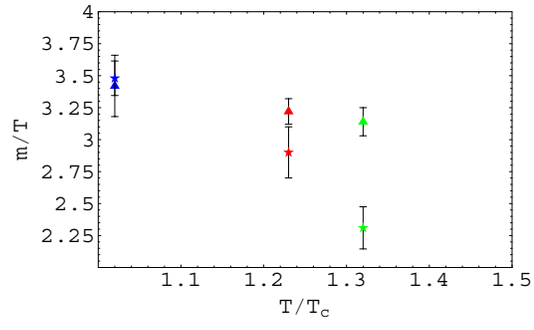

Figure 2: The magnetic screening mass m_m/T (stars) and the electric screening mass m_e/T of MILC $N_f = 2$ KS fermion unquenched configurations (triangles).

References

[1] C. Bernard et al., Phys. Rev. D**54**,4585(1996).
[2] S. Furui and H. Nakajima, Phys. Rev. D**73**,094506(2006); arXiv:hep-lat/0602027.
[3] S. Furui and H. Nakajima, Braz. J. Phys. **37**(2007).
[4] F. Karsch and E. Laermann; arXiv: hep-lat/0305025.
[5] Y. Aoki, Z. Fodor, S.D. Katz and K.K. Szabo; arXiv: hep-lat/0609068 v2.
[6] S. Furui and H. Nakajima, [arXiv:hep-lat/0612009].
[7] U.M. Heller, F. Karsch and J. Rank , Phys. Lett. B**355**,511(1995); arXiv: hep-lat/9505016.
[8] U.M. Heller, F. Karsch and J. Rank , Phys. Rev. D**57**,1438(1998).
[9] A. Nakamura, T. Saito and S. Sakai, Phys. Rev. D**69**,014506(2004).