Color qq potentials at finite temperature

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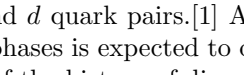
Recently a di-quark (a two-quark system) has attracted much attention in the high energy phenomenology. Jaffe and Wilczek proposed that the recently discovered penta-quark state (Θ^+) is a bound state of $(ud)(ud)\bar{s}$, where (ud) stands for highly correlated u and d quark pairs.[1] At high baryon number density and low temperature, a family of color superconducting phases is expected to occur, due to the quark pairing driven by the BCS mechanism.[2] See Ref.[3] for a review of the history of diquarks and their role in high energy reactions.

Quark-quark system is color anti-triplet (anti-symmetric) or sextet (symmetric),

$$3 \times 3 = 3^* + 6 \qquad (1)$$



We anticipate that the quark-quark interaction is attractive and strong in the color anti-triplet channel based on the perturbation [5] and the instanton induced model [6]. It is important to investigate the quark-quark potential using lattice QCD which provides us a non-pertuabative and first principle base for exploring the quark-quark interaction. To our knowledge, there has been only one such study by Wetzorke and her collaborators[4].

The first lattice QCD numerical study of heavy quark-quark potentials at finite temperature is reported [7]. Using quenched approximation, we evaluate the color anti-symmetric and symmetric potentials. The typical behavior of the symmetric and anti-symmetric free energy at $T/T_c = 2.02, 3.04, 5.61$ is shown in Fig. 1. The symmetric channel gives the repulsive force, while the anti-symmetric one the attractive force. As the system temperature is varied each potential is changed and their variations are seemed to be small.

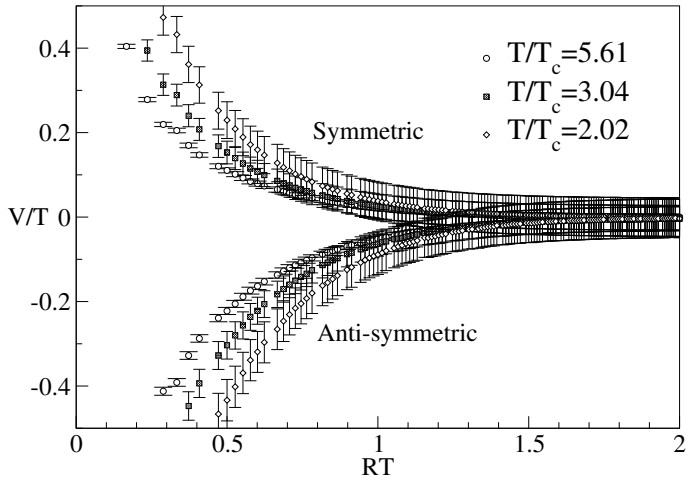


Figure 1:

The lattice calculations were carried out on SX-5 (NEC) vector-parallel computer at RCNP of Osaka University.

References

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