Numerical study of Coulomb gauge color confinement

A. Nakamura and T. Saito
Research Institute for Information Science and Education,
Hiroshima University, Higashi-Hiroshima 739-8521, Japan

Recently the color confinement scenario in Coulomb gauge has been revealing its importance [1, 2, 3, 4, 5, 6]. Zwanziger [1] discussed the significance of a color-Coulomb potential in the color confinement. He and his collaborators showed that, in Coulomb gauge, the time-time component of gluon propagators, $g^2 D_{00}$, including the instantaneous color-Coulomb potential plus the non-instantaneous vacuum polarization, is invariant under the renormalization [1], where, g is a coupling constant of gauge field theory. The instantaneous color-Coulomb potential plays an essential role in the Coulomb gauge confinement scenario. In the $SU(2)$ numerical simulation carried out by Cucchieri and Zwanziger [5], it was found that the instantaneous color-Coulomb potential $D_{00}(\vec{k})$ is strongly enhanced at $\vec{k} = 0$. Moreover, Zwanziger pointed out that there is an inequality [4],

$$V_{phys}(R) \leq V_{coul}(R), \tag{1}$$

where $V_{phys}(R)$ means the physical heavy-quark potential and $V_{coul}(R)$ the Coulomb heavy-quark potential corresponding to the instantaneous part of D_{00}. This inequality indicates that if the physical heavy-quark potential is confining, then the Coulomb heavy-quark potential is also confining. In $SU(2)$ lattice simulations, furthermore, Greensite et al. found that the Coulomb heavy-quark potential grows linearly at large quark separations [6]. They showed that the instantaneous part of D_{00} can be nonperturbatively managed with a partial-length Polyakov line (PPL) correlator. See Ref.[7] for an excellent review.

In this work, we nonperturbatively study the heavy-quark potential in the color-singlet channel using the quenched $SU(3)$ lattice QCD simulation with the PPL correlator in Coulomb gauge [8, 9].

In Fig. 1, we show the numerical results of the Coulomb instantaneous potentials at zero (left) and finite (right) temperatures. We find that the linearity of the Coulomb heavy-quark potential is not lost even in the deconfinement phase.

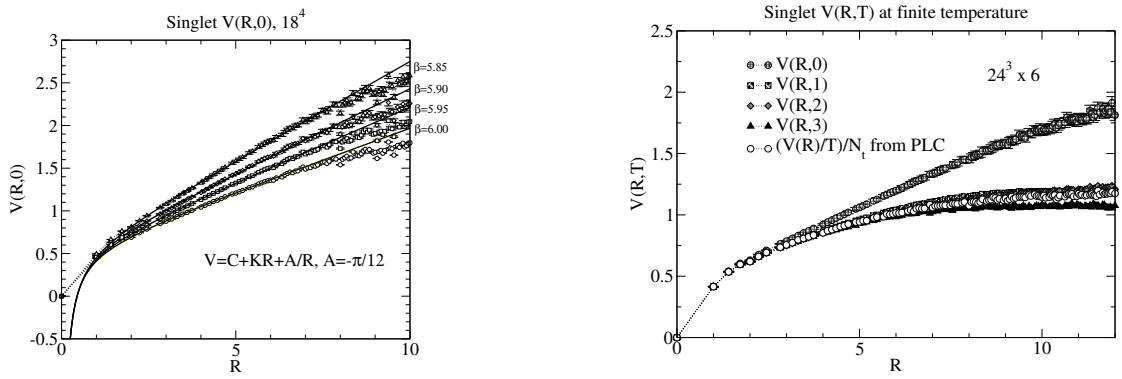

Figure 1:

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

References

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