The dual Meissner effect in local unitary gauges in SU(2) gluodynamics

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We study the flux-tube profile between the quark and antiquark in local unitary gauges. As local unitary gauges, we adopt the F12, the F123 and the spatial Polyakov loop (SPL) gauges as well as the original Polyakov (PL) gauge.

We employ the improved Iwasaki gauge action with the coupling constant $\beta = 1.20$, which corresponds to the lattice spacing $a(\beta) = 0.0792(2)$ fm on the 32^4 lattice. Here, we mainly evaluate the connected correlator defined by

$$\langle \mathcal{O}_A(r) \rangle_W = \frac{\langle \mathrm{Tr}\left[LW(R,T)L^\dagger \sigma^3 \mathcal{O}_A^3(r) \right] \rangle}{\langle \mathrm{Tr}\left[W(R,T) \right] \rangle}$$

for various operators $\mathcal{O}_A$ composed of Abelian link variables, where L is a product of non-Abelian link variables called the Schwinger line, connecting the Wilson loop W with the Abelian operator [2, 3]. In Fig. 1(left), we show the Abelian electric field profile in the F123 gauge for $W(5a, 5a)$. We find that only $\langle E_z(r) \rangle_W$ exhibits an exponential decay as a function of r and the penetration length is then found to be $\lambda = 0.133(3)$ fm. As seen from Table 1, λ in other unitary gauges are almost the same, which are also consistent with that in the MA gauge. In Fig. 1(right), we show the Abelian (dual) Ampère's law of each term in the PL gauges, where only the non-vanishing azimuthal components are plotted. We find that the curl of electric field $\vec{\nabla} \times \vec{E}$ is reproduced by the monopole current $2\pi\vec{k}$. Note that this behavior is consistent with that in the MA gauge[4].

These results suggest that the Abelian confinement scenario is gauge independent. Observing the important role of space-like monopoles in the Polyakov gauge also indicates that the monopoles defined on the lattice do not necessarily correspond to those proposed by 't Hooft in the context of Abelian projection.

The numerical simulations of this work were done using SX5 at RCNP of Osaka University.

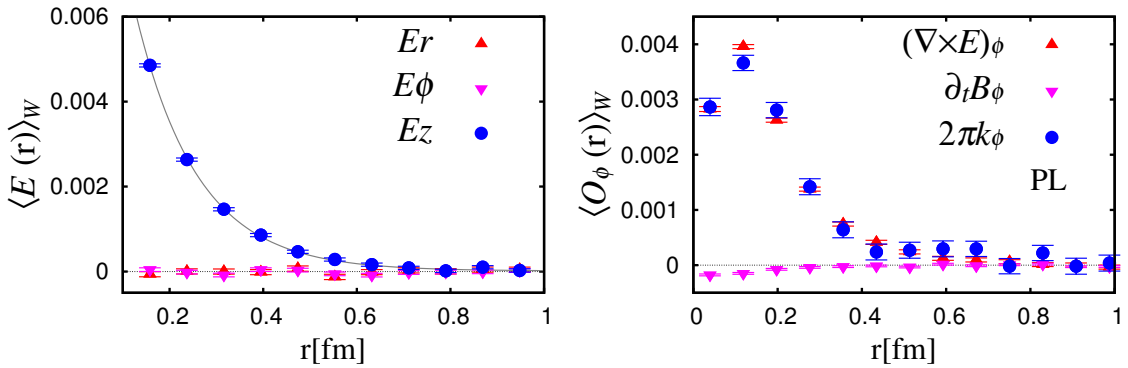

Figure 1: Left:The profile of the Abelian electric field in the F123 gague. The solid line denotes the fitting curve for $\langle E_z(r) \rangle_W$ to the function $f(r) = c_1 \exp(-r/\lambda) + c_0$. r is the distance from the midpoint between the quark pair. Right:The profile of the each term of the Abelian (dual) Ampere's law in the PL gauge.

	MA(d)	F123	F12	SPL	PL
λ	0.129(2)	0.133(3)	0.132(3)	0.134(7)	0.132(4)

Table 1: The penetration length λ in unit of fm , which are evaluated from $W(5a, 5a)$. MA(d) means the disconnected correlator in the MA gauge. In each case $\chi^2/N_{\mathrm{df}} = 0.6 - 1.1$.

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