# Abelian dominance in local unitary gauges in SU(2) gluodynamics

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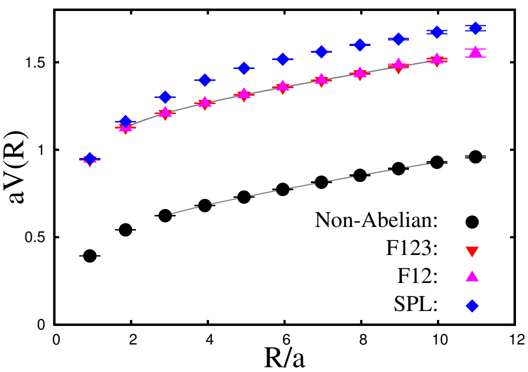
The dual Meissner effect is one of the candidate of the color confinement mechanism of QCD. Numerically, an Abelian projection with non-local gauges such as the maximally Abelian (MA) gauge has been found to support the Abelian confinement scenario beautifully. However, a question if the Abelian confinement scenario is gauge-dependent still remains. As a matter of fact, the Abelian confinement mechanism has not been observed clearly so far in other general gauges among infinite possible ways of gauge fixing, in particular, in local unitary gauges. It is the purpose of this work to show for the first time that the Abelian confinement mechanism is observed numerically also in local unitary gauges in SU(2) gluodynamics. As local unitary gauges, we adopt the F12, the F123 and the spatial Polyakov loop (SPL) gauges. Applying the multi-level noise reduction method invented by Lüscher and Weisz [1] to the Wilson gauge action, we investigate the Abelian static potential with high accuracy and find a clear signal of Abelian dominance in its confining part.

Our simulation performed on the $N^4 = 24^4$ lattice at the coupling constant $\beta = 2.5$ where the lattice spacing is $a(\beta) = 0.0836(8)$ fm. In Fig. 1, we show the Abelian static potential as well as the non-Abelian potential as a function of the $q$-$\bar{q}$ distance $R$, where a tree-level perturbative improvement of the distance is applied to avoid an enhancement of lattice artifacts especially at short distances [2, 3]. We find that the results in local unitary gauges are remarkably clean. The slope at large distances looks identical. We may fit the potentials to a usual functional form $V_{\rm fit}(R) = \sigma R - c/R + \mu$ and extract the string tension $\sigma$. The best fitting parameters are summarized in Table 1. In the F12 and the F123 gauges , the string tensions are in almost complete agreement with the non-Abelian one. On the other hand, in all gauges the force, which is defined by differentiating the potential with respect to $R$, shows a good agreement at large distances (see Fig. 1).

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



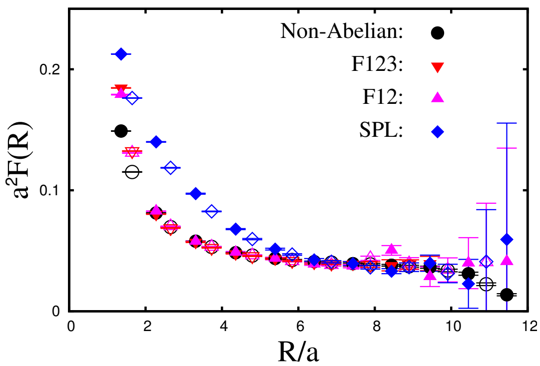




Figure 1: Left:The potential in local unitary gauges in comparison with the non-Abelian one. Right:The force in local unitary gauges in comparison with the non-Abelian one. The filled (open) symbols are forces which are defined by using the backward (mid-point) difference.

| | $\sigma a^2$ | $c$ | $\mu a$ | FR(R/a) | $\chi^2/N_{\rm df}$ | $N_{\rm iupd}$ |
|---|---|---|---|---|---|---|
| NA | .0348(7) | .243(6) | 0.607(4) | 3 - 10 | 0.35 | 15000 |
| F123 | .0350(2) | .239(1) | 1.187(1) | 2 - 10 | 0.10 | 80000 |
| F12 | .0345(6) | .244(4) | 1.192(3) | 2 - 10 | 1.08 | 80000 |

Table 1: The string tension $\sigma$ obtained by the best fit. FR means the fitting range before tree-level improvement. $\chi^2/N_{\rm df}$ is usual reduced chi-square. $N_{\rm iupd}$ is the number of internal updates used in the multi-level method. The errors are estimated by the jackknife method.

## References

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