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Further numerical evidences for the gauge-independent separation between Confinement and Higgs phases in lattice SU(2) gauge theory with a scalar field in the fundamental representation

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In the lattice SU(2) gauge-scalar model with a single scalar field in the fundamental representation of the gauge group, we have quite recently found that there exists a gauge-independent transition line separating Confinement phase and Higgs phase without contradicting the well-known Osterwalder-Seiler-Fradkin-Shenker analyticity theorem between the two phases by performing numerical simulations without any gauge fixing [Phys.Rev.D109, 054505 (2024)]. This was achieved by examining the correlation between the original fundamental scalar field and the so-called color-direction field constructed from the gauge field through the gauge-covariant decomposition due originally to Cho-Duan-Ge-Shabanov and Faddeev-Niemi.

In this talk, we give further numerical evidences for the gauge-independent separation between Confinement phase and Higgs phase in the above model to establish its physical origin. For this purpose, we measure the string tension (the Wilson loop average) and the gauge boson mass (the gauge field correlator) across the new transition line. Moreover, we investigate the contributions from magnetic monopoles to determine their role in confinement and mass generation (mass gap) from the viewpoint of the electric-magnetic duality.

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