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Monopole dominance under influence of external magnetic fields

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Monopoles and instantons play crucial roles in understanding quark confinement and chiral symmetry breaking in quantum chromodynamics. However, their relationship remains unclear. In this research, we perform Monte Carlo simulations in lattice gauge theory to identify signatures of monopoles under the influence of magnetic fields, for example, those generated in heavy-ion collision experiments.

In collaboration with a research group at the University of Pisa, we set the parameters for the quark masses to the physical pion mass and generate gauge field configurations with $N_f = 2 + 1$ flavor quarks in SU(3). We apply a uniform external magnetic field to the configurations and vary its intensity.

In our previous study, we reported on the influence of the external magnetic field on monopoles, quark confinement, instantons, chiral symmetry breaking, and the eta-prime meson mass using these configurations.

In this study, we define three contributions — abelian, monopole, and photon — and construct three types of configurations of the gauge fields corresponding to these contributions by subjecting the configurations to Abelian projection after transforming the matrices under the condition of the maximal Abelian gauge. These configurations are prepared for both the quark confinement phase and the quark deconfinement phase.

We then calculate the low-lying eigenvalues and eigenvectors of overlap fermions using the configurations. The overlap fermion represents a quark formulation that preserves the exact chiral symmetry in lattice gauge theory.

Finally, we demonstrate that monopole dominance, that is, the numerical results of observables computed from the configurations of the monopole contribution, reasonably agree with the results computed from the normal configurations, which are not transformed under any gauge condition, even in the presence of external magnetic fields.

In my presentation, I will present the preliminary results.

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