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Analytical Formulae linking Quark Confinement and Chiral Symmetry Breaking

Summary

Quark confinement and chiral symmetry breaking are two outstanding nonperturbative properties of QCD, and their relation has been one of the important issues in particle and nuclear physics. For the Polyakov and Wilson loops, we derive analytical formulae between quark confinement and Dirac eigenvalues in the lattice QCD formalism. For the temporal lattice with an odd-number, we find that the Polyakov loop is simply expressed with the Dirac eigenvalues [1]. Also, we obtain a similar relation between the Wilson loop and the Dirac eigenvalues. From these formulae, we find that the contribution from the low-lying Dirac eigenvalues is found to be negligibly small for quark confinement, while the low-lying Dirac modes are essential for chiral symmetry breaking, as was numerically shown in lattice QCD simulations [2]. We also our present recent study on Polyakov-loop fluctuations in the Dirac eigenmode expansion [3] in the context of deconfinement transition in thermal QCD [4].

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