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Local composite operator formalism in gauge theories with Gribov horizon restriction

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Content

Understanding the infrared (IR) dynamics of Quantum Chromodynamics (QCD) remains a major open problem in theoretical physics, directly related to phenomena such as confinement and the dynamical generation of mass. This work focuses on the study and application of advanced methods in non-Abelian gauge theories in the non-perturbative regime, particularly within the Refined Gribov-Zwanziger (RGZ) framework. The central formalism is quantum field theory, applied both to fundamental QCD and to infrared-modified gauge theories. Among the non-perturbative tools used, the RGZ approach restricts the functional integration over gauge fields to the Gribov region, eliminating residual infinitesimal gauge copies and enabling a semi-analytical analysis of infrared QCD. Various correlation functions computed using the RGZ action at tree level and one-loop order have shown compatible results with available lattice data in Landau gauge and also for propagators in Linear covariant gauges. This compatibility is based, however, by the fitting of infrared generated masses from lattice data and a fully self-consistent prediction for the RGZ action, even though possible through the calculation of dimension-two condensates and the solution of the gap equation, is still lacking. In this context, the Local Composite Operator (LCO) formalism plays a crucial role, providing a renormalizable method to construct effective potentials for local operators made up of nonlinear functions of the fundamental fields. Through the introduction of auxiliary fields and gap equations, this formalism allows for the non-perturbative evaluation of dimension-two condensates, which are essential for understanding mass generation in the RGZ approach and reaching ab initio predictions in this theory. The aim of this work is to explore further the calculation of this effective potential.

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