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Steps toward Dyson-Schwinger equations for equal-time correlation functions

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Abstract content

Dyson-Schwinger equations as a semi-analytical tool have given access, for the first time, to the deep infrared region of QCD (or Yang-Mills theory) in the Landau gauge. In the so-called ghost dominance approximation, even a very simple analytical solution exists. Recent efforts have gone into repeating this success for QCD in the Coulomb gauge, the reason being that the color-Coulomb potential appearing in the Hamiltonian in the latter gauge in principle gives direct access to the long-range confining potential between color charges.

However, the usual covariant (four-dimensional) quantum field theoretic formulation becomes rather awkward in the Coulomb gauge. Partially successful analytic calculations so far have used alternative noncovariant approaches in three (spatial) dimensions, but a consistent solution of the corresponding nonperturbative equations including the Coulomb potential does not exist in the approximations presently employed. Our aim here is to develop an alternative approach concentrating directly on equal-time correlation functions.

We determine a generating functional in a three-dimensional formulation that generates equal-time correlation functions. In fact, such a functional is given directly in terms of the vacuum wave functional, however, in a perturbative expansion of the equal-time correlation functions, the vacuum wave functional has to be known, in principle, to the corresponding order. As a consequence, there are many contributions here that correspond to one and the same Feynman diagram in the covariant theory. A remarkable simplification occurs, however, on summing up these different contributions. For the relatively simpler case of a ϕ^4 theory, we analyze the possibility of developing new diagrammatic rules directly for the sum of all contributions that correspond to the same proper Feynman diagram. We comment on the possibility of using these new diagrammatic rules for the formulation of Dyson-Schwinger equations for the equal-time correlation functions.

Summary

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