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A light-front coupled-cluster method for the nonperturbative solution of quantum field theories

We propose a new nonperturbative method that is based on a light-front Hamiltonian approach and the exponential-operator techniques of the many-body, coupled-cluster method. The mass eigenstates of the field theory are written as infinite expansions in Fock space but approximated by the exponentiation of an operator acting on a projection onto the lowest Fock sector. The full eigenvalue problem is then reduced to an eigenvalue problem in the lowest sector, combined with nonlinear equations that determine the operator. This replaces the usual coupled system of equations for the Fock-state wave functions and, instead of truncating this system by truncating Fock space, the possible contributions to the exponential operator are truncated. As an illustration, we apply the method to a calculation in QED of the dressed-electron state and its anomalous magnetic moment. This shows that, unlike the Fock-space truncation, the self-energy and vertex corrections are spectator-independent and physical masses appear naturally in the kinetic-energy terms. Also, the uncanceled divergences that are characteristic of Fock-space truncations do not occur.

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