Toward heavy-quarkonium states within the renormalization-group procedure for effective particles

The renormalization group procedure for effective particles (RGPEP) has been developed during the last years as a non-perturbative tool for constructing bound-states in quantum field theories [1]. It stems from the similarity renormalization group procedure (SRG) [2] and introduces the concept of effective particles, which differ from the point-like canonical, bare ones by having a finite size s. The effective particles in the Fock space build the hadronic eigenstates of a family of effective Hamiltonians H_s characterized by the scale parameter λ=1/s.
The RGPEP has been applied to interacting gluon fields in QCD. The derived effective Hamiltonian passed the test of exhibiting asymptotic freedom [3], which is a precondition for any approach aiming at using QCD explaining hadrons in the Minkowski space time.
The formulation of the bound state problem in a heavy-quark effective theory in the weak-coupling approximation including the effects due to non-Abelian contribution requires perturbative expansions up to 4th order.
We present analytical elements involved in the heavy-quark bound-state problem and study several aspects of the renormalized three-gluon vertex.

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[3] M. Gomez-Rocha and S. D. Glazek, Phys. Rev. D92 (2015) 065005.