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Chiral-vacuum excited replicae in QCD modeling

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Abstract

We present a detailed study of the Bardeen-Cooper-Schrieffer (BCS) gap equation “replicae” or excited vacuum states, orthogonal to the ground-state one, in the chiral-quark sector of the Hamiltonian Coulomb-gauge model of chromodynamics. Analyzing the number of negative eigenmodes of the energy density’s Hessian we believe that we have identified all of the (negative energy-density) vacua of this nonlinear system, namely the ground BCS state and two (or one) replicae for slightly massive (or massless) quarks, given the interaction strength typical of the strong interactions.

The meson spectrum over each of the replicae looks similar, so the differences are not significant enough given model uncertainties, but matrix elements are more sensitive and allow to distinguish them.

We propose to look for such excited vacua in lattice gauge theory by trying to identify excitations with scalar quantum numbers which have energies proportional to the lattice volume (unlike conventional mesons for which the mass stabilizes to a constant upon taking the infinite volume limit).

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