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Supporting $^3P_0$ Quark-Pair Creation using Landau Gauge Green's Functions

Phenomenological evidence suggests that strong decays of low-excitation hadrons often involve the creation of a light quark-antiquark pair with zero angular momentum, known as the $^3P_0$ mechanism, derived from a scalar bilinear. Despite Quantum Chromodynamics being mediated perturbatively by spin-one gluons and exhibiting chiral symmetry in its Lagrangian, a scalar decay term appears spontaneously upon chiral symmetry breaking. We explore this by employing the quark-gluon vertex in the Landau gauge and the nonperturbative effects recently clarified, alongside a constant chromoelectric field similar to the Schwinger pair production in Quantum Electrodynamics. We compare this to a two-field insertion diagram in QED and argue that the relevant quantum numbers for discussing production are $^3\Sigma_0$, $^3\Sigma_1$, and $^3\Pi_0$, analogous to those in diatomic molecules. Our results indicate significant contributions from the third decay mechanism, supporting the $^3P_0$ phenomenology at momenta at or below the fermion mass scale. However, ultrarelativistic fermions predominantly exhibit $^3\Sigma_1$ quantum numbers. In QED, $^3\Sigma_0$ is dominant, whereas in QCD, $^3\Pi_0$ prevails at sub-GeV momenta due to the requirement to form a color singlet.

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