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Spinning Pairs: Supporting 3P_0 Quark-Pair Creation from Landau Gauge Green's Functions

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Abstract

Abundant phenomenology suggests that strong decays from relatively low-excitation hadrons into other hadrons proceed by the creation of a light quark-antiquark pair with zero total angular momentum, the so called 3P_0 mechanism originating from a scalar bilinear. Yet the Chromodynamics interaction is perturbatively mediated by gluons of spin 1, and QCD presents a chirally symmetric Lagrangian. Such scalar decay term must be spontaneously generated upon breaking chiral symmetry. We attempt to reproduce this with the help of the quark-gluon vertex in Landau gauge, whose nonperturbative structure has been reasonably elucidated in the last years, and insertions of a uniform, constant chromoelectric field. This is akin to Schwinger pair production in Quantum Electrodynamics, and we provide a comparison with its two field-insertions diagram. We find that, the symmetry being cylindrical, the adequate quantum numbers to discuss the production are rather 3Sigma_0, 3Sigma_1 and 3Pi_0 as in diatomic molecules, and we indeed find a sizeable contribution of the third decay mechanism, which may give a rationale for the 3P_0 phenomenology, as long as the momentum of the produced pair is at or below the scale of the bare or dynamically generated fermion mass. On the other hand, ultrarelativistic fermions are rather ejected with 3Sigma_1 quantum numbers. In QED our results suggest that 3Sigma_0 dominates whereas the constraint of producing a color singlet in QCD leads to 3Pi_0 at sub-GeV momenta.

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