ID de la contribución : **802** Tipo : **no especificado**

Explaining ${}^3P_0$ quark-pair creation through Landau-gauge Green's Functions

martes, 19 de noviembre de 2024 15:00 (15)

Phenomenological evidence indicates that low-excitation hadrons often decay via the ${}^3P_0$ mechanism, involving the creation of a light quark-antiquark pair with zero angular momentum. This scalar decay term arises spontaneously upon chiral symmetry breaking, despite Quantum Chromodynamics being mediated by spin-one gluons and displaying chiral symmetry in its Lagrangian. We explore this by employing the non-perturbative quark-gluon vertex in the Landau gauge, alongside a constant chromoelectric field background similar to the Schwinger pair production in Quantum Electrodynamics. Our results support the ${}^3P_0$ mechanism at momenta below the fermion mass scale, though ultrarelativistic fermions mostly exhibit ${}^3S_1$ quantum numbers. In QED, ${}^3S_0$ dominates, while in QCD, ${}^3P_0$ is favored at sub-GeV momenta due to the requirement of color singlet formation.

Abstract

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Clasificación de la sesión : Física Teórica

Clasificación de temáticas : Física Teórica