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The gap equation in QCD and the origin of constituent quarks

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I will briefly review the gap equation which in QCD is given by the Dyson-Schwinger equation (DSE) for a quark of given flavor. Whether a gap occurs, and therefore dynamical chiral symmetry breaking that leads to a constituent-quark mass two orders heavier than the current-quark mass, depends on the DSE kernel. One crucial ingredient, besides the strong coupling itself, is the quark-gluon vertex whose tensorial structure is complex once it is dressed with gluons.

A nonperturbative approach to derive the vertex is based on longitudinal and transverse Slavnov-Taylor identities rather than on perturbative dressing or solving the inhomogeneous Bethe-Salpeter equation. The adequate manipulation of these identities with projections leads to the functional form of all twelve form factors that describe the dressed quark-gluon vertex. We combine this novel vertex with lattice QCD simulations for the gluon and ghost propagators and solve the DSE numerically.

The dynamical chiral symmetry breaking this vertex induces is very large and gives rise to a realistic mass gap for all quark flavors, compatible with those of the usual phenomenological interaction models in DSE calculations. Finally, we test the gauge covariance of our DSE kernel by studying the gauge dependence of the quark mass and wave renormalization function as well as of the quark condensate.

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