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Studying mass generation in Landau-gauge Yang-Mills theory

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A longstanding question in QCD is the origin of the mass gap in the Yang-Mills sector of QCD, i.e., QCD without quarks. In Landau gauge QCD this is encoded in a mass gap of the gluon propagator, which is found both in lattice simulations and with functional approaches. While functional methods are well suited to unravel the mechanism behind the generation of such a mass gap, a fully satisfactory answer has not yet been found. In this talk I discuss a recent solution of the coupled Dyson-Schwinger equations for the ghost propagator, gluon propagator and three-gluon vertex. Here the mass gap generation is tied to the longitudinal projection of the gluon self-energy, which acts as an effective mass term in the equations. Because an explicit mass term is in conflict with gauge invariance, this leaves two possible scenarios: If it is viewed as an artifact, only the scaling solution with an infrared dominance of the ghost survives; if it is dynamical, gauge invariance can only be preserved if there are longitudinal massless poles in either of the vertices. We find that there is indeed a massless pole in the ghost-gluon vertex, however in our approximation with the assumption of complete infrared dominance of the ghost this pole is only present for the scaling solution. To this end, we put forward a possible mechanism that may reconcile the scaling solution with the decoupling solutions based on longitudinal poles in the three-gluon vertex as seen in the PT-BFM scheme.

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