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Gluon mass and small x in QCD Hamiltonian for hadronic constituents

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The canonical Hamiltonian of QCD in the front form involves severe small-x divergences that impede access to the logarithmically scale-dependent Hamiltonians for quarks and gluons. We propose a method for circumventing these divergences, thus opening a pathway for the systematic computation of the Hamiltonians using the renormalization group procedure for effective particles (RGPEP). Our approach involves a gluon mass parameter and an auxiliary scalar octet field whose quanta correspond to the longitudinal gluons. The auxiliary field drops out of the dynamics in the limit of the gluon mass parameter going to zero. We first explain how the severe small-x divergences can cancel out in the quark and gluon scattering amplitudes in the femtouniverse despite our introduction of mass for gluons. Then we discuss the cancelation in the renormalized bound-state dynamics, using the RGPEP. Hence, the perturbative and bound-state features of the theory are approached in the same formulation, instead of matching complementary formulations in the different regimes.

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