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Quark and gluon spin and orbital angular momentum in the proton : A light-front Hamiltonian approach

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There is a well-known crisis: one of the fundamental properties of the proton, its spin, is not the same as the sum of its constituent quark spins. The gluon's contribution to the proton spin is nonvanishing and likely sizable. Yet, there remain large uncertainties about the gluon's contribution and resolving this issue is one of the major goals of the upcoming Electron-Ion-Colliders. We address this fundamental issue with a fully relativistic and nonperturbative approach based on a light-front quantized Hamiltonian with Quantum Chromodynamics (QCD) input. From this, we calculate the effects from incorporating a dynamical gluon on the proton's gluon densities, helicity distribution and orbital angular momentum that constitutes the proton spin sum rule. We predict about 26% of the proton's spin is carried by the gluon's helicity and about 1.3% by its orbital angular momentum in low-momentum transfer experiments. Our approach also provides a good quality description of the proton's quark distribution functions following QCD scale evolution.

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