

Hyperons Gluon Helicity from Lattice QCD

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We present the first lattice QCD calculation of the total gluon helicity contribution ΔG_H to the spin of Λ , Σ , and Ξ hyperons.

The calculation employs the Coulomb-gauge fixed topological current K^μ , whose forward matrix element in the infinite momentum frame yields ΔG_H without non-trivial perturbative matching.

Using a single $N_f = 2 + 1$ flavor dynamical ensemble with lattice spacing $a \approx 0.105$ fm and pion mass $m_\pi \approx 292$ MeV, we extract the bare matrix elements via the Feynman-Hellmann method, with distillation and momentum smearing to control excited-state contamination.

The bare matrix elements are non-perturbatively renormalized in the RI/MOM scheme and subsequently converted to the $\overline{\text{MS}}$ scheme; the renormalization factor $\bar{Z}_{11}^{\text{lat}}$ is employed, whose state-independence is guaranteed by the intrinsic nature of operator ultraviolet divergences.

After infinite-momentum extrapolation and renormalization, we obtain

$$\Delta G_\Lambda = 0.165(19)_{\text{stat}}(19)_{\text{ren}},$$

$$\Delta G_\Xi = 0.160(14)_{\text{stat}}(19)_{\text{ren}}, \text{ and}$$

$$\Delta G_\Sigma = 0.232(24)_{\text{stat}}(28)_{\text{ren}}$$

at the $\overline{\text{MS}}$ scale $\mu^2 = 10 \text{ GeV}^2$, corresponding to approximately

$$37(5)_{\text{stat}}(4)_{\text{ren}}\%,$$

$$33(3)_{\text{stat}}(4)_{\text{ren}}\%, \text{ and}$$

$$48(5)_{\text{stat}}(6)_{\text{ren}}\% \text{ of the hyperon total spin, respectively.}$$

The temporal and spatial components of K^μ yield consistent results, confirming Lorentz covariance of the approach beyond the nucleon sector.

These first-principles results reveal the impact of flavor-symmetry breaking on gluon polarization across the baryon octet.

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