Measurements of the Longitudinal Spin Structure of the Proton from STAR

STAR collaboration

How is the spin of the proton distributed among its quark, anti-quark, and gluon constituents? The Solenoidal Tracker at the Relativistic Heavy Ion Collider (STAR) experiment probes the gluon $\Delta g(x, Q^2)$ and sea quark $\Delta\bar{u}(x, Q^2)$, $\Delta\bar{d}(x, Q^2)$ helicity distributions using collisions of longitudinally polarized protons at $\sqrt{s} = 200$ GeV and $\sqrt{s} = 510$ GeV. $\Delta g(x, Q^2)$ can be accessed through the double spin asymmetries A_{LL} in gluon-dominated hard scattering processes via inclusive jet and di-jet production, while the $W^{+/-}$ longitudinal single spin asymmetries A_L are sensitive to the light quark and anti-quark polarization in the proton.

Perturbative QCD analyses including STAR jet data at $\sqrt{s} = 200$ GeV and mid-pseudorapidity $|\eta_{\rm jet}| < 1$ provided evidence for positive gluon polarization for the momentum fraction $x > 0.05$ at a hard perturbative scale $Q^2 = 10$ GeV^2. The STAR data on $W^{+/-}$ revealed the existence of a flavor asymmetry in the polarization of light sea anti-quarks. Moreover, compared to inclusive jet observables, the di-jet A_{LL} measurements provide a better determination of the functional form of $\Delta g(x, Q^2)$, and the measurements at higher center-of-mass energy and more forward pseudorapidities can constrain $\Delta g(x, Q^2)$ at lower x.

This talk will provide an overview of recent results on understanding the longitudinal spin structure of the proton from STAR, including inclusive jet and di-jet A_{LL} measurements in $p+p$ collisions at 200 GeV and 510 GeV and measurements of $W^{+/-}$ A_L at 510 GeV at mid- and intermediate-pseudorapidities.