Constraining the quark and gluon helicity at STAR

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Abstract

How do quarks and gluons conspire to provide the total spin of proton is a long-standing puzzle in quantum chromodynamics (QCD). The unique capability of RHIC, that can provide longitudinally polarized $p+p$ collisions at both $\sqrt{s} = 200$ GeV and $\sqrt{s} = 510$ GeV, opened new territory to constrain the helicity structure of the proton with unprecedented depth and precision.

Results from various STAR spin measurements have contributed significantly to our understanding of the quark and gluon helicity distributions inside the proton. The longitudinal double-spin asymmetry, A_{LL}, from the STAR 2009 inclusive jet measurement, provides the first indication of the positive gluon polarization with partonic momentum fraction x greater than 0.05 inside the proton. More precise measurements using the $p+p$ data collected in 2012, 2013 and 2015 at both $\sqrt{s} = 510$ and 200 GeV confirm the previous findings and provide additional constraints in the largely unexplored region of $x < 0.05$. Compared to the inclusive jet observables, analyses of dijet production extending to higher pseudorapidity (up to $\eta \sim 1.8$) provide better constraints on the x dependent behavior of $\Delta g(x)$. Moreover, the reconstruction of $W^{\pm}/Z$ in longitudinally polarized proton-proton collisions provides significant constraints on the flavor separation of the light sea quark helicity distributions inside the proton, while the longitudinal spin transfer to Λ and $\bar{\Lambda}$ hyperons provides access to the helicity of strange and anti-strange quarks in the proton.

In this talk, an overview of recent results on longitudinal spin structure of the proton from STAR as well as their impact on global analysis of helicity distributions will be presented.