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Abstract

Measuring the anti-quark contribution to the proton spin using parity violating W production in polarized proton-proton collisions

By

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Since the 1980s the spin puzzle has been at the heart of many experimental measurements. The initial discovery that only ~30% of the spin of the proton comes from quarks and anti-quarks has been refined and cross checked by several other deep inelastic scattering (DIS) and semi inclusive DIS (SIDIS) experiments. Through measurements of polarized parton distribution functions (PDFs) the individual contributions of the u, d, $\bar{u}$, $\bar{d}$, quarks have been measured. The flavor separation done in SIDIS experiments requires knowledge of fragmentation functions (FFs). However, due to the higher uncertainty of the anti-quark FFs compared to the quark FFs, the quark PDFs (u, d) are significantly better constrained than the anti-quark distributions ($\bar{u}$, $\bar{d}$). By accessing the anti-quarks directly through W boson production in polarized proton-proton collisions ($u\bar{d} \rightarrow W^+ \rightarrow e^+/\mu^+$ and $d\bar{u} \rightarrow W^- \rightarrow e^-/\mu^-$), the large FF uncertainties are avoided and a cleaner measurement can be done. The parity violating single spin asymmetry of the W decay leptons can be directly related to the polarized PDFs of the anti-quarks. The $W^{\pm} \rightarrow e^{\pm}$ measurement has been performed with the PHENIX central arm detectors at $\sqrt{s} = 500\ GeV$ at the Relativistic Heavy Ion Collider (RHIC) and is presented in this thesis.

Approximately 40 pb^{-1} of data from the 2011 and 2012 was analyzed and a large parity violating single spin asymmetry for $W^{\pm}$ has been measured. Since the detector configuration from the initial 2009 PHENIX measurement (8.6 pb^{-1}) has been changed, increasing the conversion background, new analysis cuts were developed and implemented. Furthermore, the increased statistical precision enabled and required a more careful analysis of the background contamination for the single spin asymmetry measurement. A method based on Gaussian Processes for Regression has been employed to determine this background contribution. This thesis contains a detailed description of the analysis together with the asymmetry results and future prospects.

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