Measurements of the Neutron Longitudinal Spin Asymmetry $A_1$ and Flavor Decomposition in the Valence Quark Region

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Abstract

The current data for the nucleon-virtual photon longitudinal spin asymmetry $A_1$ on the proton and neutron have shown that the ratio of the polarized-to-unpolarized down-quark parton distribution functions, $\Delta d/d$, tends towards $-1/2$ at large $x$, in disagreement with the perturbative QCD prediction that $\Delta d/d$ approaches 1 but more in line with constituent quark models. As a part of experiment E06-014 in Hall A of Jefferson Lab, double-spin asymmetries were measured in the scattering of a longitudinally polarized electron beam of energies 4.74 and 5.89 GeV from a longitudinally and transversely polarized $^3$He target in the deep inelastic scattering region, allowing for the extraction of the neutron asymmetry $A_1^n$ and the ratios $\Delta d/d$ and $\Delta u/u$. We will discuss our analysis of the data and present results for $A_1$ and $g_1/F_1$ on both $^3$He and the neutron, and the resulting quark ratios for the up and down quarks in the kinematic range of $0.2 < x < 0.65$ and $2 < Q^2 < 5$ GeV$^2$ for the scattered electrons. Our measurements are compared to the world data and various theoretical models and more recent predictions using the Dyson-Schwinger Equations (DSE) approach. Further plans to measure $A_1^n$, $\Delta d/d$ and $\Delta u/u$ at larger $x$ with the upgrade of Jefferson Lab will be discussed.