Heavy Flavor Production in Charged Current DIS and Polarized Parton Density

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In recent years, much experimental data for heavy flavor (charm or bottom quark) production and decay are reported by some collaborations. Since the heavy quark mass scale is quite larger than Λ_{QCD}, it is considered that we can treat heavy quarks purely perturbatively. Heavy quarks are produced only at the short distance scale within the framework of a fixed flavor number scheme (FFNS), where only light quarks (u, d, and s) and gluons are considered as active partons, and any heavy quarks (c, b, ...) contribution is calculated in fixed order α_s perturbation theory.

The study of heavy flavor production in deep inelastic scattering (DIS) is one of the promising way to access the parton density in nucleon. As is well known, the polarized parton distribution function (PDF) plays an important role on deep understandings of the spin structure of nucleon. However, knowledge about the polarized sea quark and gluon distribution remain still poor, and theoretical and experimental ambiguity is rather large. In order to understand the spin structure of nucleon, we need more information about the polarized sea quark and gluon distribution function.

Charged current (CC) DIS is effective to extract the flavor decomposed polarized PDF's, since $W^{\pm}$ boson changes the flavor of parton. Since there is no initial heavy flavor component in the FFNS, we can identify an initial flavor of parton to study the heavy flavor production in CC DIS.

In this work, to extract the polarized PDF's we studied charmed hadron (D, Λ_c, ...) production in CC DIS including $\mathcal{O}(\alpha_s)$ corrections in electron and polarized proton collisions. Dominant contribution comes from the following two subprocesses: (1) leading order contribution via W boson exchange $W^+ s \to c$ and (2) $\mathcal{O}(\alpha_s)$ next-to-leading order contribution via boson-gluon fusion process $W^+ g \to c\bar{s}$. Though there are gluon radiation subprocesses $W^+ s \to cg$ at the same $\mathcal{O}(\alpha_s)$ order, the contributions to cross section are not so large.

We have numarically calculated the spin-independent and -dependent cross sections and the spin correlation asymmetry for these processes. It is indicated that we might be able to separate the contribution of Born term ($W^+ s \to c$) from the one of boson-gluon fusion process ($W^+ g \to c\bar{s}$). Therefore, we can clearly extract the polarized strange sea quark distribution and gluon distribution. Also, it might be effective to test the parametrization model of the polarized PDF's.