Deep Inelastic Semi-inclusive Λ_c^+ Production in Polarized Reaction and Gluon Polarization in the Proton

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Understanding the spin structure of the nucleon is a crucially important subject in nuclear and particle physics. Due to extensive study on polarized structure functions of nucleons, we have, at present, rather good knowledge of polarized quark distribution. However, knowledge of polarized gluons is still limited. To probe the gluon polarization in the proton, we studied deep-inelastic semi-inclusive Λ_c^+ production in unpolarized electron-polarized proton scattering:

$$e\vec{p} \to e\vec{\Lambda}_c^+ X.$$

Λ_c^+ consists of u, d and c quarks in a naive quark model, in which the spin wave functions of u and d quarks are anti-symmetrically combined and then the spin of Λ_c^+ is the same as that of the c quark. Therefore, we can expect that the spin of Λ_c^+ largely depends on that of the c quark in the hard process. Furthermore, the c quark is produced in pairs of $\bar{c}$ by boson-gluon fusion in the lowest order of QCD. Therefore, one expects that this process can provide rich information on the polarized gluon in the proton.

We have taken into account the neutral weak boson exchanges as well as virtual photon exchanges because it is expected that future colliders will reach the very high energy region in which the effects of weak interaction is not ignored.

By assuming that the helicity of the produced c quark is preserved in hadronization of the c quark into Λ_c^+, we have calculated the spin-dependent differential cross section in the lowest order of QCD for $e\vec{p} \to e\vec{\Lambda}_c^+ X$ and the spin correlation asymmetry between the incident proton and the produced Λ_c^+. In this analysis, we have shown that those transverse momentum and rapidity distribution largely depends on the models of polarized gluon distributions and thus the process is quite effective to obtain good information on the polarized gluon distribution.

This work is the one substantially developed from our preliminary calculation[1].

References

[1] Satoshi Oyama, talk at the Workshop "Physics in ep Collision" VI (2001) (ps file of transparencies) http://www-zeus.desy.de/~kuze/epws6/