PION EFFECT IN DEEP-INELASTIC POLARIZED
LEPTON-POLARIZED NUCLEON SCATTERING

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The deep-inelastic lepton-nucleon asymmetry measured in a polarized experiment is conventionally defined as

$$A \equiv \frac{d\sigma(+-)}{d\sigma(+-)} - \frac{d\sigma(++)}{d\sigma(++)}, \quad (1)$$

where ++ and +- indicate respectively antiparallel and parallel beam and target spins. Determination of the asymmetry in the scaling region yields knowledge about the distributions of quark spins in the target; it is thus very useful in testing various theoretical models of nucleon spin structure.

In recent years, the asymmetry A has been measured in deep-inelastic electron-proton scattering [1]. Even though the data is consistent with several theoretical quark-parton model predictions, detailed knowledge of the nuclear spin structure is still lacking. This is because one does not know precisely what mechanisms determine the quark spin distribution. What one has been able to do, even in the "successful" models, is to make educated guesses of the x -dependence of the quark spin distribution, and then fix the overall strength by evoking certain sum rules, such as the Bjorken sum rule. This procedure is highly superficial. The purpose of this note is to point out a calculable mechanism which affects the quark spin distribution in a nucleon. Specifically, we show that, due to virtual pion excitations, sea quarks can have a sizable diluting effect on the nucleon quark spin polarization, and thus play an important role in determining the asymmetry A . This effect has never been included in previous theoretical considerations of nucleon quark spin structure.

The basic idea of this work is depicted in Fig. 1. That is, before the proton absorbs the virtual photon, it can emit a pion, and at the same time flips its spin. The net effect would be an effective dilution of the proton target polarization. Including the nucleon intermediate state only, we have calculated the spin diluting effect of the virtual pions. The results are shown in Fig. 2. The curves are calculated using a πNN vertex form factor corresponding to a bag radius of 0.9 fm in the cloudy bag model [2]. $D(x)$ corresponds to the effective proton

polarization as seen by the virtual photon (for a 100% polarized target). We find that the pionic effect is quite large (~20%) and hence is not negligible. It might be difficult to separate this effect from others in an experiment, the point is rather that this effect is sizable, and therefore should be taken into account if one is to have a better understanding of the nucleon spin structure.

Fig. 1. Dilution of the nucleon polarization due to pion emission.

Fig. 2. $f_\pi(x)dx$ is the probability of finding a pion carrying momentum fraction between x and $x + dx$. $D(x)$ is the proton spin dilution factor due to pion emission.

[1] G. Baum et al., Phys. Rev. Lett. 51 (1983), 1135.

[2] A.W. Thomas, S. Theberge, and G.A. Miller, Phys. Rev. D 24 (1981), 216.

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