A Helium-3 polarimeter using electromagnetic interference

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Measuring polarization levels of a high energy beam of polarized He-3 ions will be required for studies of many spin dependent hadronic processes. In particular, this will facilitate investigations involving the spin of a down quark as the spin properties of helium-3 are not unlike those of a neutron [1].

The successful use of electromagnetic hadronic interference in proton high energy polarimetry [2] is examined in the context of a helium-3 beam. The carbon nuclei recoiling both left and right from elastic scattering off a very thin carbon target provide a sensitive indication of the polarization of incident fermions. More stringent kinematic cuts are necessary in the case of helium to ensure that elastic collisions have taken place, thus excluding helium break-up and carbon nuclear excitation events.

Though the greater hadronic total cross section of helium-3 carbon scattering reduces the optimal analyzing power by comparison with the proton case, the large anomalous magnetic moment of He-3 nuclei is helpful. The doubling of the electric charge and the more prominent Coulomb phase arising from two photon exchange effects also serve to enhance the analyzing power. Against this, the finite nuclear size of helium reduces it for momentum transfers outside the interference region [3].

Hadronic spin-flip effects need to be known as they influence the accuracy of interference polarimetry [4]. Such effects have recently been shown to be small for high energy proton elastic collisions [5]. Nevertheless, a polarized helium-3 jet should be made available to fully calibrate the helium polarimeter.

References

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