Deuteron analyzing powers for \(d-p\) elastic scattering at 186.6 MeV/nucleon

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The study of three nucleon forces (3NFs) is essentially important for clarifying nuclear phenomena. 3NFs arise naturally in the standard meson exchange force (MEF) which has a link to QCD. Generally good agreements are found for the vector analyzing power \(iT_{11}\), while large discrepancies are found for the tensor analyzing power \(T_{22}\). In order to examine how \(\chi\) EFT 3NFs describe the data, theoretical treatments are in progress.

A schematic diagram of the experimental setup has been provided in Ref. (4). Vector- and tensor-polarized deuteron beams were accelerated by the injector cyclotrons AVF and RRC up to 70 MeV/N; subsequently, they were accelerated up to 186.6 MeV/N by SRC. The measurement for \(d-p\) elastic scattering was performed using a detector system, BiDpol, which was installed at the extraction beam line of SRC. Polyethylene with a thickness of 330 mg/cm\(^2\) was used as the hydrogen target. In BiDpol, four pairs of plastic scintillators coupled with photo-multiplier tubes were placed symmetrically in the directions of azimuthal angles to the left, right, up and down. Scattered deuterons and recoil protons were detected in the kinematical coincidence condition by each pair of detectors. The angles (\(\theta_{c.m.}\)) measured in the center-of-mass system are in the range of 39°–165°. In the experiment, the deuteron beams were stopped in a Faraday cup installed at the focal plane F0 of the BigRPS spectrometer. The beam polarizations were monitored continuously with a beam line polarimeter Dpol prior to acceleration by SRC using the reaction of elastic \(d-p\) scattering at 70 MeV/N. At RIBF, single-turn extractions were available for all the cyclotrons used for the experiments. The angles \(\theta_{c.m.}\) measured in the center-of-mass system are in the range of 39°–165°. In the experiment, the deuteron beams were stopped in a Faraday cup installed at the focal plane F0 of the BigRPS spectrometer. The beam polarizations were monitored continuously with a beam line polarimeter Dpol prior to acceleration by SRC using the reaction of elastic \(d-p\) scattering at 70 MeV/N. At RIBF, single-turn extractions were available for all the cyclotrons used for the experiments. Therefore, depolarizations were expected to be small during beam acceleration. In the measurement typical values of the beam polarizations were 80% of the theoretical maximum values.

The statistical uncertainties are shown. It is interesting to see the potential of \(\chi\) EFT to describe deuteron analyzing powers for \(d-p\) elastic scattering. In Fig. 1, the data are compared with the calculations based on the \(\chi\) EFT N4LO NN potentials. Generally good agreements are obtained for the vector analyzing power \(iT_{11}\), while large discrepancies are found for the tensor analyzing power \(T_{22}\). In order to examine how \(\chi\) EFT 3NFs describe the data, theoretical treatments are in progress.

Results of the deuteron analyzing powers \(iT_{11}\) and \(T_{22}\) are shown with solid circles in Fig. 1. Only the statistical uncertainties are shown. It is interesting to see the potential of \(\chi\) EFT to describe deuteron analyzing powers for \(d-p\) elastic scattering. In Fig. 1, the data are compared with the calculations based on the \(\chi\) EFT N4LO NN potentials. Generally good agreements are obtained for the vector analyzing power \(iT_{11}\), while large discrepancies are found for the tensor analyzing power \(T_{22}\). In order to examine how \(\chi\) EFT 3NFs describe the data, theoretical treatments are in progress.

Fig. 1. Results of deuteron analyzing powers \(iT_{11}\) and \(T_{22}\) for \(d-p\) elastic scattering at 186.6 MeV/N.

References
6) E. Epelbaum, private communications.