Deuteron analyzing powers for *d*-*p* elastic scattering at 186.6 MeV/nucleon

K. Sekiguchi,[*1,*2] T. Akieda,[*1] Y. Wada,[*1] D. Eto,[*1] A. Watanabe,[*1] H. Kon,[*1] N. Sakamoto,[*2] H. Sakai,[*2] M. Sasano,[*2] H. Suzuki,[*2] T. Uesaka,[*2] Y. Yanagisawa,[*2] M. Dozono,[*3] Y. Kubota,[*3] K. Yako,[*3] Y. Maeda,[*4] S. Kawakami,[*4] T. Yamamoto,[*4] S. Sakaguchi,[*5] T. Wakasa,[*5] J. Yasuda,[*5] A. Ohkura,[*5] Y. Shindo,[*5] M. Tabata,[*5] E. Milman,[*2,*6] and S. Chebotaryov[*2,*6]

The study of three nucleon forces (3NFs) is essentially important for clarifying nuclear phenomena. 3NFs arise naturally in the standard meson exchange picture[1] as well as in the framework of the chiral effective field theory (χEFT) which has a link to QCD.[2,3] Three-nucleon scattering at intermediate energies ($E/A \sim 200$ MeV) is one attractive approach to investigate the dynamical aspects of 3NFs, such as momentum and/or spin dependences. Here we report the measurement of all deuteron analyzing powers (iT_{11}, T_{20}, T_{21}, and T_{22}) in deuteron–proton (d–p) elastic scattering at 186.6 MeV/nucleon (MeV/N) performed in May 2015.

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, BigDpol, 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 BigDpol, 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 ($\theta_{\mathrm{c.m.}}$) 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 BigRIPS 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.

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 χEFT to describe deuteron analyzing powers for d–p elastic scattering. In Fig. 1, the data are compared with the calculations based on the χEFT N4LO NN potentials.[5] Gnerally 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 χEFT 3NFs describe the data, theoretical treatments are now in progress[6].

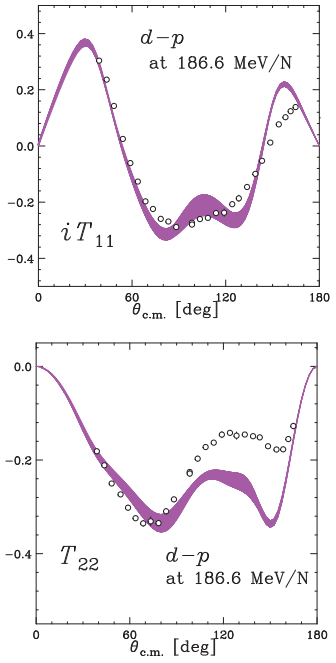

Fig. 1. Results of deuteron analyzing powers iT_{11} and T_{22} for d-p elastic scattering at 186.6 MeV/N.

*1 Department of Physics, Tohoku University
*2 RIKEN Nishina Center
*3 CNS, University of Tokyo
*4 Faculty of Engineering, University of Miyazaki
*5 Department of Physics, Kyushu University
*6 Department of Physics, Kyungpook National University

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