Deuteron Analyzing Powers for *dp* elastic scattering at 250–294 MeV/nucleon and three-nucleon force

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The study of three-nucleon forces (3NFs) is essential for clarifying various nuclear phenomena. In addition to the first signals indicating 3NF effects in the binding energies of ^{3}H and ^{3}He, the significance of 3NFs has been recently pointed out for descriptions of discrete states in higher-mass nuclei. 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. With the aim of clarifying the roles of the 3NFs in nuclei, experimental programs with polarized deuteron beams at intermediate energies are in progress at RIBF. As the first step, we measured a complete set of deuteron analyzing powers (iT_{11}, T_{20}, T_{21}, T_{22}) in deuteron–proton (*dp*) elastic scattering at 250 and 294 MeV/nucleon (MeV/N).

A schematic diagram of the experimental setup can be found in Ref. (1). Vector- and tensor-polarized deuteron beams were accelerated by the injector cyclotrons AVF and RRC up to 90 (100) MeV/N; subsequently, they were accelerated up to 250 (294) MeV/N by the SRC. Typical values of the beam polarizations were 80% of the theoretical maximum values. The measurement for *dp* elastic scattering was performed by using a detector system, BigDpol, installed at the extraction beamline of the SRC. Polyethylene (CH_2) of thickness 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 azimuthal directions 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 ($\theta_{\rm c.m.}$) measured in the center-of-mass system are in the range 40°–162°. In the experiment, the deuteron beams were stopped in a Faraday cup, which was installed at the focal plane F0 of the BigRIPS spectrometer.

Here, we report the results of energy dependence of the deuteron tensor analyzing power T_{22}. The angular distribution of T_{22} is shown with open circles, together with the previously reported data at 70 and 135 MeV/N[1]. The red (blue) bands in the figure are the Faddeev calculations with (without) Tucson–Melbourne'99 (TM99) 3NF[2] based on the modern NN potentials, namely CDBonn[3], AV18[4], Nijmegen I, and Nijmegen II[5]. The solid lines are the calculations including Urbana IX 3NF[6] based on the AV18 potential.

The tensor analyzing power T_{22} reveals an energy dependence different from those obtained for the cross section and the other analyzing powers iT_{11}, T_{20}, and T_{21}[1]. At 135 MeV/N and below, adding 3NFs degrades the description of data in a large angular region. It is contrary to what happens at energies above 250 MeV/N, for which large 3NF effects are supported by the T_{22} data.

In order to obtain a consistent understanding of the spin dependence of 3NFs up to high momenta, we plan to perform deuteron analyzing power measurements at 190 MeV/N.

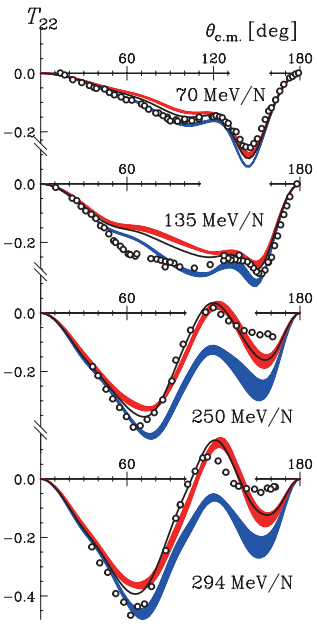

Fig. 1. Tensor analyzing power T_{22} for *dp* elastic scattering at 70–294 MeV/N.

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