Deuteron Analyzing Powers for d–p elastic scattering at 190 MeV/nucleon and three–nucleon force effects

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Study of three-nucleon forces (3NFs) is essentially important in clarifying nuclear phenomena, e.g. discrete states of nuclei and equation of state of nuclear matter. Nucleon–deuteron (Nd) scattering, for which a rigorous formulation in terms of Faddeev equations exists and exact solutions of these equations for any dynamical input can be obtained, offers a good opportunity for the dynamical aspects of 3NFs, such as momentum, spin and/or iso-spin dependences. With the aim of clarifying properties of the 3NFs the study of energy dependent deuteron–proton (d–p) scattering with polarized deuteron beams at intermediate energies ($E \sim 200$ MeV/nucleon(MeV/N)) are in progress at RIBF. Here we report a measurement of all the deuteron analyzing powers (iT_{11}, T_{20}, T_{21}, and T_{22}) in d–p elastic scattering at 190 MeV/N performed in May 2015.

A schematic diagram of the experimental setup is provided in Ref.[1]. 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 190 MeV/N by the SRC. The measurement of the d–p elastic scattering was performed using a detector system, BigDpol, which was installed at the extraction beam line of the SRC. Polyethylene (CH_2) with a thickness of 330 mg/cm^2 was used as 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 the detectors. The measured angular range is 39°–165° in the center-of-mass system. In the experiment, the deuteron beams were stopped in the Faraday cup, which was installed at the focal plane F0 of the BigRIPS spectrometer. The beam polarizations were monitored continuously with a beam line polarimeter Dpol prior to the acceleration by the SRC using the reaction of elastic d–p scattering at 70 MeV/nucleon. The analyzing powers for this reaction have been calibrated in the previous measurement by using the $^{12}C(d,\alpha)^{10}B^*[2^+]$ reaction[2]. In the measurement typ-

ical values of the beam polarizations were 80% of the theoretical maximum values.

Preliminary results are shown with open circles in Fig. 1. Only the statistical uncertainties are shown. The data are compared with the Faddeev calculations with (without) Tucson–Melbourne'99 3NF[3] based on the modern NN potentials, namely CDBonn[4], AV18[5], Nijmegen I and II[6]. The solid lines are the calculations with the Urbana IX 3NF[7] based on the AV18 potential. Generally data for the backward angles $\theta_{c.m.} \gtrsim 120°$ are well explained by the calculations with the 3NFs except for T_{20}.

Detailed analysis is now in progress. Discussions on the energy-dependence of the deuteron analyzing powers for d–p elastic scattering at 70–300 MeV/N will be performed.
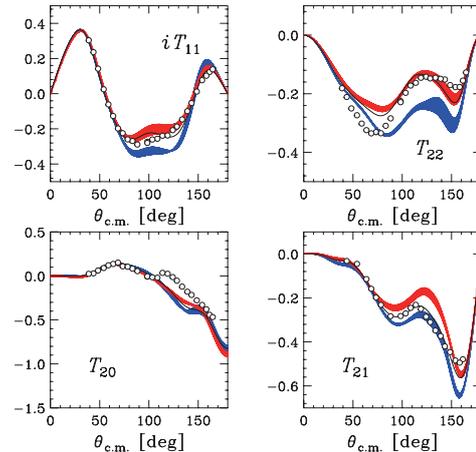
Fig. 1. Preliminary results of the vector and tensor analyzing powers for the d-p elastic scattering at 190 MeV/N.

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