Absolute normalization of the differential cross section of the *pd* elastic scattering at 250 MeV

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Recently, large progress has been made in the study of the three-nucleon (3N) system both experimentally and theoretically. The set of data is being significantly enriched for cross section and spin observables in the elastic nucleon-deuteron scattering and the break-up process at proton energies lower than 200 MeV [1, 2, 3, 4]. Theoretical formulation of 3N scattering based on modern nucleon-nucleon (NN) forces has matured in recent years, and computationally accurate solutions of the 3N Faddeev equation can be achieved [5].

At RCNP, we measured angular distributions of the differential cross section of the *pd* elastic scattering at 250 MeV [6]. We used deuterated polyethylene (CD_2) foils with a thickness of 24.3 and 51.7 mg/cm^2 as deuteron targets. Target thickness has an uncertainty of about 10 %. It is essential to get precise absolute cross sections for comparison with Faddeev calculations. Then we performed measurements by using a gaseous target system (see Fig. 1) in order to normalize cross sections taken with the solid CD_2 target. The gaseous target consisted of a cylinder of 40 mm in diameter made of 200 μm thick aluminum. The absolute gas pressure was continuously monitored by a barometer during measurements. The target cell was kept at room temperature and the temperature of the cell wall was measured during the experiment. The target cell was mounted on a target ladder, enabling quick change between either a solid target or a gaseous target. Spectra with filled and empty cells were measured to determine background contributions from the aluminum wall. A double slit system was used to define the target volume and the solid angle of the Grand Raiden spectrometer. The opening of the slit was 8 mrad and 10 mrad in the horizontal and vertical plane, respectively. The effective target thickness and the solid angle were estimated by Monte Carlo simulations. In addition, a measurement was performed with hydrogen gas to check the system.

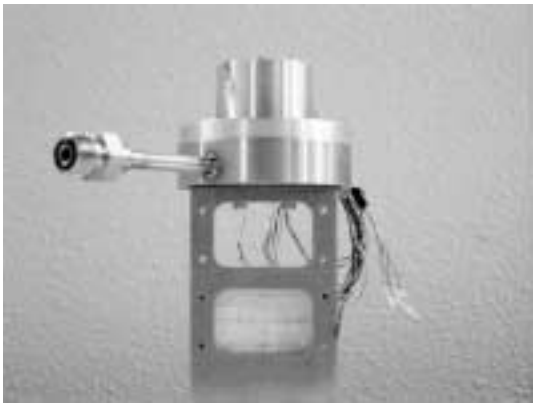

Figure 1: Gaseous target system mouted on the target ladder.

Figure 2 shows the measured cross section at 25.5° of the *pp* elastic scattering by open circle. The experimental datum is consistent within 3% with the value calulated by the phase-shift analysis program SAID [7]. Figure 3 shows the cross sections of the *pd* elastic scattering independently measured at c.m. angles of 40°, 60° and 95°. Experimental data are compared with results of Faddeev calculations by H. Kamada [8] using charge dependent Bonn potential with and without Tucson-Melbourne (TM) [9] 3NF. Previous cross sections measured with solid CD_2 targets are normalized by using the present results.

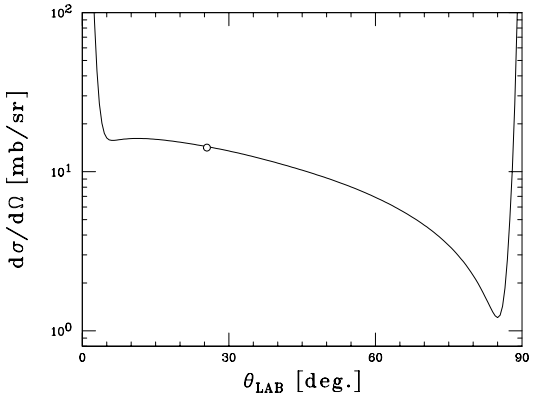

Figure 2: The differential cross section in *pp* elastic scattering at $E_p = 250$ MeV using H_2 gaseous target (open circle). The solid line shows the calculations with the program code SAID.

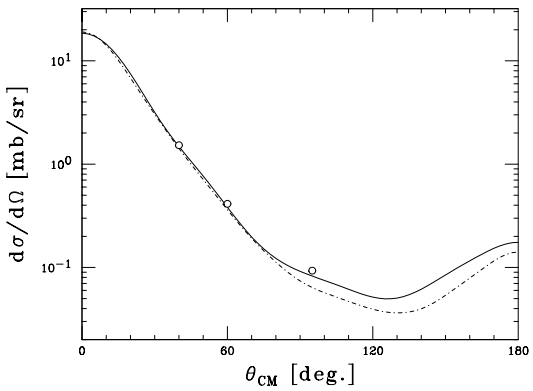

Figure 3: The differential cross section in *pd* elastic scattering at $E_p = 250$ MeV using D_2 gaseous target (open circles). The solid and dashed lines are calcurations with the CD-Bonn + TM 3NF and CD-Bonn only, respectively.

References

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