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VECTOR AND TENSOR ANALYZING POWERS IN THE SCATTERING OF 30 MeV POLARIZED DEUTERONS BY PROTONS

par

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The polarization effects in the nucleon-deuteron scattering at the nucleon energy up to about 80 MeV have been investigated in several recent three-body calculations ([1-5]). With the two-nucleon interaction restricted to only S-waves, the calculated differential cross section ([6]) have been in remarkable agreement with the experimental data. However the P-wave interactic together with the $^3S_1 - {}^3D_1$ tensor force should be included in order to reproduce both the vector and the tensor polarizations ([1,2,5]). In spite of some successful results ([7]), a quantitative description of the polarizations is still an open problem. It is expected that accurate measurements of the spin observables would help a further investigation of the nucleon-deuteron scattering.

The present letter reports the measurements of the deuteron vector and tensor analyzing powers in the H(d,d) scattering at 30 MeV. The experiment was performed with the polarized deuteron beam from the isochronous cyclotron of Grenoble. The general features of the experimental arrangement has been described previously ([8]). The main scattering chamber of 65 cm diameter contains a gas target of 8 cm diameter with steel foil window of 10 μm thick. The target was filled up with H_2 gas at 1.2 atm. pressure. Azimuthal angles of detection ([9]), $-90° \leq \varphi \leq 90°$, may be obtained by rotating the scattering chamber around the beam axis. The scattered particles were detected by two cooled E.ΔE silicon telescopes. The positioning accuracy of the detector telescopes was approximately 0.1° and their angular resolution was about ± 1.5°. A polarimeter placed downstream of the main scattering chamber, furnished a continuous monitoring of the beam polarization. This polarimeter was in fact a scattering chamber of 40 cm diameter, containing a carbone target and a pair of Si(Li) detectors at left and right scattering angles of 45°. The electronic circuitry was similar to that of ref. ([8]). The beam energy was measured with $(CD_2)_n$ thin foil target by cross-over techniques The beam vector and tensor polarizations were about 64 % of their maximum possible values ([9]).

The angular distributions of the deuteron analyzing powers iT_{11}, T_{20} and T_{22} were deduced from measurements at azimuthal angles $\varphi = 0°$ and 90°.

The principle of measurements has been described at another time [9]. The experimental data are shown in Fig. 1, where the errors do not include the overall normalization uncertainties of ± 5 % for iT_{11} and of ± 10 % for the second-rank components. Also shown in Fig. 1 are the theoretical curves predicted by the exact three-body calculations of refs. [4,5] for the deuteron - neutron scattering at 28.2 MeV deuteron bombarding energy. The $^1S_0$, $^3S_1 - ^3D_1$, $^1P_1$, $^3P_0$, $^3P_1$ and $^3P_2$ one-term separable interactions have been taken into account in those calculations based on the Faddeev equations.

The experimental minimum of the vector analyzing power at 100° is clearly deeper than the calculated one, while the experimental maximum at 135° is well reproduced by the theoretical results. Similar features are observed for the maximum and the minimum of the T_{20} analyzing power at respectively 145° and 120°. The theoretical T_{20} component agrees at forward angles with the measured data, while the predicted backward minimum is less pronounced than the experimental one. Notwithstanding some discrepancies, the calculations of refs. [4,5] gives a good overall description of both the vector and the tensor analyzing powers. Better results for the vector analyzing power [7] have been provided by calculations [3] based on a perturbation technique, including all the S-, P- and D- wave central interactions ; however the tensor components could not be reproduced. The strong tensor analyzing powers measured in the present work suggest that the tensor force is as necessary as the high-partial-waves interactions in the further theoretical investigations of the nucleon-deuteron scattering.

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Figure caption

Fig. 1 Vector and tensor analyzing powers in the H(d,d)H scattering at 30. MeV. The theoretical curves are from a three-body calculation of ref.([4]), performed for the d-n scattering at E_d = 28.2 MeV.

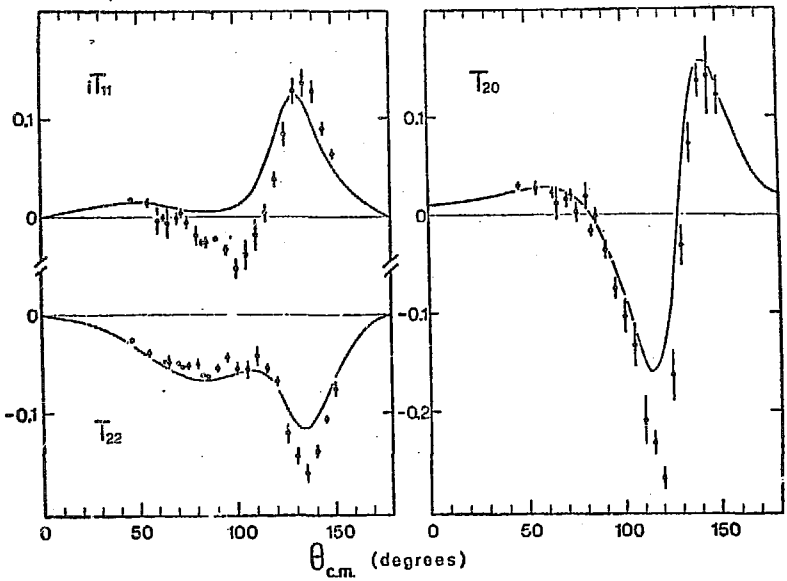

Fig. 1