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3.28 Measurement of the Analyzing Power and the Differential Cross Section of D($\vec{p}$,p)D Elastic Scattering at 10.0 and 14.1 MeV Especially for Small Scattering Angles

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The three - nucleon system has been investigated in a number of experiments in order to understand details of the nucleon - nucleon interaction. Polarization effects in the N-N system are very small at laboratory energies below 50 MeV. Therefore, especially for the study of the spin - dependent forces in the N-N system, the nucleon - deuteron system with polarization effects an order of magnitude larger is a suitable choice. In principle the nuclear interaction in the three - nucleon system can be described exactly by the Faddeev theory using two - body N-N interactions as input. However, the Coulomb interaction due to its infinite range causes difficulties and in the calculations is taken into account only approximately.

In p-d elastic scattering observables Coulomb effects are evident. In the differential cross section the steep increase at extreme forward angles and the interference of Coulomb and nuclear amplitudes with the indication of a minimum at forward angles are typical characteristics. In the vector analyzing power the Coulomb effects cause a decrease of the maximum at about 130^o (relative to n-d scattering) and a relatively sudden decrease to A_y=0 at small scattering angles. The purpose of the present investigation was the study of these effects in more detail and with higher accuracy.

The measurements were done with the Cologne FN-Tandem Van de Graaff accelerator and a polarized proton beam from the Lamb-shift source LASCO. The transverse polarization was measured simultaneously using the p-α scattering at 112^o and was typically 0.73 and stable. The target consisted of deuterated polyethylene of average thickness 50 μg/cm^2. The spectra were reduced using a peak - fitting routine in order to separate the relevant p-d peaks from tails of interfering peaks and applying dead - time corrections.

Figs. 1 to 4 show the results for the one energy of 14.1 MeV. The cross section data were normalized to the earlier data of Grüebler et al.[1,2] in the angular range from 60^o to 150^o. Figs. 3 and 4 display an enlarged view of the Coulomb interference region. The solid line is a result of a Faddeev calculation including a Coulomb correction performed by Koike[3]. The two - body interaction is PEST 3 - PEST 4 using $^1S_0$ and $^3S_1$-$^3D_1$ waves and Doleschall's rank-1 potential for higher partial waves[4].

For both incident energies the agreement between our data and the data of Grüebler is satisfactory. However, there are discrepancies between our data and the Faddeev calculations especially for the analyzing power at both energies. In the maximum at 130^o the theory is significantly below the data (very pronounced at 10.0 MeV). Below 50^o the theory falls off to zero too fast. This indicates that the approximate treatment of Coulomb effects in the Faddeev calculations needs to be improved.

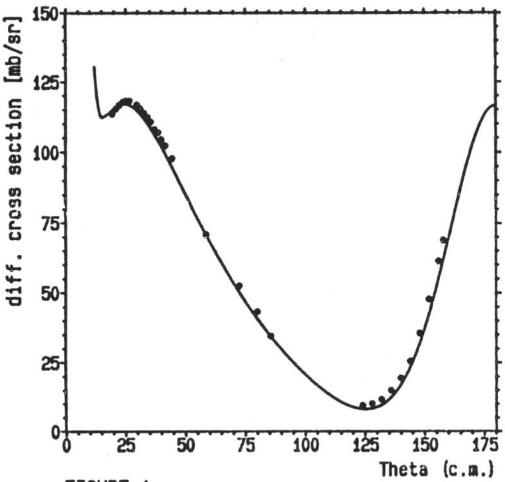

FIGURE 1:

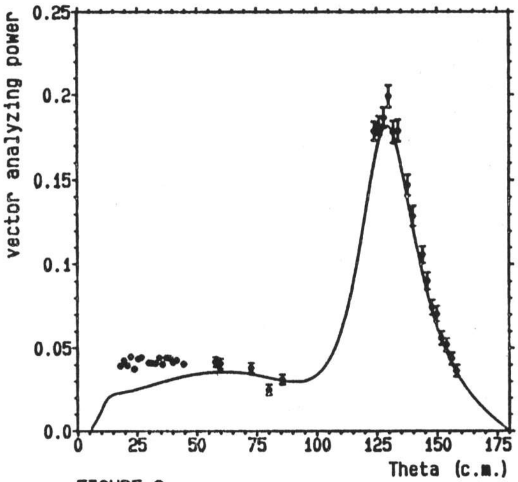

FIGURE 2:

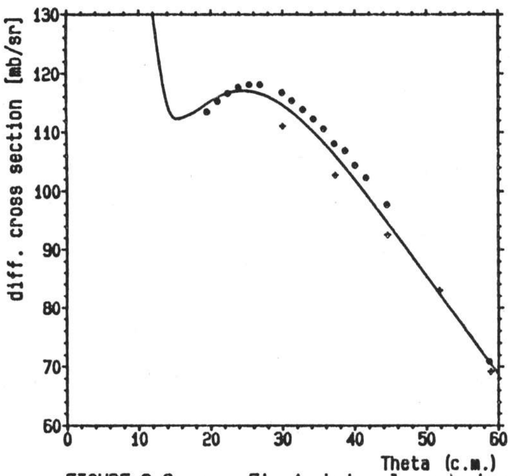

FIGURE 3: Same as Fig.1, but enlarged view

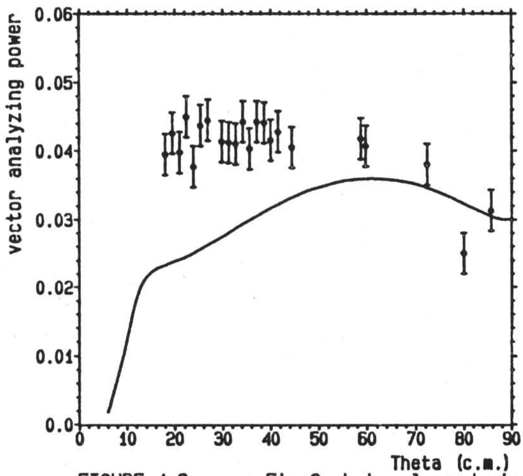

FIGURE 4: Same as Fig.2, but enlarged view

FIGURES 1 to 4: Differential cross section and vector analyzing power of $D(\vec{p},p)D$ at 14.1 MeV. The solid line is the Faddeev calculation including a Coulomb correction made by Koike[3]. Circles are our own results. In Fig. 3 Koike's calculations and our results are compared with Grüebler data[2] (crosses).

References

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