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Neutron polarization from the D(d, n)^{3}He reaction at 10·8 MeV incident deuteron energy

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Abstract. The polarization of neutrons from the D(d, n)^{3}He reaction at 10·8 MeV incident energy has been measured at six angles between 35° and $60°_{lab}$. The results of the experiments are in agreement with the recent unpublished work of R L Walter *et al*

As part of a program to establish a polarized neutron beam facility at this laboratory the polarization of neutrons from the D(d, n)^{3}He reaction has been measured at six angles between 35° and $60°_{lab}$. The experiment involved the use of a superconducting spin-precession solenoid and a liquid helium polarimeter.

The 12·4 MeV deuteron beam from the University of Birmingham Radial Ridge Cyclotron was steered and focussed into the centre of a deuterium gas target. The gas, at a pressure of 4×10^5 N m^{-2}, was contained within a 0·0356 mm Havar window† through which the deuteron beam entered and left the chamber. Circulation of the gas through a water cooled heat exchanger and rotation of the target cell served to reduce the heating effect of the charged particle beam.

The polarization of the neutrons was measured by observing the asymmetry in scattering from helium in the region of $80°_{lab}$. One stationary neutron detector together with the spin-precession solenoid eliminated false asymmetries due to detection efficiency effects or the inaccurate moving of a heavily shielded detector. The superconducting solenoid‡ used in the present experiment was capable of rotating the neutron spin vector through 180° and thus a useful check of the experimental technique could be made by comparing the clockwise and anticlockwise precession runs.

The liquid helium polarimeter, which has been described previously (Birchall *et al* 1968), was 1·5 m from the deuterium target. This instrument incorporated a quartz light pipe 38 cm long to transmit the scintillations from the liquid helium to the photomultiplier which operated at room temperature. The scattered neutron was detected 1 m away in a liquid scintillator system employing pulse shape discrimination to reduce the γ detection efficiency.

The neutrons of interest were identified by their flight time from the polarimeter to the side detector. By requiring that the polarimeter signals corresponded in time and pulse height to the scattering of D(d, n)^{3}He neutrons the background on the time of flight spectra was kept to a low level, typically 7% of the total peak. The effect of the solenoid field on the polarimeter photomultiplier could not be entirely eliminated

† Supplied by the Hamilton Watch Co, Lancaster, Pennsylvania.
‡ Supplied to our specifications by BOC, Deer Park Road, London SW19, UK.

in this experiment and was compensated for by alteration of the tube voltage. As a check that this procedure did not invalidate the data the clockwise and anticlockwise precession runs were compared for false asymmetries. None was found outside statistics. The effective analysing power of the polarimeter was calculated by the Monte Carlo program MOCCASINS (written by J R Sawers and Th Stammbach, Duke University). This program, which used the n-alpha phase shifts of Stammbach and Walter (1971), takes account of the finite geometry of the system and of the possibility of double scattering in the helium. The option for including double scattering involving the walls of the cryostat was not used. Depolarization in the solenoid due to radial field components (Atkinson and Sherwood 1965) and due to the finite energy spread of the neutron beam was estimated to be less than 0·5% and was ignored.

The results of the experiment are presented in figure 1 together with the recent Duke data (Spalek *et al* 1971). Although the n-alpha parameters used were the same as

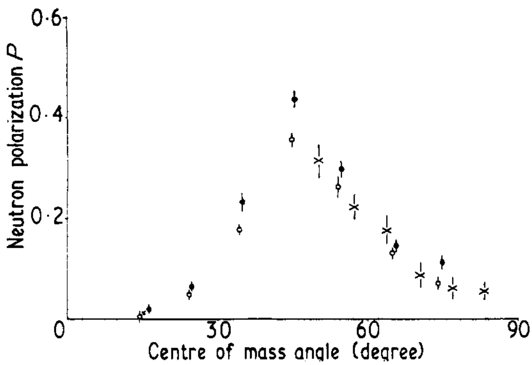

Figure 1. Neutron polarization from the D(d, n)^{3}He reaction. × 10·8 MeV, present data; ○ 10·0 MeV, ● 12·0 MeV, from the data of Spalek *et al* (1971).

in the present analysis the techniques differed considerably (Taylor *et al* 1970) and in view of these differences the agreement is satisfactory.

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Taylor J *et al* 1970 *Phys. Rev.* C **1** 803–8