Proton Polarization in the Reaction $O^{16}(d,p)O^{17*}$ (0.87 MeV)

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The polarization of protons following the $O^{16}(d,p)O^{17*}$ (0.87 MeV) reaction ($l_n=0$) has been measured over the angular range $15° \leqslant \theta_p \leqslant 110°$ at $E_d=7$, 8.2, and 9.55 MeV and at 15° and 30° at several energies in the range 6.5 MeV $\leqslant E_d \leqslant$ 9.55 MeV. Large polarizations are observed which are practically independent of deuteron energy; this fact suggests that the polarization arises from a direct interaction mechanism. The results imply that spin-dependent distortions will be required in any distorted-wave stripping description of this reaction.

1. INTRODUCTION

In the preceding paper,[1] it emerged that in the $C^{12}(d,p)C^{13}$ reaction, compound nucleus interference bedevilled a description of the mechanism in terms of the distorted-wave stripping theory. *A priori*, one might expect that the use of the doubly closed shell nucleus O^{16} as target would bring more success by stressing the direct nature of the reaction. The polarization of protons leaving the first excited state (0.87 MeV) was observed because under the stripping assumptions this transition corresponds to $l_n=0$ and then proton polarization can be attributed to spin-dependent distortions of the deuteron or proton waves.

2. EXPERIMENTAL

The method was described in Ref. 1 except for the preparation of the oxygen targets. These were made by blowing a large bulb of silica (SiO_2) which was later shattered and pieces about 0.012 mm thick were selected. This thickness was close to 3 mg/cm². The targets would withstand only about 1 μA of deuteron beam on a spot of 2-mm diam.

The protons from the (d,p) reactions on the silicon in the target were readily resolved from $O^{16}(d,p)O^{17*}$ protons as is shown in Fig. 1. The peak that is intermediate between those labeled O^{17} appears at the position computed from reaction kinematics for the $Si^{28}(d,p)Si^{29*}$ reaction going to a group of unresolved levels that are known[2] near 4.9-MeV excitation in Si^{29}. Both the peaks from the oxygen reactions and that from silicon reactions were observed throughout the experiment and were found to change with deuteron energy and angle in accord with reaction kinematics. The relative intensities of the two oxygen groups agreed with other measurements[3] at $E_d=7.73$ MeV. Spectra for the scattered protons observed in the side counters of the polarimeter are shown in Fig. 2.

3. RESULTS

Figure 3 shows measurements at $\theta_p=15°$ and 30° lab for five different bombarding energies. The angular dependence of the polarization is given for three energies

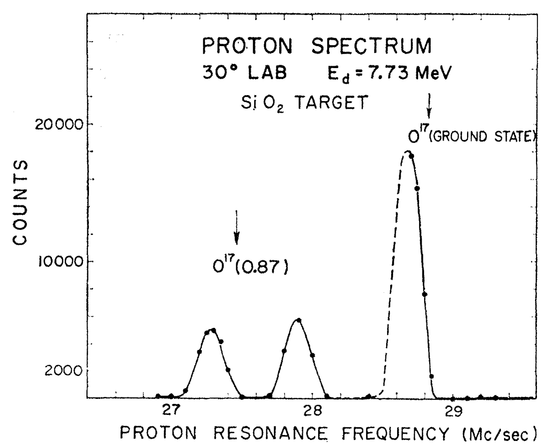

FIG. 1. Proton groups in the region of interest observed with the magnetic spectrometer using the same conditions as in the polarization measurements. The middle group is attributed to the reaction $Si^{28}(d,p)Si^{29*}$ as discussed in the text.

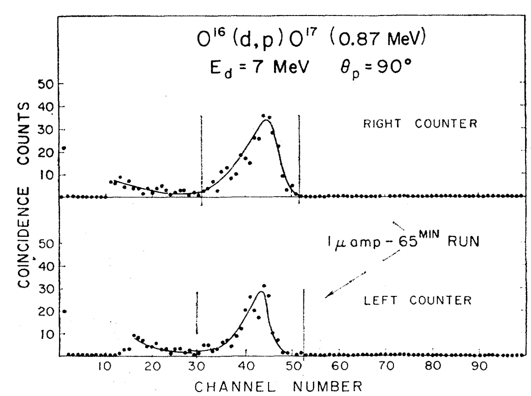

FIG. 2. Typical proton spectra from "right" and "left" counters in polarimeter. The channels between the vertical lines were summed to obtain the right and left counting rate.

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[1] J. E. Evans, J. A. Kuehner, E. Almqvist, preceding paper, Phys. Rev. **131**, 1632 (1963).

[2] J. A. Kuehner, E. Almqvist, and D. A. Bromley, Nucl. Phys. **19**, 614 (1960); P. M. Endt and C. Van der Leun, *ibid.* **34**, 1 (1962); C. P. Brown and J. T. Radzyminski, *ibid.* **19**, 164 (1960).

[3] E. J. Burge, H. B. Burrows, W. M. Gibson, and J. Rotblat, Proc. Roy. Soc. (London) **A210**, 534 (1951).

in Fig. 4. The only significance of the dashed line is that it is drawn through the weighted mean at each angle and can be reconciled with the results at all three energies. In Fig. 3, there is a suggestion of a small fluctuation with energy near 7.5 MeV. Otherwise, there is no evidence of energy dependence even at angles well removed from the main stripping peak.

4. DISCUSSION

Absence of energy dependence in the polarization implies good averaging over compound nucleus resonances. Then under the usual assumptions of stripping theory, the polarization can be attributed only to spin-dependent distortion of the deuteron and proton waves. That these effects may give rise to large polarization is in agreement with the theoretical findings of Johnson.[4]

If the distorted-wave Born approximation is at all applicable to polarization in stripping reactions on the light nuclei, it seems that here is an ideal test. The difficulty will lie in deciding realistic values for the optical model parameters and for this purpose, a study of the $O^{16}(d,d)$ and $O^{17}(p,p)$ reactions is desirable.

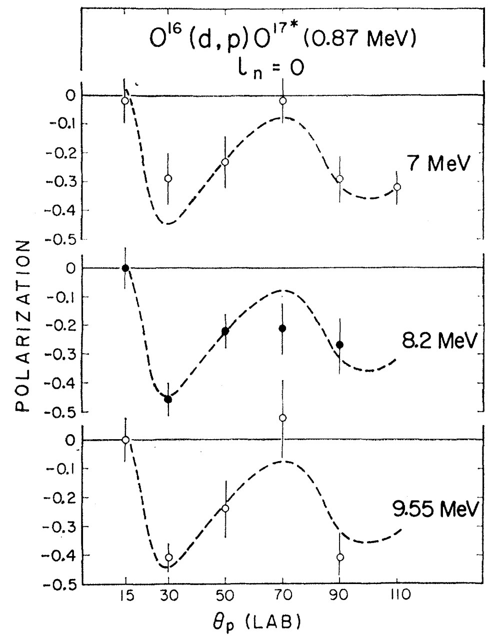

FIG. 4. The polarization of the protons from $O^{16}(d,p)O^{17}$ at three energies. The positive direction is taken along $\mathbf{k}_d \times \mathbf{k}_p$.

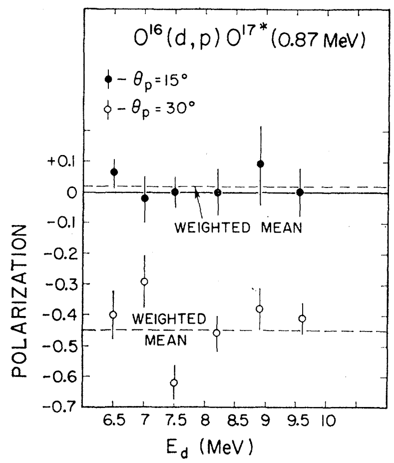

FIG. 3. The polarization of the protons emitted at 15° and 30° to the beam from the reaction $O^{16}(d,p)O^{17}$ at several energies. The Basel convention of taking the positive direction along $\mathbf{k}_d \times \mathbf{k}_p$ is used.

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[4] R. C. Johnson, Nucl. Phys. **35**, 654 (1962).