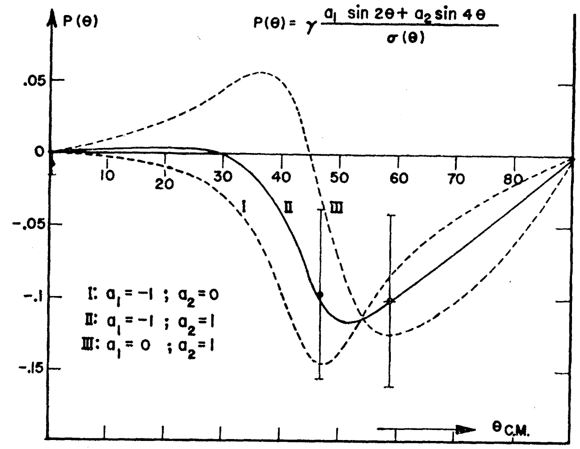

FIG. 4. Angular dependence of the neutron polarization in the reaction $D(d,n)He^3$ at $E_d=8.2$ Mev. Data points and three possible theoretical fits are shown.

possible theoretical fits are shown in Fig. 4. γ is a scale factor used to fit the points.

The statistical errors for the values of $P(47°)$ and $P(59°)$ are such that no great significance can be attributed to the numerical values of P, but the sign and the small magnitude of the polarization seem clearly established.[8] On account of these and earlier data for lower energies,[1–5] it can be expected that for all deuteron energies below 10 Mev the maximum neutron polarization is negative, slowly varying, and small, probably showing a maximum of $|P_{\max}(E)|=0.20$ in the region between 2 and 4 Mev (Fig. 1). This observation is in accordance with the surprisingly good fits to the observed differential cross sections of the $D(d,n)He^3$ reaction which could be obtained by the use of a pure stripping approach,[9] in which all polarization-producing interactions were neglected.

ACKNOWLEDGMENT

The author wishes to thank Professor J. M. Fowler for the suggestion of this research and many helpful discussions.

[8] The data presented here are the result of 840 hours of cyclotron running time. It seemed impractical to try for better statistics by continuing the measurements with the apparatus described here.

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PHYSICAL REVIEW VOLUME 115, NUMBER 4 AUGUST 15, 1959

Back-Angle Elastic Scattering of 14.6-Mev Neutrons from Aluminum, Copper, and Zirconium*

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(Received March 26, 1959)

Differential elastic scattering cross sections have been measured for 14.6-Mev neutrons on aluminum, copper, and zirconium in 5° steps from 85° to 155°. The copper and zirconium angular distributions are in good agreement with optical-model calculations by Bjorklund and Fernbach, who employ a spin-orbit coupling term in their potential. The aluminum differential cross sections are systematically higher than the predictions at the back angles, indicating that the Bjorklund-Fernbach optical-model parameters which fit the medium and heavy elements are not as successfully applied to an element as light as aluminum.

INTRODUCTION

OPTICAL-MODEL calculations[1] by Bjorklund and Fernbach show excellent agreement with measured 14-Mev neutron elastic scattering angular distributions for the medium and heavy elements. However, their predictions are low at the back angles for the light elements beryllium and carbon.[2] This is not unexpected since the concept of an optical-model potential becomes questionable when a nucleus has a small number of nucleons. For aluminum, the previously measured cross sections[1] were not absolute, and when normalized to theory[1] at $\theta=30°$ the theoretical curve was systematically low at the back angles. This experiment was undertaken to measure the absolute cross section for aluminum at the back angles. Copper and zirconium were also measured. The method used for large-angle elastic scattering measurements has been described in a previous paper.[3]

The aluminum, copper, and zirconium cross sections, corrected for multiple scattering, absorption, and angular resolution due to finite ring size, are shown in Figs. 1 and 2. The solid curves are the predictions of Bjorklund and Fernbach,[1] who employ a spin-orbit coupling term in their optical-model potential.

* This work was performed under the auspices of the U. S. Atomic Energy Commission.

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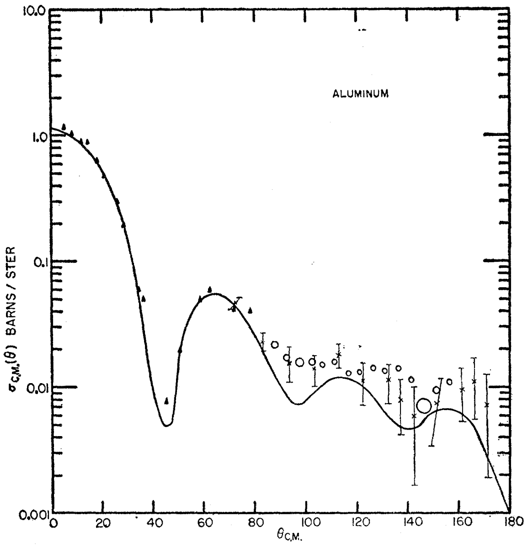

FIG. 1. Differential cross sections for elastic scattering of 14.6-Mev neutrons from aluminum. Open circles are the results of this experiment; size of circles indicates statistics. Triangles and crosses are the measurements of Coon *et al.* and K. Yuasa, respectively; solid line indicates the optical-model predictions of Bjorklund and Fernbach.

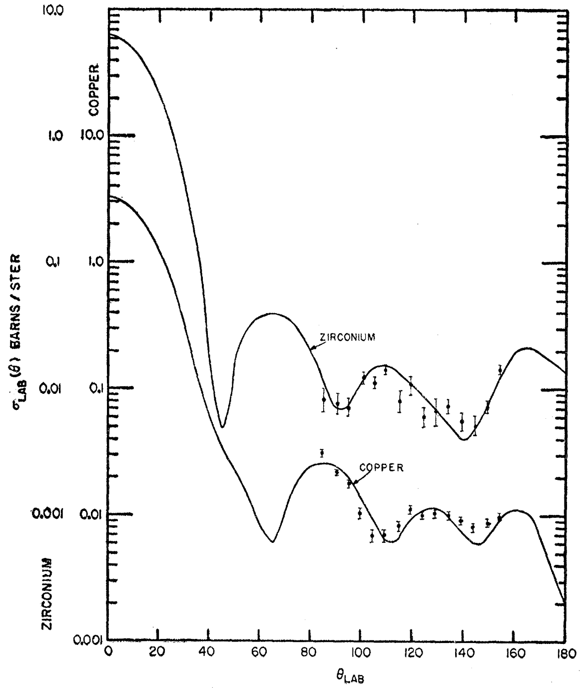

FIG. 2. Differential cross sections for elastic scattering of 14.6-Mev neutrons from copper and zirconium. Solid line indicates the optical-model predictions of Bjorklund and Fernbach.

ALUMINUM

The aluminum results are shown in Fig. 1. The measured back-angle cross sections are systematically higher than the predictions, indicating that the Bjorklund-Fernbach optical-model parameters which fit the medium and heavy elements are not as successfully applied to an element as light as aluminum. The possibility of contamination by inelastically scattered neutrons was investigated, since, at the detector bias of 10.1 Mev, neutron groups from the 0.842- and 1.013-Mev levels[4] in Al^{27} can contribute. Using a longer flight path and a lower detector bias, an attempt was made to detect neutron groups from the first two levels in Al^{27}. It was concluded that the discrepancy between theory and measurement in the region of $\theta_{cm}=90°$ cannot be ascribed to the detection of inelastic neutrons.

Recently several groups[5–7] have reported measurements on aluminum. The measurements of Coon *et al.*[5] which extend from 5° to 80° in the center-of-mass system, and of Yuasa[6] which extend from 72.1° to 170.6°, are plotted in Fig. 1. In the region of overlap, our measurements agree with those of Yuasa but disagree with those of Berko *et al.*[7] In general, the results of Berko *et al.* agree quite well with the theoretical predictions. The reason for this disagreement is not obvious since all three experiments were performed with a neutron detector bias between 10 and 11 Mev.

COPPER AND ZIRCONIUM[8]

The copper and zirconium results plotted in Fig. 2 show good agreement with the predictions. The neutron detector bias was 11.3 Mev for copper and 12.3 Mev for zirconium. The data have not been corrected for the detection of inelastically scattered neutrons. Using the data of MacGregor *et al.*,[9] these corrections are estimated to be smaller than the statistical uncertainty in the measurements. For copper our cross sections agree with the measurements of Coon *et al.*,[5] who quote a detector bias of approximately 14.0 Mev.

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