Title

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Energy Dependence of the Polarization in p-O^{16} Elastic Scattering Between 21 and 53 MeV*

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It is clear that the cross sections and polarizations of medium energy protons scattered by the heavier nuclei are well described by the optical model; however, its applicability to light nuclei is less certain. An extensive analysis [1] of p-C^{12} and p-O^{16} differential cross-section data between 10 and 20 MeV has indicated that the optical model is surprisingly successful in accounting for the p-C^{12} data, but less so for p-O^{16} where the parameters vary severely as a function of energy.

In order to study the validity of the optical model for light nuclei at higher energies, in particular, to investigate the energy dependence of the spin-orbit potential, we have determined the polarization in the p-O^{16} elastic scattering at seven energies between 21 and 53 MeV. The source of polarized protons is the alpha-hydrogen scattering utilizing the variable energy feature of the Berkeley 88" cyclotron. In the data presented in Figure 1 (the lines are visual aids and have no significance) a drastic change in the polarization pattern is found between 21 and 25 MeV. Above this energy the polarization distribution varies slowly with energy. We have also measured the differential cross section at 42.1 and 52.5 MeV to supplement the available data at 30.3 MeV (Harwell).

The optical model analysis was performed in Berkeley with SCAT 4 and at NASA with a modified version of SCAT 4 employing the Argonne search routine.# In this priliminary analysis, we have only considered the polarization data in the less energy dependent region and have limited the search to the conventional seven parameter potential consisting of a real central potential of the Saxon-Woods type (V, a, R_o) a surface peaked imaginary potential with a derivative Saxon-Woods form factor (W, a_I, R_I) and a spin-orbit potential of the Thomas type (V_s, a, R_o). Keeping R_o fixed at $1.25 \pm .05$ fermis and gridding on a, a_I and R_I we have searched for the best parameters V, W, Vs, to give good fits to both polarization and cross-section data. For the search at 32.8 MeV we have used the 30.3 MeV cross-section data from Harwell, at 36.7 MeV interpolated cross sections as a guide to the search routine. The "best fits" were selected by visual inspection under the constraint that the parameters were reasonable and compromising over this energy range. The results of the analysis are shown in Figure 2. The solid lines present the optical model predictions with the parameters from Table 1. With the exception of the highest energy quite satisfactory fits to polarization and cross-section data can be obtained up to 120^o CM.

At present, we conclude that the optical model is a reasonably applicable to the p-O^{16} elastic scattering at these energies although there are some fluctuations in the parameters. We are optimistic that a more detailed analysis will produce better fits at large angles and give a more systematic variation of the parameters.

TABLE I

E	V	W	V_s	a	a_I	R_o	R_I
32.8	41.0	5.4	7.5	.65	.50	1.25	1.35
36.7	41.3	6.3	8.1	.67	.50	1.25	1.30
42.0	36.0	3.5	8.1	.75	.76	1.20	1.30
52.5	31.4	3.6	5.7	.70	.44	1.20	1.25

Footnotes and references:

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1) J. S. Nodvik, C. B. Duke, and M. A. Melkanoff, Phys. Rev. 125, (1962) 975.
C. B. Duke, Phys. Rev. 129 (1963) 681.

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FIGURE CAPTIONS

Figure 1 Energy dependence of the p-O^{16} polarization.

Figure 2 Optical model predictions to the polarization and cross-section data using the parameters of Table 1.

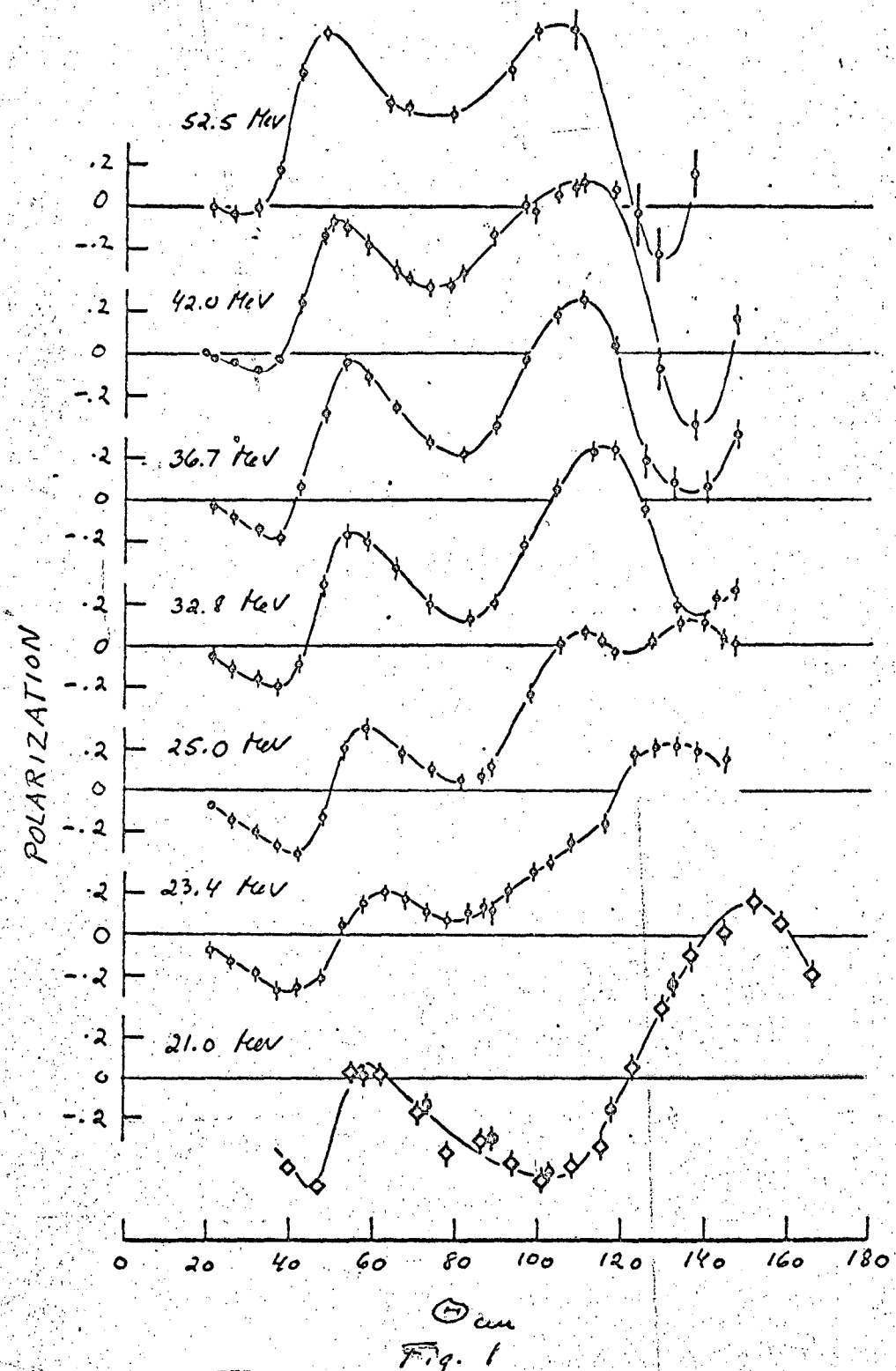
52.5 MeV
42.0 MeV
36.7 MeV
32.8 MeV
25.0 MeV
23.4 MeV
21.0 MeV
.2
0
-.2
POLARIZATION
0
20
40
60
80
100
120
140
160
180
θ cm

Fig. 1

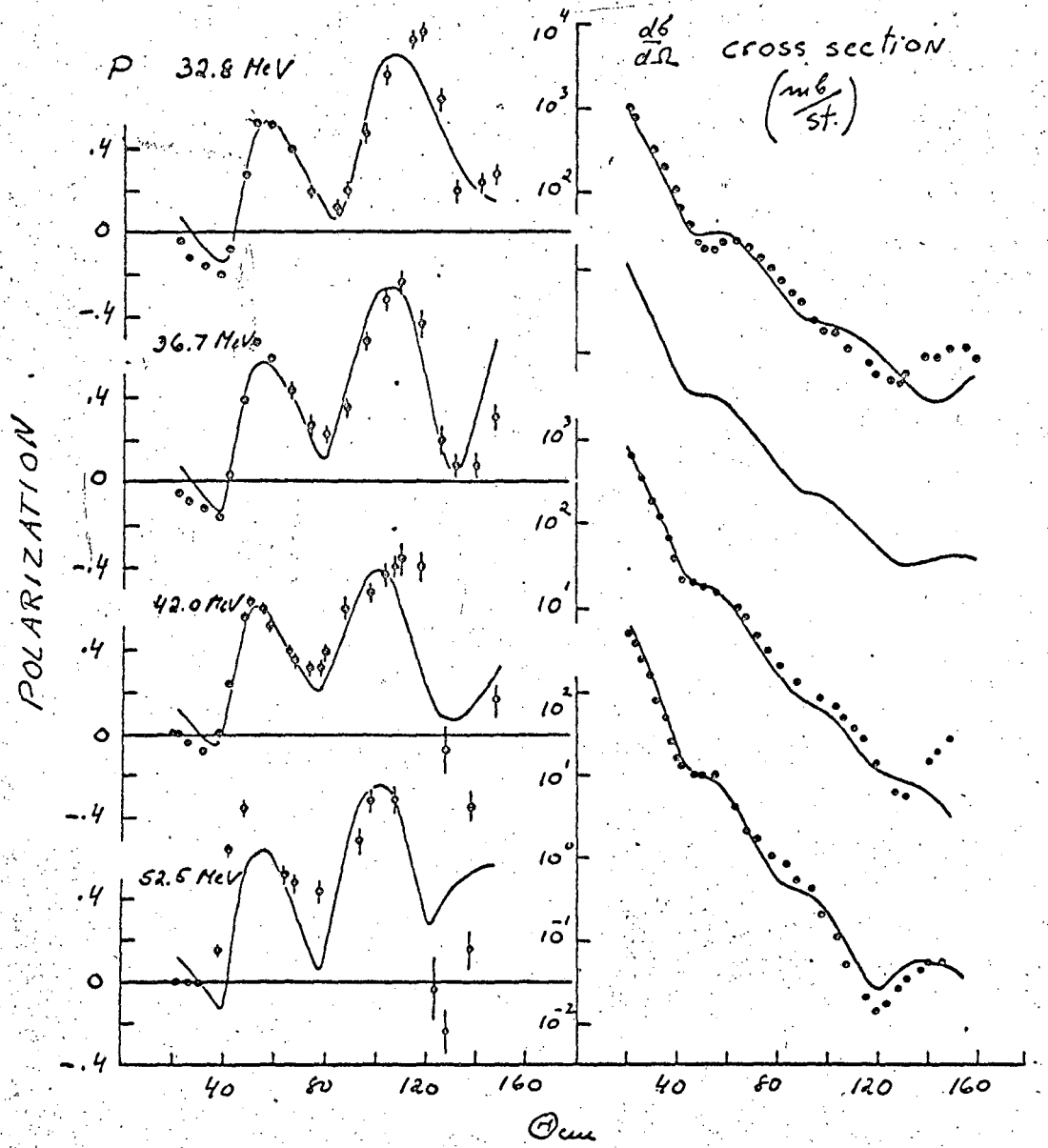
P 32.8 MeV
36.7 MeV
42.0 MeV
52.5 MeV
POLARIZATION
dσ/dΩ cross section (mb/st.)
θcm
40
80
120
160

Fig. 2