LA-UR-80-1925
34c

CONF-800824-10

TITLE: Polarized Triton Scattering From ^{26}Mg, ^{27}Al and ^{28}Si at 17 MeV*

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SUBMITTED TO: Fifth International Symposium on Polarization Phenomena in Nuclear Physics, Santa Fe, August 11-15, 1980

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Form No. 836 R3
St. No. 2629

UNITED STATES
DEPARTMENT OF ENERGY
CONTRACT W-7405-ENG. 36

Polarized Triton Scattering from ^{26}Mg, ^{27}Al and ^{28}Si at 17 MeV*

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We have measured differential-cross-section and analyzing-power angular distributions for 17 MeV tritons elastically scattered from targets of ^{26}Mg, ^{27}Al, and ^{28}Si in the angular range 20° to 160°. The experiment was performed at the Los Alamos Scientific Laboratory Van de Graaff facility using the Lamb-shift polarized triton source[1] and the supercube[2] scattering chamber. A pair of detector telescopes with angular resolutions of ± 0.4° detected the reaction products, with mass identification and storage performed by an on-line computer. The triton beam intensity available at the target was about 70 nA with a polarization of 0.77. The target thicknesses were about 3 mg/cm^2, although thinner targets were used for the ^{27}Al forward-angle data.

We recently completed a study[3] of the triton optical model (OM) for targets with masses in the range 40 ≲ A ≤ 208. The present purpose was to extend that study to somewhat lighter nuclei. In addition, we wanted to obtain OM parameters in this lighter mass range for reaction calculations and for comparison with the results of polarized ^3He (helion) scattering.[4] The polarized triton data are shown in Figs. 1-3 along with curves from the OM calculations.

Of the 3 nuclei studied, the ^{26}Mg data showed the most regular pattern of oscillations in both the differential cross-section and analyzing power distributions, and most of our calculation efforts attempted to fit these data. Although the fit is acceptable for the cross sections, it is only marginal for the polarization data, a feature that we have also noted in other polarized

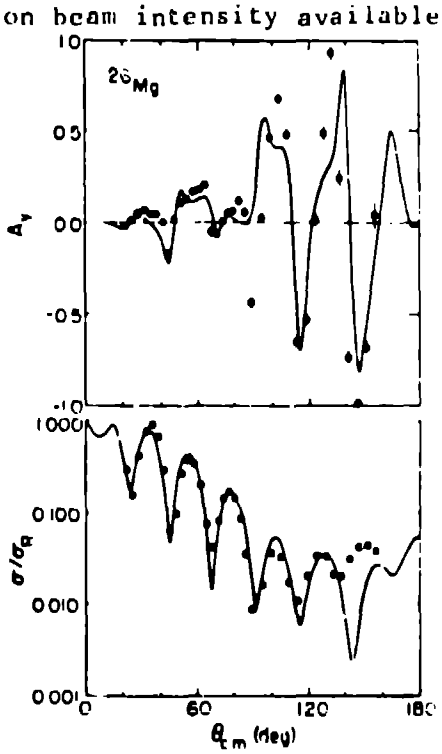

Fig. 1. Analyzing powers A_y and differential cross-sections σ/σ_R (ratio-to-Rutherford) for 17 MeV triton elastic scattering from ^{26}Mg. The curves are from OM calculations using the parameters in Table 1.

*Work supported by the U.S. Department of Energy.

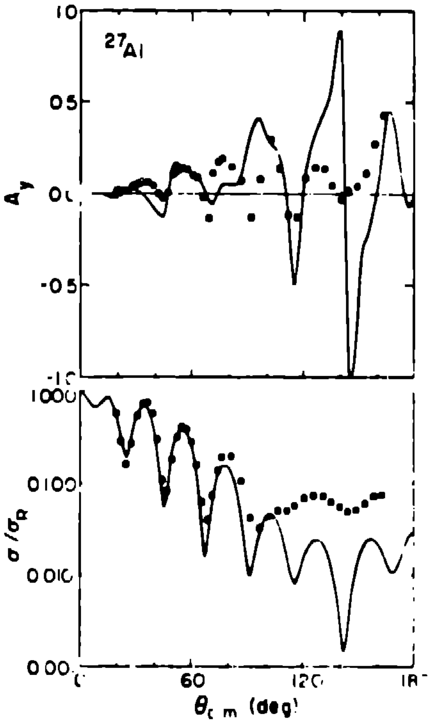

Fig. 2. Triton elastic scattering from ^{27}Al at 17 MeV. See caption to Fig. 1. The curves are from OM calculations using the ^{26}Mg parameters.

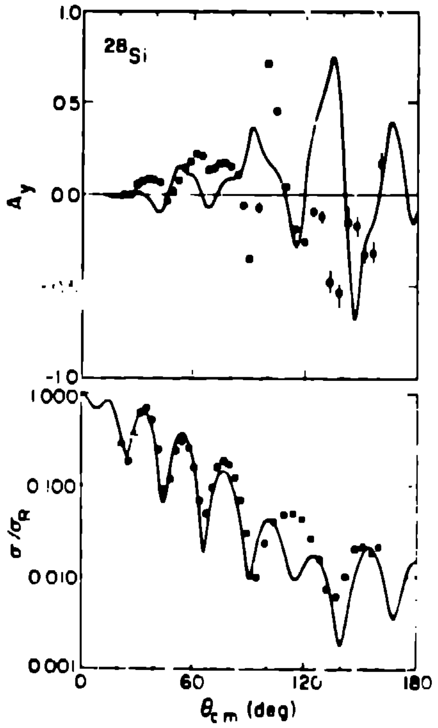

Fig. 3. Triton elastic scattering from ^{28}Si at 17 MeV. See caption to Fig. 1. The curves are from OM calculations using the ^{26}Mg parameters.

triton studies. The analyzing power data seem to provide a severe test of the applicability of the OM in this mass and energy range and thus constrain the acceptable parameters more than do the cross section data alone. The curves shown with the ^{27}Al (Fig. 2) and ^{28}Si (Fig. 3) data use the same parameters found for the ^{26}Mg data. Although some additional calculations were made for these nuclei, no significant improvement could be achieved in the fits.

It can be noted for all of the cross-section distributions that a departure from the OM calculations occurs at backward angles, past 135° for ^{26}Mg and past 100° for ^{27}Al and ^{28}Si. In the latter cases, the analyzing power magnitudes are also reduced, pointing to the importance of compound nuclear contributions to the scattering in this angular range. A Hauser-Feshbach compound-elastic contribution was added to the ^{26}Mg calculation, improving the cross-section fit near 150°, but the overall improvement was slight. We could find no combination of parameters that give a satisfactory fit to the middle-angle analyzing power data for ^{26}Mg while maintaining a good representation of the cross sections.

Table I gives the OM parameters for the curves shown in the figures along with parameters reported by the Birmingham group[4]

TABLE I. Optical model parameters found in the present study for $^{26}Mg(t,t)$ and from Ref. 4 for $^{26}Mg(^3He,^3He)$. Well depths are in MeV and other parameters are in fm.

	V_o	r_o	a_o	W_v	r_w	a_w	V_{so}	r_{so}	a_{so}
Triton	160	1.16	0.71	28.0	1.38	0.92	14.5	1.04	0.25
Helion	160	1.12	0.68	31.7	1.37	0.95	7.2	0.96	0.25

for helion scattering at 33.4 MeV. In spite of the energy difference in the two data sets and the fact that the helion polarization data extend only to 77°, the parameter agreement is quite good. This is the first case we have studied with polarized tritons in which there is clear evidence for a small spin-orbit radius, a feature often noted in the analyses of helion data. The real volume integral per nucleon for the triton potential is about 495 MeV fm^3, which is in the same family as the heavier nuclei we have studied.[3] Although a real potential radius of 1.16 fm resulted from the automatic searches carried out, a radius of 1.20 fm, as used in Ref. 3, gives an equally good fit if V_0 is decreased to 153 MeV, maintaining roughly the same volume integral.

The spin-orbit well depth of 14.5 MeV is higher than the average of 6 MeV found for heavier nuclei, and much higher than the folding-model prediction of about 2.5 MeV. In the present study, the analyzing-power fit is not good enough to warrant a firm conclusion, but the result does support our earlier indications[3,5] that there is something wrong with the assumptions of the simple folding-model.

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