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$^{18}O(\vec{p},t)^{16}O$ at Tp = 90 MeV

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In the $^{17}O(\vec{p},t)^{15}O$ experiment[1] we also obtained some data for $^{18}O(\vec{p},t)$ from the 25% ^{18}O component of the target. As can be seen in Fig. 1 of the $^{17}O(\vec{p},t)$ report in the IUCF Annual Report of 1983 several ^{16}O excited states were resolved in the excitation range from about 5 to 17 MeV. A gap of about 2 MeV between 10 and 12 MeV excitation energy resulted at most angles from the two non-overlappinng QDDM momentum bites. One state in this 10-12 MeV region has been excited in earlier (p,t) work, the 4^+ state at 10.35 MeV.[2,3] However, in an analysis of the projectile energy dependence M. Pignanelli et al.,[3] observed a sharp decline of the integrated cross sections with increasing energy. At 38 MeV the 4+ state at 10.35 MeV had a cross section of 0.067 mb, and at 44 MeV it was no longer seen in their work. At 10 deg laboratory angle this state was, at most, extremely weak in our 90 MeV experiment. Similarly the "unnatural parity" 2^- state at 8.88 MeV was not seen in our experiment. Its integrated cross section was already down to 0.043 mb at 44 MeV in the former work.

Three relatively strong and three weaker triton groups from $^{18}O(\vec{p},t)$ were analyzed in the present work. The $0^+/3^+$ doublet at 6.05/6.13 MeV, the 3^- state at 13.3 MeV and a poorly resolved state at 16.35 MeV (see Fig. 1 in Ref. 1) are excited with maximal cross sections of about 0.1 mb/sr. The 2^+ state at 6.92 MeV, the 1^+ state at 7.12 MeV and the 2^+ state at 9.85 MeV are seen with only 10% of that strength.

The DWBA analysis of $^{18}O(\vec{p},t)$ became increasingly interesting as three kinds of problems were encountered with the evaluation of the $^{17}O(\vec{p},t)$ angular distributions.

Firstly, a strong sensitivity to the optical potentials was found. We dealt with this by using measured elastic scattering cross sections from $^{17}O(\vec{p},p)^4$ and from nat.O(^{3}He,^{3}He)[5] to deduce optical model parameters, listed in the Table.

Secondly, since the initial state in the $^{17}O(p,t)$ reaction has $J=5/2^+$, all but the transition to $J=1/2^-$ (L=3) have mixed L-values. Only for the well known configurations in ^{15}O it is therefore possible to perform reliable DWBA calculations. In $^{18}O(p,t)$, however, the L transfers are unique.

Thirdly, the DWBA codes used, FRUCK2 and CHUCK3, showed increasing divergence with decreasing momentum-

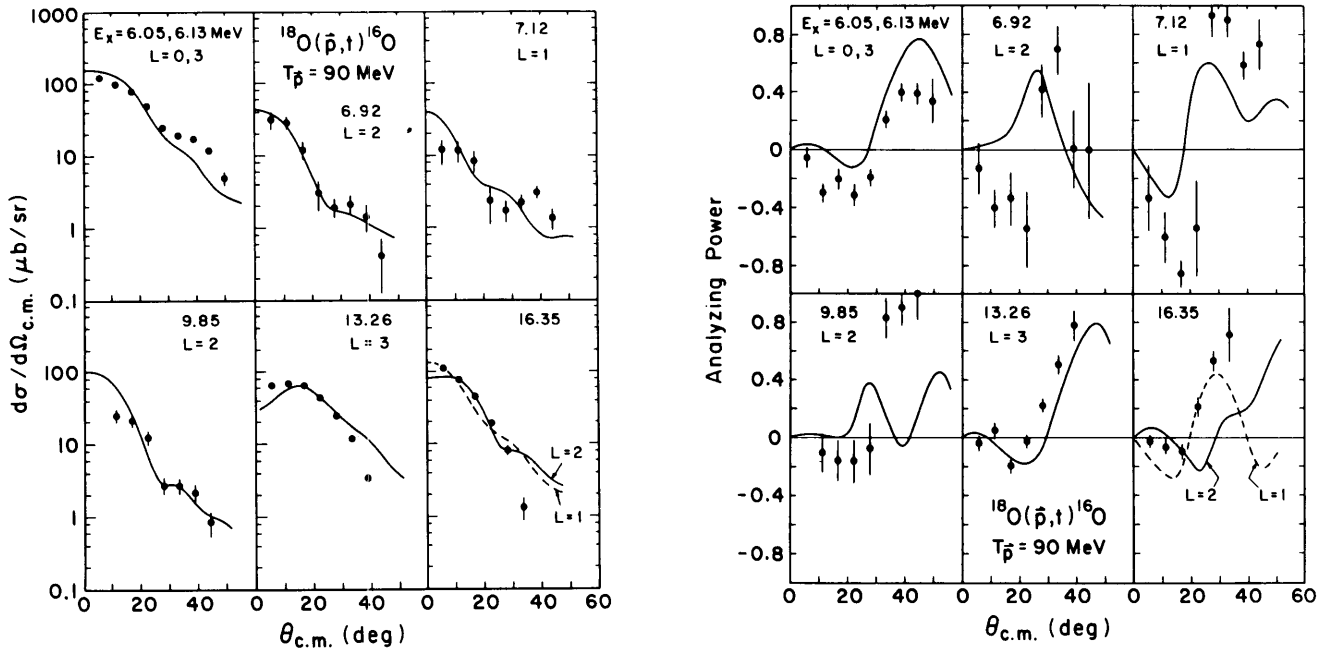

Figure 1. Angular distributions of cross sections and analyzing powers. Solid curves are finite-range predictions by code FRUCK2, visually normalized to the data.

Table I. Optical potential parameters used in the DWBA calculations

	V	r	a	W	W_d	r_i	a_i	V_{so}	r_{so}	a_{so}	X**2
p	33.0	1.20	0.64	10.3	--	1.34	0.66	6.18	1.08	0.49	4.7
t	205.	1.08	0.72	--	14.9	1.35	0.67	5.67	0.73	0.67	3.3

and angular-momentum matching. Whereas for good momentum matching conditions the two codes are known to produce similar angular distributions, in the present analysis they yield opposite polarities for the analyzing powers in some cases.

Having a target with $J=0^+$ the problems described above could be investigated better. The effects of the optical potential parameter sensitivity could be checked for several pure L transitions to ^{16}O final states. Cross section- and analyzing power angular distributions for the six triton groups from $^{18}O(\vec{p},t)$ are displayed in the figures together with finite range DWBA calculations.

The 13.26 MeV 3^-; T=1 state has not been reported in earlier (p,t) work. It displays angular distributions for both cross sections and analyzing powers in agreement with L=3. Near 16.35 MeV a triplet of states has been reported, a 6^+ state at 16.28, a

$(0^+, 1^-)$ state at 16.35 MeV and a 2^+; T=1 state at 16.44.[6] Our data cannot be fit with an L=0 distribution. Both, L=1 and L=2 distributions are fairly consistent with the cross section data whereas the L=1 description is slightly better for the analyzing power data.

The overall reproduction of the data by DWBA is similar for $^{17}O(p,t)$ and $^{18}O(p,t)$ for the known configurations in the final nuclei. The question whether the zero-range approximation or the finite-range DWBA code or perhaps both develop serious problems at large momentum mismatch is still under investigation.

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ENERGY DEPENDENCE OF THE $^{24}Mg(\vec{p},d)$ REACTION FOR VARIOUS ℓ TRANSFERS

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Early analyses[1] of results of (p,d) reaction cross-section and analyzing-power measurements obtained for ℓ = 0 transitions raised substantial questions regarding the applicability of standard DWBA methods to this reaction at or above 100-MeV bombarding energy. The purpose of the present investigation was to study transitions involving different orbital angular momentum (ℓ) and spin (j) transfers as a function of bombarding energy to provide a data base for detailed theoretical investigations of the energy dependence of the reaction mechanism.

Measurements of cross-section and analyzing-power angular distributions were carried out using the same detector telescope at bombarding energies of 49.2 and 150.3 MeV for the $^{24}Mg(\vec{p},d)$ reaction to the known low-lying $J^\pi = 1/2^+$, $1/2^-$, $3/2^-$, $3/2^+$, $5/2^+$, and $7/2^+$ residual states of ^{23}Mg. A few data points were also taken at 95 MeV in order to provide a cross normalization of the telescope results with earlier 95-MeV spectrometer measurements.[2,3] An analysis of the distributions for the lowest $1/2^+$ state, incorporating results from a number of other laboratories spanning the bombarding-energy range from 27 to 185 MeV, has already been published.[4]

The telescope consisted of five elements, a 2-mm thick Si surface barrier detector followed by 12.0, 13.0, 9.4 and 13.0-mm thick intrinsic Ge detectors. The overall (full width at half maximum) resolution of the system including target thickness, kinematic spread, and the detector stack plus electronics was about