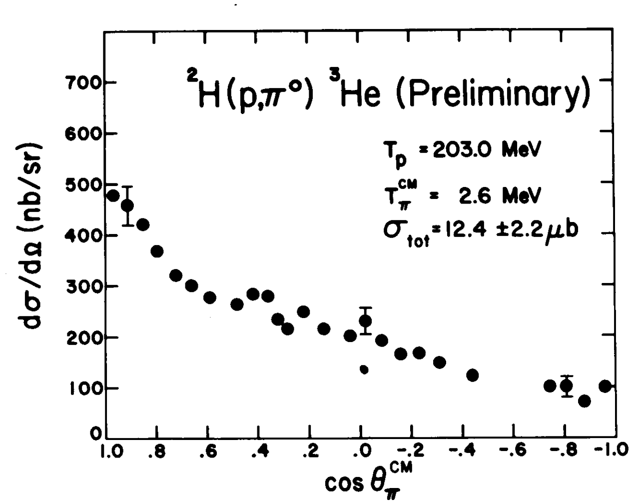


Figure 1. $^2H(p,\pi^\circ)^3He$ differential cross section at $T_\pi{}^{cm}$ = 2.59 MeV. The indicated uncertainties are statistical only.

3) the hodoscope calibration

4) the efficiency of the lead glass detectors, both intrinsic and due to a resricted geometry

5) distortion due to the finite target thickness

6) distortion due to a finite spread in the beam energy

7) distortion due to a finite angular spread in the incident beam caused by a non-zero emittance and a finite sized-beam spot

8) distortion due to multiple scattering

All these effects are well understood, although rather time consuming to evaluate. This work will be completed by March, 1981. A preliminary report of this work has been presented.[1)]

1) M.A. Pickar, R.E. Pollock, H.-O. Meyer, A.D. Bacher, and G.T. Emery, Bull. Am. Phys. Soc. 25, 725 (1980).

ANALYZING POWERS OF THE $^{16}O(p,\pi^+)^{17}O$ REACTION AT 157 MeV BOMBARDING ENERGY

T.P.Sjoreen†, P.H. Pile††, R.E. Pollock, R.D. Bent, M.C. Green, W.W. Jacobs, H.O. Meyer, and F. Soga
Indiana University Cyclotron Facility, Bloomington, Indiana 47405

Recently Auld et al.[1)] measured analyzing powers of the $^9Be(\vec{p},\pi^+)^{10}Be$ and $^{12}C(\vec{p},\pi^+)^{13}C$ reactions at 200 MeV bombarding energy ($T_\pi{}^{cm} \simeq$ 40 MeV) and discovered that the analyzing power angular distributions, at least for the states studied, were remarkably similar in nature. Each transition was characterized by analyzing powers which were negative at all angles, with maximum absolute value near $\theta_\pi{}^{cm}$ = 60°. These results have been used to suggest that the $(\vec{p},\pi^+)$ analyzing power distributions are not sensitive to the final states, and are a feature only of the reaction mechanism. So far theoretical calculations of analyzing powers using the stripping model[2)] (projectile emission) or the pionic knockout model[3)] (target emission) have not been able to reproduce this feature. Generally, the calculations yield negative analyzing powers in the forward hemisphere, but often show a state dependence in the magnitude and shape of the analyzing power distributions.

In order to obtain additional information about the state dependence of the analyzing powers for the $(\vec{p},\pi^+)$ reaction, we have measured near threshold ($T_\pi{}^{cm}$ < 12 MeV) spin-averaged differential cross sections and analyzing powers of the $(\vec{p},\pi^+)$ reaction for transitions to the ground, 2.12 MeV, and 4.44 MeV states in ^{11}B, the ground, 3.09 MeV and (3.68-3.85) MeV doublet states in ^{13}C, the ground and 0.87 MeV states in ^{17}O and the ground state of ^{41}Ca. The ^{11}B, ^{12}C and ^{40}Ca results, which were reported earlier[4)] and the ^{16}O results, which we report here, will be published in a forthcoming paper.

The results of the present measurement of the differential cross sections and analyzing powers for the $^{16}O(\vec{p},\pi^+)^{17}O$ reaction for the transitions to the $5/2^+$ g.s. and $1/2^+$ 0.87 MeV state are shown in Fig. 1. Like most of the other $(\vec{p},\pi^+)$ analyzing power distributions, the ^{17}O distributions are generally negative, but there is a large difference in the magnitude and shape of the two distributions, which indicates a dependence upon the final state. The curves in Fig. 1 are the results of fitting the data by the functions $d\sigma/d\Omega(\theta) = \sum_{K=0}^{N} a_K P_K(\cos\theta)$ and $A(\theta) = [d\sigma/d\Omega(\theta)]^{-1} \sum_{K=1}^{N} b_K P_K^{m=1}(\cos\theta)$ where P_K are Legendre polynomials and $P_K^{m=1}$ are associated Legendre polynomials. Best fits were obtained for N=3 indicating that d-wave pions are present and interfer with the s-and p-waves.

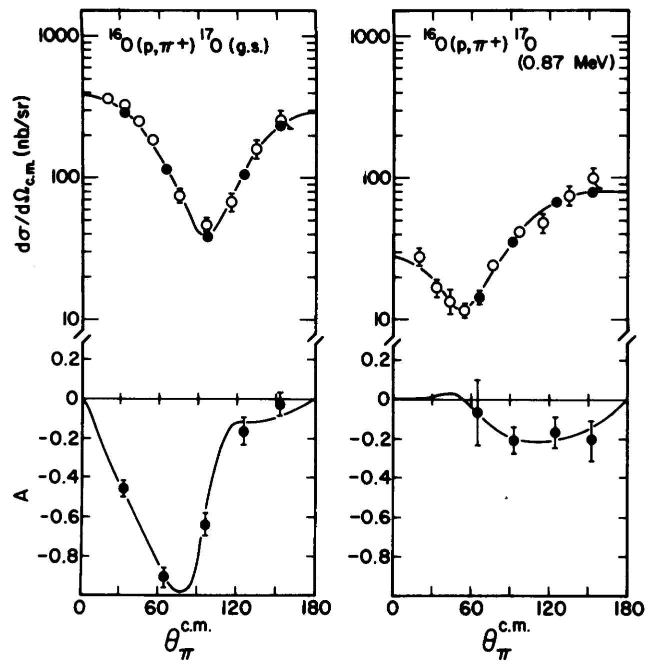
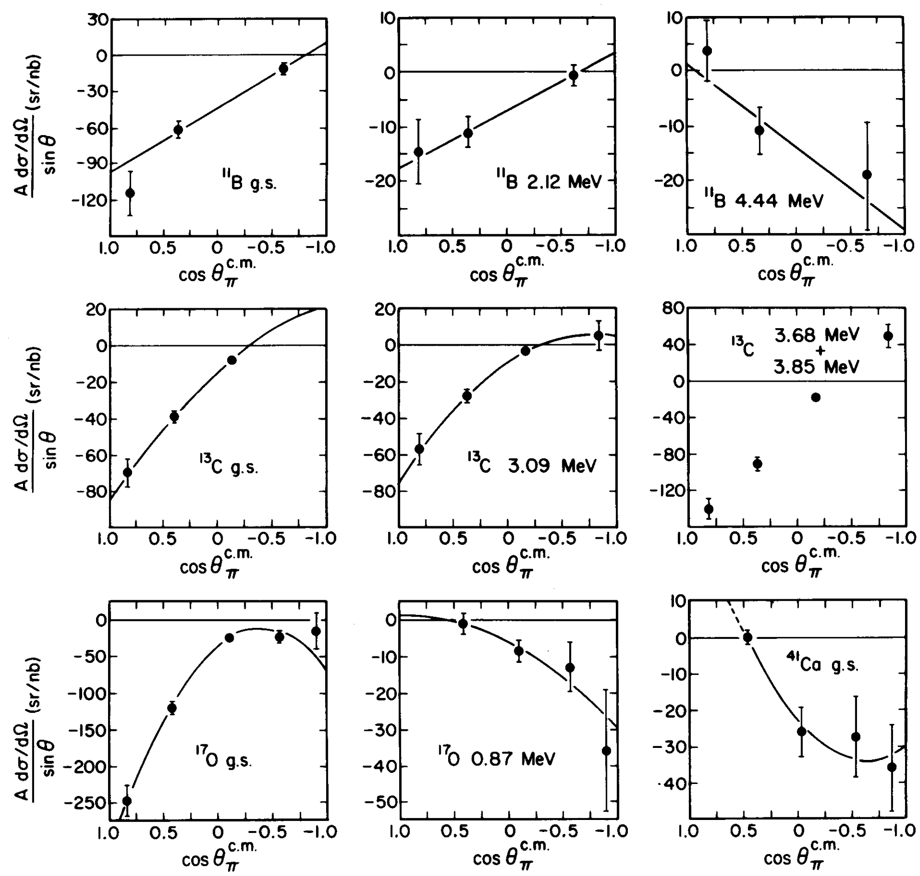


Figure 1. Results of the present differential cross section and analyzing power measurements of the $^{16}O(\vec{p},\pi^+)^{17}O$ reaction at 157 MeV bombarding energy. The cross sections denoted by open circles are taken from Ref. 5. The curves are the result of polynomial fits.

Since the analyzing power distribution can also be written as $A(\theta) = [d\sigma/d\Omega(\theta)]^{-1} \sin\theta \sum_{K=0}^{N-1} c_K \cos^K\theta$, we have plotted A $(d\sigma/d\Omega/\sin\theta)$ as a function of $\cos\theta$ in Fig. 2. This figure includes the ^{10}B, ^{12}C and ^{40}Ca data and fits, as well as those for ^{16}O. Plotting the analyzing powers in this manner removes the differential cross section dependence in the analyzing power angular distribution. Inspection of Fig. 2 shows that there is a strong state dependence in the analyzing powers. Comparison of the analyzing powers in Fig. 2 shows that the ^{11}B results are considerably different for each final state as are those in ^{17}O. For ^{13}C, however, the analyzing power distributions are very similar to each other. It is also interesting to compare the analyzing power distributions of the $1/2^+$ 3.09 MeV state in ^{13}C with that for the $1/2^+$ 0.87 MeV state in ^{17}O. Both of these states are known to be predominantly $2s_{1/2}$ single particle states, yet as shown in Fig. 2, they have completely different analyzing power distributions. This suggests that the core nucleons play a role in the pion production mechanism. It would be very interesting to see what the two-nucleon model predicts for the analyzing powers of these two states, since this model, unlike the stripping model, includes core nucleons in the reaction mechanism.

†Present address: Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830

††Present address: Carnegie-Mellon University, Pittsburgh, Pennsylvania



<u>Figure 2.</u> Results of near-threshold analyzing power measurements represented in the form $A(d\sigma/d\Omega)/\sin\theta_{\pi}$ vs. $\cos\theta_{\pi}$.

1) E.G. Auld, et al., Phys. Rev. Lett. 41, 462 (1978).

2) M.C. Tsangarides, thesis, Indiana University, 1979 unpublished); H.J. Weber and J.M. Eisenberg, Nucl. Phys. A312, 201 (1978); S.K. Young and W.R. Gibbs, Phys. Rev. C17, 837 (1978); J.V. Noble, Nucl. Phys. A244, 526 (1975).

3) W.R. Gibbs, LASL Report No. LA-8303-C, 1980 (unpublished), page 208.

4) P.H. Pile, et al., IUCF Scientific and Technical Report 1979, page 63.

5) T.P. Sjoreen et al., IUCF Scientific and Technical Report 1979, pages 70 and 132.

DEVELOPMENT OF A TWO-NUCLEON MODEL CODE FOR THE (p,π) REACTION

M. Dillig,† F. Soga†† and T.P. Sjoreen†††
Indiana University Cyclotron Facility, Bloomington, Indiana 47405

Although a substantial amount of (p,π) data has been produced at IUCF during the past 4 years, the reaction mechanism is still poorly understood, and the (p,π) reaction has not yet become a useful nuclear structure probe. The DWBA stripping theory has been found[1)] to be only partially successful in reproducing the main features of existing data.

In view of the gap between data and analysis, the development of a (p,π) code based on a more fundamental approach has been undertaken. It is assumed that the pion production processes at low energies is basically a two-nucleon process in which the meson propagation between two nucleons is explicitly incorporated. Transition amplitudes are decomposed into S-wave π