NEUTRON KNOCKOUT REACTIONS

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Our first (p,pn) neutron knockout experiment was performed at the IUCF in July 1980. The targets chosen for that project were ^{40}Ca, ^{48}Ca, and ^{2}H. The primary objective of this project was to study the "valence" neutrons for the calcium isotopes, i.e., the $1f_{7/2}$, $1d_{3/2}$, $2s_{1/2}$, and $1d_{5/2}$ neutron states. A short article[1] was published presenting a preliminary analysis of these data; a manuscript describing the completed analysis of these data is in preparation. This work was the Ph.D. dissertation[2] project of KSU graduate student M. Ahmad, who received his Ph.D. in December 1982.

One of the important results from our July 1980 (p,pn) experiments on ^{40}Ca and ^{48}Ca was the realization that we had the capability to study neutron "deep-hole states", i.e., the knockout of inner-shell neutrons in addition to valence neutrons. We therefore undertook a second (p,pn) project at the IUCF in January 1982. This experiment was a survey of the (p,pn) reaction on targets covering a broad range of A, namely ^{9}Be, ^{16}O, ^{28}Si, ^{58}Ni, and ^{90}Zr. This second (p,pn) experiment is the Ph.D. dissertation of KSU graduate student P. Pella. These measurements were made with a polarized beam in a fixed coplanar geometry with $\theta_n \sim \theta_p = 35°$. This geometry is optimally momentum-matched for neutron separation energies of about 30 MeV; in addition, the analyzing power signatures[3] for $j = \ell + 1/2$ and $j = \ell - 1/2$ states should be strong for this geometry.

Figure 1 shows triply differential cross sections and analyzing powers for the ^{16}O(p,pn)^{15}O reaction for knockout of $1p_{1/2}$, $1p_{3/2}$, and $1s_{1/2}$ neutrons. Figure 2 presents our analyzing power data for these three hole states. Also shown in Figs. 1 and 2 are Distorted-Wave Impulse-Approximation (DWIA) calculations made with the "THREEDEE" code of Chant et al.[4] These calculations utilize Elton and Swift wavefunctions,[5] Indiana global optical potentials,[6] and the free p-n t-matrix at the final state p-n rest energy. Spectroscopic factors 2, 4, and 2, respectively, were used for the DWIA calculations; these values are the full $(2j+1)$ allowed shell-model strengths. The shapes of the DWIA
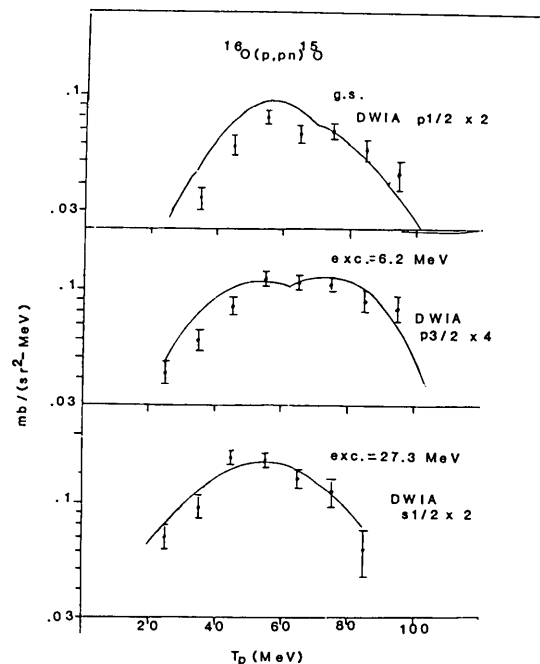

Figure 1. Triply differential cross sections for the ^{16}O(p,pn)^{15}O reaction at 150 MeV, for knockout of $1p_{1/2}$, $1p_{3/2}$, and $1s_{1/2}$ neutrons. The solid lines are Distorted-Wave Impulse-Approximation (DWIA) calculations normalized by spectroscopic factors of 2, 4, and 2, respectively, which are the full $(2j+1)$ allowed shell-model strengths.
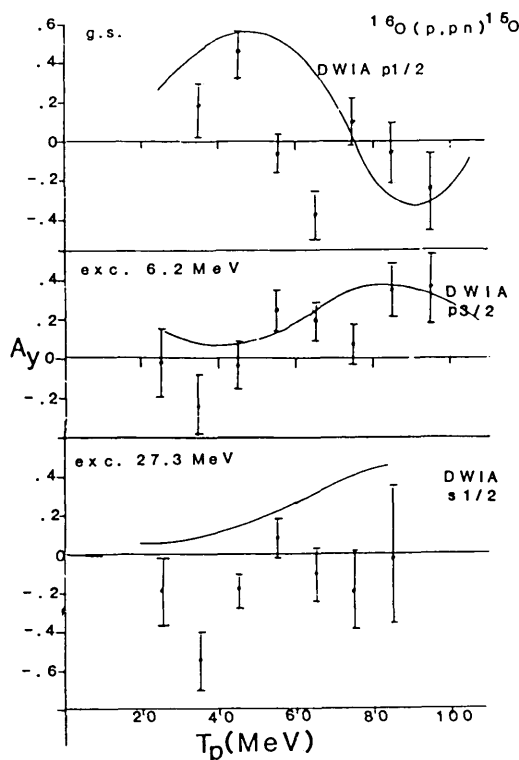
Figure 2. Analyzing powers for the $^{16}O(p,pn)^{15}O$ reaction at 150 MeV for knockout of $1p_{1/2}$, $1p_{3/2}$, and $1s_{1/2}$ neutrons. The solid lines are DWIA calculations.

cross sections are in good overall agreement with the data; the shapes of the DWIA analyzing powers are not. Although both the experimental and DWIA analyzing powers show strong j-signatures, as suggested by Jacob

et. al,[3] they are quite different. This result is in marked contrast to results from polarized (p,2p) experiments[7,8] where the DWIA calculations and the data appear to be in good agreement; it is quite possible, however, that part of the agreement between DWIA and experiment for (p,2p) reactions is imposed by the necessary symmetries resulting from detection of identical particles in a symmetric geometry.

Analysis of the data on the other targets is in progress.

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