THE (p,n) REACTION AT INTERMEDIATE ENERGIES WITH THE ISOTOPES OF OXYGEN (^{16}O, ^{17}O, ^{18}O) and ^{9}Be AS PART OF A UNIFIED APPROACH TO THE STUDY OF THESE NUCLEI

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We analyzed data obtained previously during an exploratory run at 119.8 MeV in an effort to extract information on the analog transitions for (p,n) reactions on ^{9}Be, ^{17}O and ^{18}O targets. Because the ^{18}O target contained 56% ^{16}O, and the ^{17}O target had 14% ^{16}O and 66% ^{18}O, the ^{18}O and ^{17}O spectra could be obtained only by performing large subtractions for the unwanted isotopes. Spectra to be obtained from newly available BeO targets will require only small corrections for the unwanted oxygen isotopes. The BeO^{17} target is 90% ^{17}O and the BeO^{18} target is 95% ^{18}O. The (p,n) measurements to be performed with these targets can be compared with similar (p,p') and (e,e') measurements being performed at Indiana and M.I.T. respectively. The comparisons are expected to resolve uncertainties associated with the nuclear structure of the A = 17 and A = 18 systems.

In addition to the comparison of (p,n) spectra with (p,p') and (e,e') spectra, these measurements are important also for studying analog and Gamow-Teller type transitions at intermediate energies. From our preliminary run, we obtained spectra for the analog transitions in $^{9}Be(p,n)^{9}B$, $^{17}O(p,n)$ $^{18}O(p,n)^{18}F$. As part of the experimental testing for another experiment, we obtained spectra also for the analog transition in $^{27}Al(p,n)^{27}Si$. The 1.5° energy spectra for $^{9}Be(p,n)^{9}B$ and $^{27}Al(p,n)^{27}Si$ at 120 MeV are shown in Fig. 1. Both spectra are dominated by the analog state peaks seen at 0 MeV of excitation in the residual nuclei. We extracted the angular distributions of these analog transitions and fit them with microscopic DWBA calculations[1] assuming central interactions

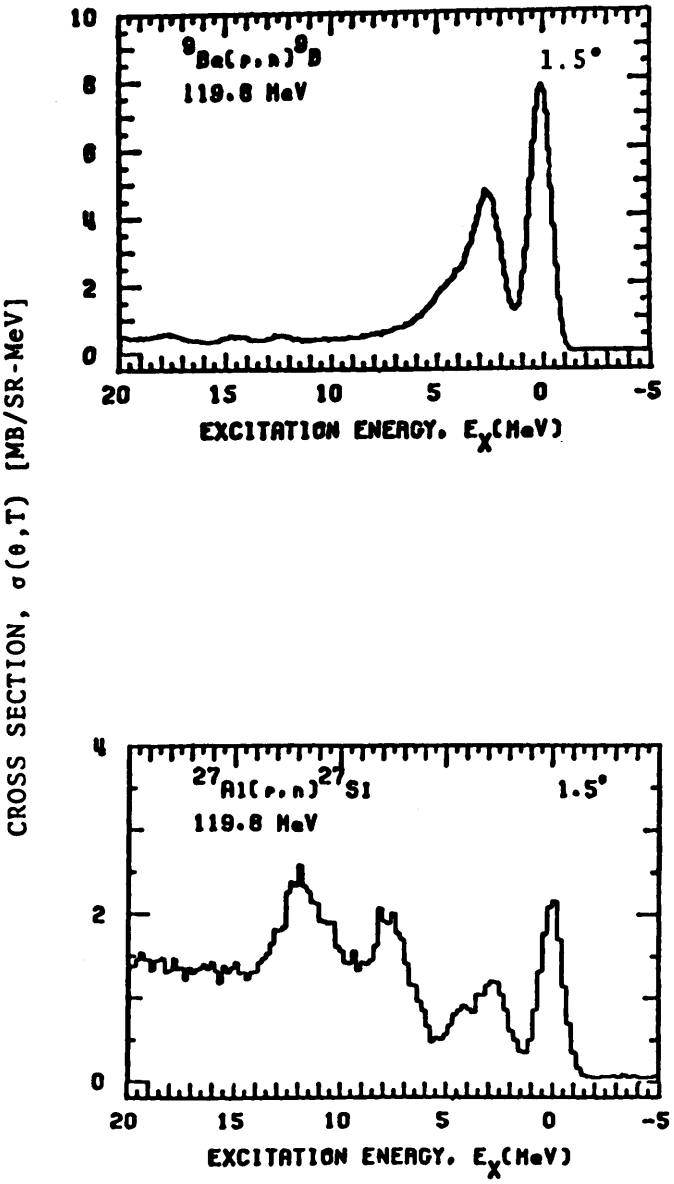

Figure 1. Neutron energy spectra for $^{9}Be(p,n)^{9}B$ and $^{27}Al(p,n)^{27}Si$.

only. The experimental calculated angular distributions are shown in Fig. 2 for $^{9}Be(p,n)^{9}B$ and in Fig. 3 for $^{27}Al(p,n)^{27}Si$. The agreement between the measured and theoretical curves is considered to be good.

Since the analog transition on a target nucleus with non-zero spin involves both Fermi (non-spin-flip) and Gamow-Teller (spin-flip) amplitudes,[2] it is im-

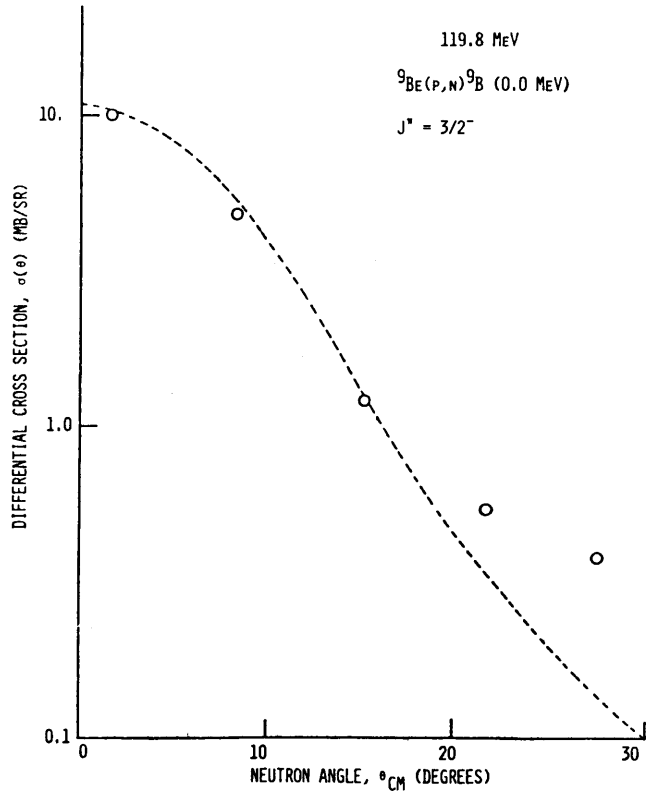

Figure 2. $^{9}Be(p,n)^{9}B$ angular distribution at 119.8 MeV. The dashed curve is a DWBA fit with central interactions only.

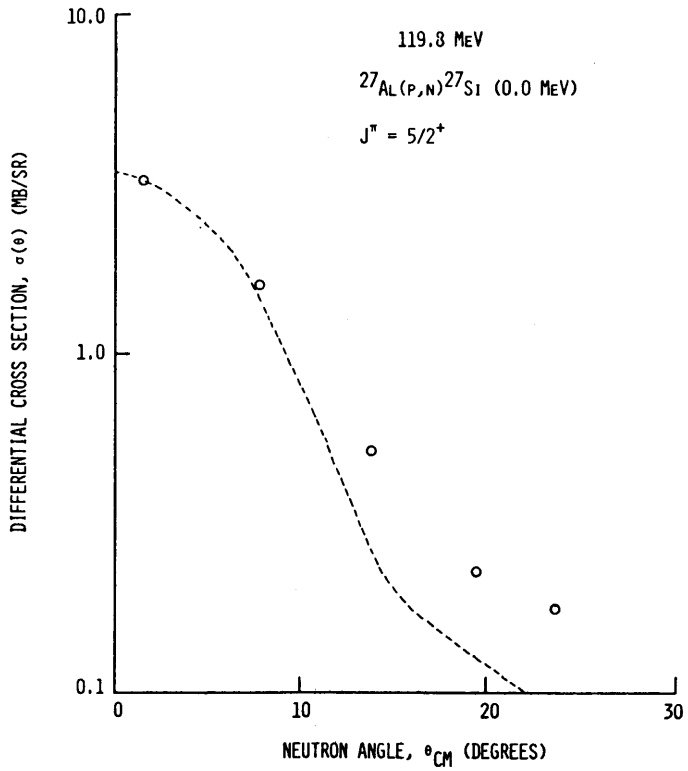

Figure 3. $^{27}Al(p,n)^{27}Si$ angular distribution at 119.8 MeV. The dashed curve is a DWBA fit with central interactions only.

portant also to study reactions in which only one type of transition is involved. Our measurements with self-conjugate nuclei provide separate information on the Gamow-Teller interaction because only the Gamow-Teller (spin-flip) transition can occur with self-conjugate nuclei. The analog (non-spin-flip) transition can be isolated in the $^{18}O(p,n)^{18}F$ reaction where both transitions occur but to separate final states. For the $^{18}O(p,n)^{18}F$ reaction, the analog transition proceeds to the 0^{+} state at 1.04 MeV in ^{18}F, and the Gamow-Teller transition proceeds to the 1^{+} ground state of ^{18}F. Unfortunately, these two states could not be resolved in our preliminary data.

It is interesting to note that the $^{18}O(p,n)^{18}F$ cross section to the unresolved ground state plus 1-MeV complex of states was approximately twice the cross section of the $^{17}O(p,n)^{17}F$ analog cross section in our prelininary data. This factor of two is to be expected because ^{18}O has twice the neutron excess of ^{17}O and because both the analog and Gamow-Teller amplitudes are involved with each target (to the same final state in ^{17}F and to two unresolved states in ^{18}F). The new measurements planned for this experiment will be performed with a longer flight path to achieve improved energy resolution. We expect to be able to resolve the analog and Gamow-Teller states in ^{18}F and thereby provide separate determinations of these strengths.

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1) DWUCK, P.D. Kunz, U. of Colorado, private communication.

2) J.D. Anderson, S.D. Bloom, C. Wong, W.F. Hornyak, and V.A. Madsen, Phys. Rev. 177, 1416 (1969).