THE $^{14}N(p,p')$ REACTION AT 159.4 MeV

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The QDDM magnetic spectrograph and a 159.4 MeV polarized proton beam have been used at the IUCF to measure differential cross sections and analyzing powers for the $^{14}N(p,p')^{14}N$ (g.s., 2.31-MeV and 3.95-MeV) transitions. The data span the angular range 7.5° (12.5°) $< \theta_{lab} <$ 45° for the elastic (inelastic) transitions in 2.5° steps. Absolute normalization of the differential cross sections has been determined from the measured thickness and known composition of the melamine ($C_3H_6N_6$) target. During the same run a graphite target was used to obtain data for the $^{12}C(p,p')^{12}C$ (g.s. and 4.44-MeV) transitions. The graphite-target data allow subtraction of the ^{12}C contribution to the melamine spectra (a problem only for the forward-angle elastic peak) and provide a check on the cross-section normalizations. The ^{12}C cross sections obtained using the nominal graphite and melamine target thicknesses agree to within 5%. A typical spectrum obtained at θ_{lab} = 27.5° is shown in Fig. 1.

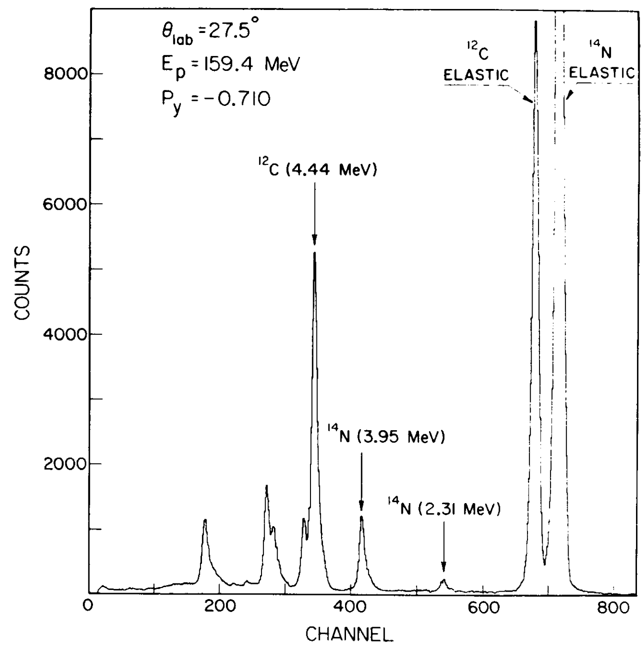

Figure 1. Spin-down proton spectrum obtained at θ_{lab} = 27.5° with a melamine target.

The differential cross section angular distributions for the transitions to the 2.31-MeV and 3.95-MeV states in ^{14}N (Fig. 2) are similar to those previously measured at 122 MeV.[1)] Analyzing powers for these transitions are shown in Fig. 3. For the 2.31-MeV state, $|A_y(\theta)| < 0.3$ and the shape resembles that for the 15.11-MeV transition in ^{12}C for momentum transfer q > 200 MeV/c. $A_y(\theta)$ for the 3.95-MeV state is quite similar to that of the 4.44-MeV transition in ^{12}C.[2)]

The 2.31-MeV transition involves spin-parity and isospin transfers of $\Delta J^\pi = 1^+$, $\Delta T = 1$. It is related through isospin invariance to the $^{14}C(p,n)^{14}N$ (g.s.) and $^{14}N(p,n)^{14}O$(g.s) reactions. A preliminary angular distribution for the $^{14}C(p,n)^{14}N$(g.s) reaction is shown in Fig. 2. The (p,n) data are discussed in more detail elsewhere in this report. Time-reversal and isospin invariance arguments predict that the $^{14}C(p,n)$ and $^{14}N(p,p')$ cross sections should be related by[3)]

$$\frac{d\sigma}{d\Omega}(p,n) = 6\,\frac{d\sigma}{d\Omega}(p,p')$$

The absolute normalization at the (p,n) data in Fig. 2 is at present uncertain and has been adjusted to reflect the above relationship. Note that there is excellent agreement in shape between the angular distributions.

The (p,p') and (p,n) transitions between the ^{14}N ground state and the 0^+, T=1 ^{14}C(g.s.), ^{14}N(2.31-MeV), and ^{14}O(g.s) levels have been used as tests of tensor-force strength in the microscopic effective interaction.[1,3,4,5,6] The L=0 central-force contribution to the direct transition amplitudes for these reactions is suppressed in a manner analogous to the well-known retardation of the ^{14}C Gamow-Teller β-decay rate.[4] Microscopic distorted-wave calculations have met with mixed success in fitting differential cross sections for these transitions, with the best fits being obtained for $E_p < 40$ MeV.[3,5] DWIA calculations for comparison with the present data are under way.

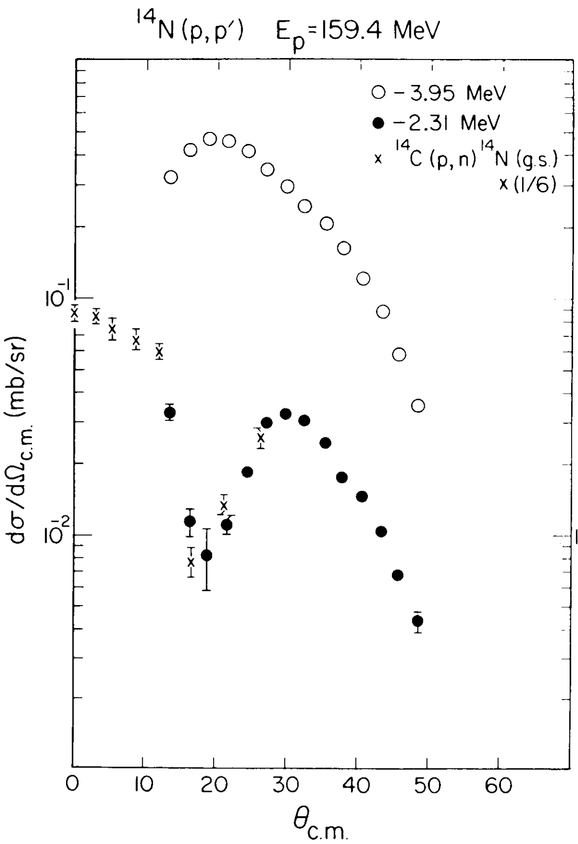

Figure 2. Differential cross sections for the transitions to the 2.31-MeV and 3.95-MeV states in ^{14}N. The ^{14}C(p,n) ^{14}N(g.s.) points are from a preliminary analysis of data obtained by Goodman et al. (see contribution, this report).

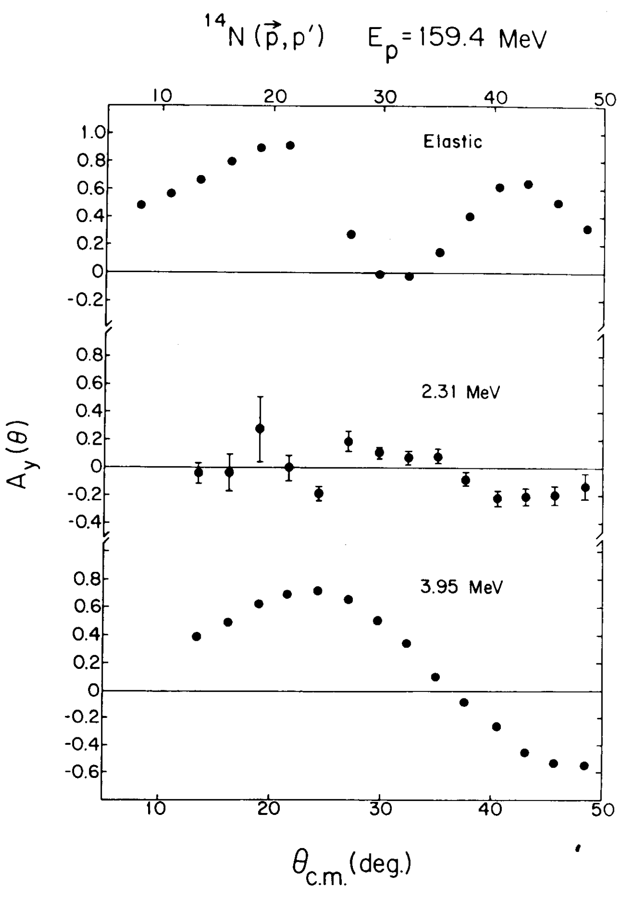

Figure 3. Analyzing powers for the transitions to the ground state and first two excited states in ^{14}N.

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ANALYZING POWERS FOR THE PROTON EXCITATION OF HIGH-SPIN STATES IN ^{28}Si: A NEW LOOK AT THE EFFECTIVE INTERACTION

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One of the outstanding new features of inelastic proton scattering at intermediate energies has been the observation of high-spin states of simple structure, that are excited primarily through the non-central components of the effective nucleon-nucleon interaction.[1-6] In the present work, analyzing powers $A_y(\theta)$ have been measured for 135 MeV $(\vec{p},p')$ excitation of the 5^-, T=0 (9.70 MeV), 6^-, T=0 (11.58 MeV), and 6^-, T=1 (14.35 MeV) states in ^{28}Si. Differential cross sections for transitions of this nature have provided definitive information on the strength of the high-momentum components of the non-central parts of the effective interaction,[4-6] and generally confirm the validity of the impulse approximation.[7]

For the three states of interest, the differential cross sections, analyzing powers, and their products are shown from top to bottom in Figs. 1 and 2. While the shapes of the cross-section angular distributions are quite similar, the analyzing-power angular distributions are distinctly different and provide a definite signature of the spin and isospin transfer for each transition. The curves in Figs. 1 and 2 are the result of distorted-wave impulse approximation (DWIA) calculations. These calculations used the complex central and real spin-orbit components of the two-nucleon t-matrix interaction[8] supplemented by a real tensor interaction.[9,10] The imaginary parts of t^{LS} and t^{T}, which have been neglected, are small.[8] Optical-model parameters were taken from Schwandt