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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Preliminary work on this project was described last year. During the past year a second detector station was commissioned for the beam swinger facility, which can be used for measurements at laboratory angles between 24° and 48°. With a flight of 76 m, we achieved an energy resolution of about 350 keV for 80 MeV neutrons from the $^{16}O(p,n)^{16}F$ reaction at 99 MeV with the 49 mg/cm^2 $^{9}Be^{16}O$ target contributing about 310 keV. With a thinner 23 mg/cm^2 ^{12}C target, we achieved an energy resolution of 230 keV for 80 MeV neutrons from the $^{12}C(p,n)^{12}N$ reaction. This resolution is better than anticipated when this project was approved; we need to be able to clearly separate the ground and first-excited states of ^{17}F which are 500 keV apart. Further work awaits the construction of a third detector station for measurements at laboratory angles between 48° and 72° in order to achieve the momentum transfer up to 3 fm^{-1} needed for this project.

THE ^{27}Al, ^{40}Ca AND $^{48}Ca(p,n)$ REACTIONS AT 160 MeV

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We obtained some data in October 1979 on coherent and incoherent neutron production in the 160 MeV (p,n) reaction on nuclei with one excess neutron (^{27}Al), many excess neutrons (^{48}Ca), and no excess neutrons (^{40}Ca). For a coherent process, the scattering amplitudes from different nucleons are summed; whereas for an incoherent process, the squares of the amplitudes are summed. Neutron production will be studied in order to look for a predicted suppression at forward angles (within an angular region of the order of λ/R) in the cross section for an incoherent process, an expected suppression (outside of this angular region) in the cross section for a coherent process, and information on the relative amounts of coherent and incoherent neutron production in the region of the giant resonances.

The neutron spectra from intermediate-energy (p,n) reactions on nuclei with excess neutrons can be regarded to consist of the ground state (and other low-lying individual nuclear states), and giant-resonance and continuum regions. The excitation of the giant resonance is always a coherent process and the excitation of the continuum is always an incoherent process. The ground-state transition is an incoherent process for a target with one excess neutron and a coherent process for a target with many

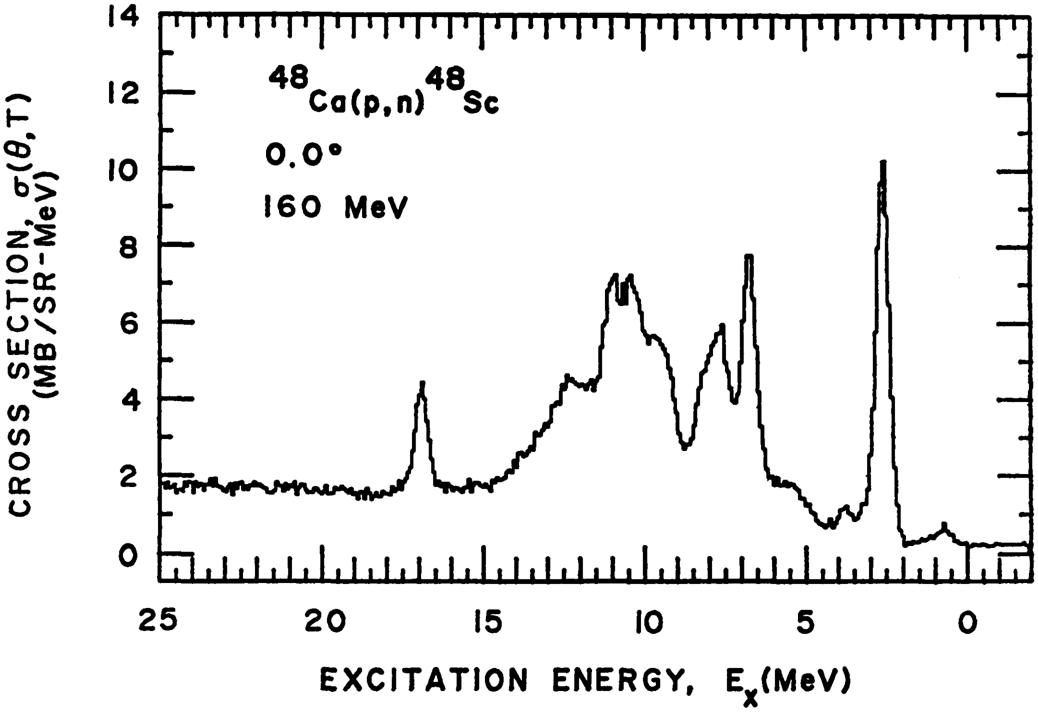

Figure 1. The neutron energy spectrum at a laboratory angle of 0° from the $^{48}Ca(p,n)^{48}Sc$ reaction at 160 MeV.

excess neutrons. Both intranuclear-cascade-model calculations[1] and Glauber-model calculations[2] have predicted the existence of a dip in the forward direction for incoherent processes. The existence of such a dip in the forward direction for incoherent scattering is not tied to the validity of any particular theory, but is expected from simple kinematics and the Pauli exclusion principle.

We examined data for discrete states excited in the 160 MeV (p,n) reaction on ^{27}Al, ^{40}Ca and ^{48}Ca. For these transitions the structure of the angular distributions near 0° appears to be dominated by the angular momentum transfers involved, and coherence and incoherence effects are apparently minor in comparison. Currently we are examining the giant resonance and continuum regions of our spectra for such effects. For the analysis of the continuum, it is important that all sources of background, especially cosmic rays and overlapping neutrons from earlier beam bursts, be removed from our time-of-flight spectra.

In the $^{48}Ca(p,n)^{48}Sc$ data, we observed a prominent narrow peak 240 ± 40 keV wide at an excitation energy of 16.8 ± 0.1 MeV. Figure 1 shows the 0° spectrum of neutrons obtained with a 0.52 m^2 x 10 cm thick detector array at a 68 m flight path. An energy resolution of 450 keV was obtained for the 157 MeV neutrons in the isobaric analog peak at 2.52 MeV excitation. The 16.8 MeV peak is seen very clearly. We interpret this peak as the T=4 component of a $(\pi f_{5/2}, \nu f^{-1}_{7/2})_{1^+}$ excitation and find that it carries a large fraction of the $T_>$ Gamow-Teller (GT) strength. This state is much narrower than a similar $T_>$ GT state reported in ^{90}Nb by Galonsky et al.[3] An abstract on our 160 MeV ^{48}Ca(p,n) work was submitted to the American Physical Society for presentation at the April 1980 meeting in Washington, D.C.

1) H.W. Bertini, Second Symposium on Protection Against Radiation in Space, Gatlinberg, TN, NASA SP-71.

2) R.J. Glauber, High-Energy Physics and Nuclear Structure, ed. S. Devons (Plenum Press, 1970), p. 261.

3) A. Galonsky et al., Phys. Lett. 74B, 176 (1978).