INVESTIGATION OF GAMOW-TELLER STRENGTH FROM THE $^{41}Ca(p,n)^{41}Sc$ REACTION

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The nuclei ^{41}Ca and ^{41}Sc have especially simple descriptions in the nuclear shell model. They are, respectively, a single neutron outside a core that is saturated for both ls and jj coupling single particle states, and a single proton outside that core. Since all allowed beta decay transitions for the core nucleons are Pauli blocked, the beta decay transition from the ground state of ^{41}Sc to the ground state of ^{41}Ca should be a single-nucleon transition. The measured ft value indicates that the strength of the Gamow-Teller component of this decay is only 58% of the value required by the model. This fact has been recognized as a serious problem for the shell model.

We have investigated the transitions from ^{41}Ca to the spectrum of states in ^{41}Sc with the (p,n) reaction. Since ^{41}Ca is radioactive, the target material has to be produced artificially. A quantity of $CaCO_3$ enriched to 85% ± 1% ^{41}Ca was obtained by our Oak Ridge collaborator, and a target was prepared by Bill Lozowski of IUCF in the form of a pressed wafer of $CaCO_3$, 33.7 mg/cm^2 covered with gold foils of 2.5 mg/cm^2. For subtraction of the CO_3 component a similar $^{40}CaCO_3$ target was prepared along with a number of ^{nat}C, ^{40}Ca, and Au targets. Angular distributions were measured using the stripper loop at 120 and 160 MeV for angles between 0° and 10° (lab).

A (p,n) spectrum taken at zero degrees is shown in Fig. 1. This spectrum was obtained by subtracting the spectrum from a $^{40}CaCO_3$ target from the $^{41}CaCO_3$ spectrum, normalized to the strong ground state transition from ^{12}C. The region where the f 5/2 single particle strength is expected is indicated on the figure. At slightly lower neutron energies the fluctuations are artifacts of the subtraction of the sharp peaks from carbon and oxygen. The ^{40}Ca spectrum is oversubtracted due to the difference in the ^{40}Ca to ^{12}C ratio in the two targets.

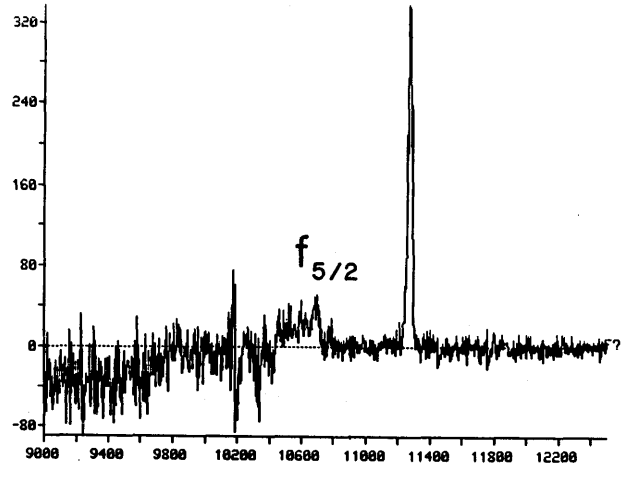

Figure 1. Neutron spectrum from $^{41}Ca(p,n)^{41}Sc$. The target was $CaCO_3$ enriched to 85% ^{41}Ca. The spectrum from a $^{40}CaCO_3$ target has been subtracted. The oscillations around E_n=102 are artifacts of the subtraction of the sharp peaks from ^{12}C and ^{40}Ca. The ^{40}Ca is oversubtracted because of its higher abundance in the $^{40}CaCO_3$ target relative to ^{12}C. The region labelled $f_{5/2}$ is where the $f_{5/2}$ single hole state should appear.

It is apparent that the $f_{5/2}$ particle strength is fragmented and may extend into the region where the subtraction effects are severe. The quantitative extracton of the $f_{5/2}$ strength awaits a careful evaluation of the subtraction uncertainties.

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MEASUREMENTS OF $^{17,18}O(p,n)$

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In an effort to increase our understanding of the distribution of Gamow-Teller (GT) strength and to try to shed light on the missing strength problem we are trying to study nuclei for which the shell model space in a first order calculation is so small that all the expected levels can be easily counted. We wish to scan the excitation region where these levels lie as well as the region somewhat above it under experimental conditions that put as little non-GT background in the spectrum as possible. The exploration of $^{17}O(p,n)$ and $^{18}O(p,n)$ meet the shell model criteria, but oxide targets put background in the region of interest from the other chemical ingredient and with gas targets the ratio of window nuclei to gas nuclei is unfavorable, especially for targets suitable for use in the beam swinger.

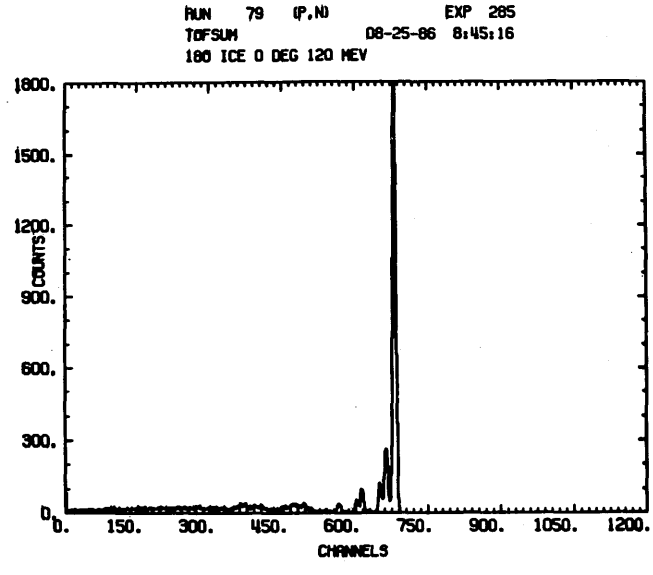

Figure 1. $^{18}O(p,n)$ time-of-flight spectrum. This is raw data with no background subtracted.