PROGRESS REPORT ON E356

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The Gamow-Teller strength function for $^{37}$Cl $\rightarrow$ $^{37}$Ar has received considerable attention over many years because $^{37}$Cl is the nucleus used as the neutrino detector in the Homestake Mine experiment that revealed the so-called "solar neutrino problem."

About thirteen years ago at IUCF we measured $^{37}$Cl(p,n)$^{37}$Ar (Ref. 1). The distribution of Gamow-Teller strength as measured in the (p,n) experiment seemed to disagree somewhat with that reported from a measurement of the spectrum of protons emitted from $^{37}$K following the beta decay of $^{37}$Ca $\rightarrow$ $^{37}$K (Ref. 2). $^{37}$Ca is the isospin mirror of $^{37}$Cl, and to the accuracy of isospin conservation, the GT strength function for that beta decay should be the same as that for $^{37}$Cl $\rightarrow$ $^{37}$Ar.

Haxton and Adelberger pointed out that the discrepancy could be understood if not all of the proton emission from $^{37}$K fed the ground state of $^{36}$Ar (Ref. 3). This led García, *et al.*,[4] to remeasure the beta-delayed proton spectrum with the addition of a gamma detector in coincidence with the proton detector.

The GT strength function deduced from the new delayed proton experiment showed that the conjecture of Haxton and Adelberger was correct, but new mismatches between the Gamow-Teller strength distributions deduced from the beta-delayed protons and from (p,n) showed up. With this background the present experiment was undertaken.

This new (p,n) experiment achieved much improved resolution, about 230 keV (FWHM), compared to about 600 keV (FWHM) in the older experiment. Data were taken with 100-MeV protons and with 160-MeV protons. The target material was $^{40}$Ca$^{37}$Cl$_2$. Since the target material was converted from isotopically enriched NaCl, and the (p,n) Q-value for $^{23}$Na(p,n)$^{23}$Mg coincided within the resolution to one of the levels where a major disagreement occurs between the beta-delayed proton experiment and the (p,n) experiment, data were also taken for $^{23}$Na(p,n)$^{23}$Mg.

Fig. 1 shows the $^{37}$Cl(p,n) spectrum in the excitation energy region below the IAS where level assignments can be found in Endt,[5] and a level by level comparison between the (p,n) strengths and the GT strengths reported by García, *et al.*,[4] can be made. All of the levels with spin-parity assignments corresponding to allowed GT transitions can be seen in the (p,n) spectrum. The results are summarized in Table I. Comparison of the 100-MeV

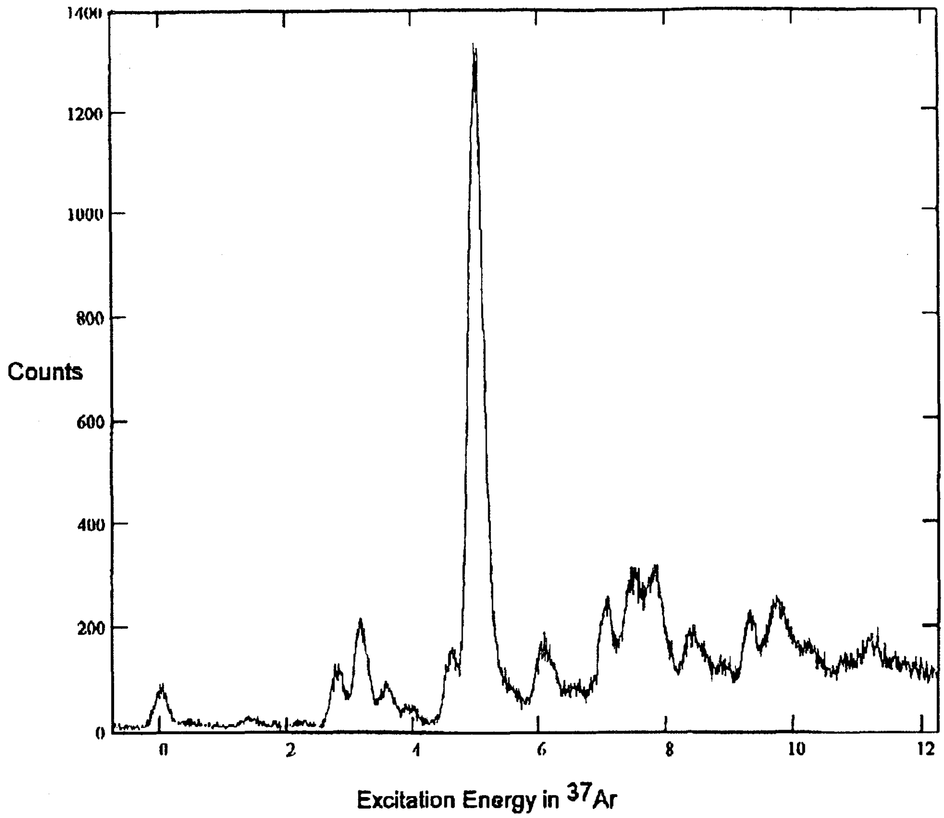


*Figure 1.* Spectrum for $^{37}Cl(p,n)^{37}Ar$ at 0° and $E_p$=100 MeV. Thes are raw data. The time of flight has been transformed to excitation energy in $^{37}Ar$, but no background has been subtracted and no corrections have been applied.

and the 160-MeV (p,n) spectra indicate that the $(q,\omega)$ correction needed to extract B(GT) values from the (p,n) cross section is larger for the 100-MeV data than that predicted from DWIA calculations using parameters that we have previously used for 120-MeV and 160-MeV data.[6] This effect is under investigation, and we caution the reader that some adjustments in the B(GT) values in Table I might be made prior to final publication.

Referring to Table I, two prominent discrepancies can be noticed: The level at 3.17-MeV is strongly excited in the (p,n) reaction, but its analog is only weakly seen in the delayed proton experiment, and the level at 1.41-MeV is excited only weakly in the (p,n) reaction, while García, *et al.*, attribute considerable GT strength to its analog. Some differences are to be expected due to imperfect isospin symmetry, but these discrepancies are too large to attribute to that cause.

These discrepancies can, however, be understood as follows: The level at 3.17-MeV has a very small proton decay width. It was not seen as a proton capture resonance on $^{36}Ar$ (Ref. 7), and its proton to gamma width ratio has recently been measured.[8] Since the primary decay mode of that level is by gamma emission, its full GT strength was not seen in the García experiment. The GT strength for the analog of the 1.41-MeV level was not measured directly by García, *et al.*, but was deduced by the requirement that the sum of all decay branches equal the total decay rate. The strength missed in the 3.17-MeV level would be attributed to the unmeasured 1.37-MeV level in $^{37}K$ (analog of the 1.41-MeV level in $^{37}Ar$).

The $^{23}Na(p,n)^{23}Mg$ data provides considerable new information on the A=23 system and is being written up for separate publication.[9] Fig. 2 shows the zero-degree spectrum.

Special thanks are due to Bill Lozowski for making a sodium free $CaCl_2$ target and a rolled, pure metal sodium target.

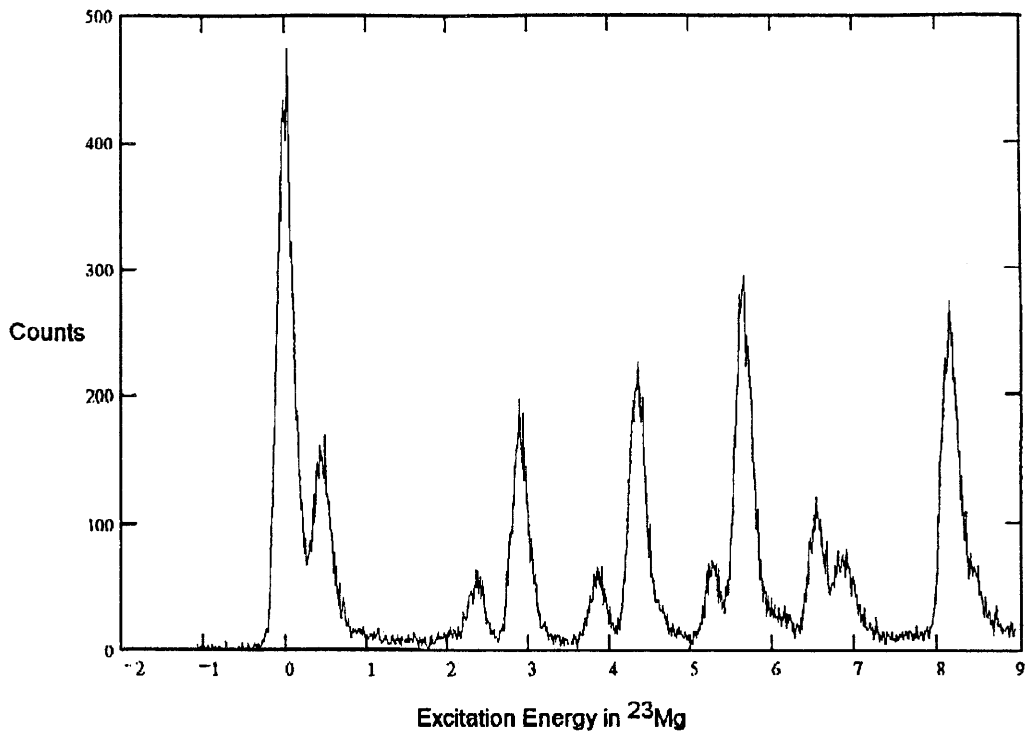


*Figure 2.* Spectrum for $^{23}Na(p,n)^{23}Mg$ at 0° and $E_p$=100 MeV. These are raw data. The time of flight has been transformed to excitation energy in $^{23}Mg$, but no background has been subtracted and no corrections have been applied.

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Table I.

| Delayed Protons | | (p,n) | | Endt | |
|---|---|---|---|---|---|
| $E_x(^{37}K)$ | B(GT) | $E_x(^{37}Ar)$ | B(GT) | $E_x(^{37}Ar)$ | spin-parity |
| 0.000 | 0.0304* | 0.000 | 0.0308* | 0.000 | 3/2+ |
| 1.371 | 0.0409 | 1.404 | 0.0077 | 1.410 | 1/2+ |
| 2.750 | 0.0434 | 2.791 | 0.0496 | 2.796 | 5/2+ |
| 3.239 | 0.0025 | 3.166 | 0.0898 | 3.171 | 5/2+ |
| 3.622 | 0.0478 | 3.576 | 0.0257 | 3.602 | 3/2+ |
| 3.840 | 0.0604 | 3.937 | 0.0140 | 3.937 | 3/2+ |

*Not measured. Normalized to beta decay.