GAMOW-TELLER STRENGTH DISTRIBUTION FOR $^{37}Cl(p,n)^{37}Ar$

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A new measurement of $^{37}Cl(p,n)^{37}Ar$ (Exp. 356) has been made with better energy resolution and lower background than a previous measurement[3] in order to resolve some questions about the Gamow-Teller strength function for transitions from the ground state of ^{37}Cl. This GT strength function has been of special interest because ^{37}Cl is the nucleus used for detection of neutrinos in the Homestake Mine neutrino detector that disclosed the solar neutrino problem.[1]

The GT strength distribution deduced from the previous measurement was somewhat inconsistent with that deduced from a measurement of delayed protons from $^{37}Ca(\beta)^{37}K \rightarrow ^{36}Ar + p$ (Ref. 2), where $^{37}Ca \rightarrow ^{37}K$ is the isospin mirror of $^{37}Cl \rightarrow ^{37}Ar$. The discrepancy was thought to be due to proton emission leaving ^{36}Ar in an excited state which was not taken into account.[4] A new delayed proton experiment[5] measured p-γ coincidences in an effort to resolve that problem. The GT strength function deduced from the new delayed proton measurement[5] was also not completely consistent with the (p,n) measurement. A particularly large discrepancy appeared near $E_x = 3$ MeV. This region, by chance, corresponds in Q-value to the ground state transition of $^{23}Na(p,n)^{23}Mg$, and, since the separated isotope ^{37}Cl was obtained as NaCl, it seemed plausible that some of the (p,n) cross section might be due to $^{23}Na(p,n)^{23}Mg$ from a trace of sodium that remained in the target.

For the new (p,n) experiment the enriched $Na^{37}Cl$ was converted to $CaCl_2$ with Ca enriched to > 99.9 % ^{40}Ca. The Q-value for $^{40}Ca(p,n)$, -15.25 MeV, is sufficiently more negative than that for $^{37}Cl(p,n)$, -1.60 MeV, to provide a large window with no contribution to the spectrum. In a separate experiment the spectrum of elastically scattered protons was measured in the K600 spectrometer, and it was found that the Na atomic content was $< 0.1\%$. This was also confirmed by chemical analyses.

The (p,n) experiment was performed in the IUCF Swinger facility with a flight path of 130 m, a proton energy of 98 MeV, and a proton pulse separation of 2.89 microseconds,

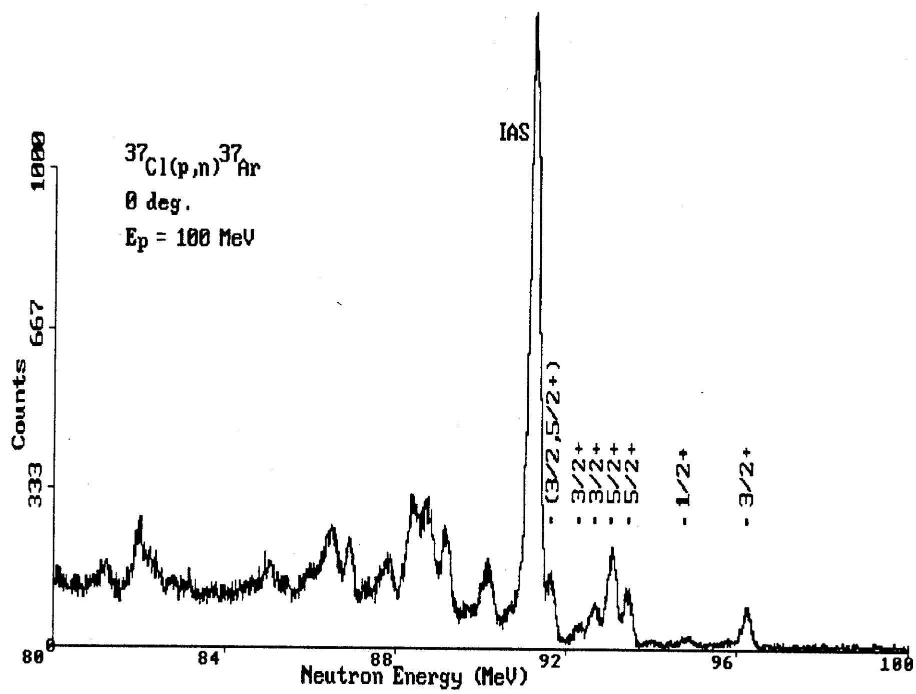

Figure 1. Neutron energy spectrum from ^{37}Cl(p,n)^{37}Ar at 0° and proton energy 98 MeV. The spin and parity identifications mark the expected positions of levels for allowed GT transitions according to the level scheme given in Ref. 6.

achieved with the use of the stripper loop. The time of flight of the neutrons of interest is about 1 μs. With this arrangement there is no noticeable background from frame overlap, as can be seen in the spectra which have no background subtracted.

The energy resolution, about 250 keV, is sufficient to resolve most of the known states below the IAS with spin-parity assignments of $1/2^+$, $3/2^+$, and $5/2^+$ reported in the energy-level compilation[6] that might be excited through GT transitions. The positions of these levels are indicated in Fig. 1 which shows a 0° neutron spectrum.

The most obvious differences between this spectrum and that from the new delayed proton experiment[5] concern the first $1/2^+$ level and the second $5/2^+$ level. It is now thought that GT strength is missed in the delayed proton experiment for the second $5/2^+$ level, because that level in ^{37}K has a very small proton width for decay to ^{36}Ar, and it decays mainly by γ emission.[7] This can also explain the apparent difference for the first $1/2^+$ level. Since the GT strength ascribed to that $1/2^+$ level was the residual strength required to make the branching ratios sum to unity, any strength missed from the upper $5/2^+$ level would be ascribed to the lower $1/2^+$ level.

Because of the conjectured problem with sodium in the target, ^{23}Na(p,n)^{23}Mg was also measured. The 0° spectrum is shown in Fig. 2. This contains new information on the levels in ^{23}Mg, and these data will be published in a separate paper.

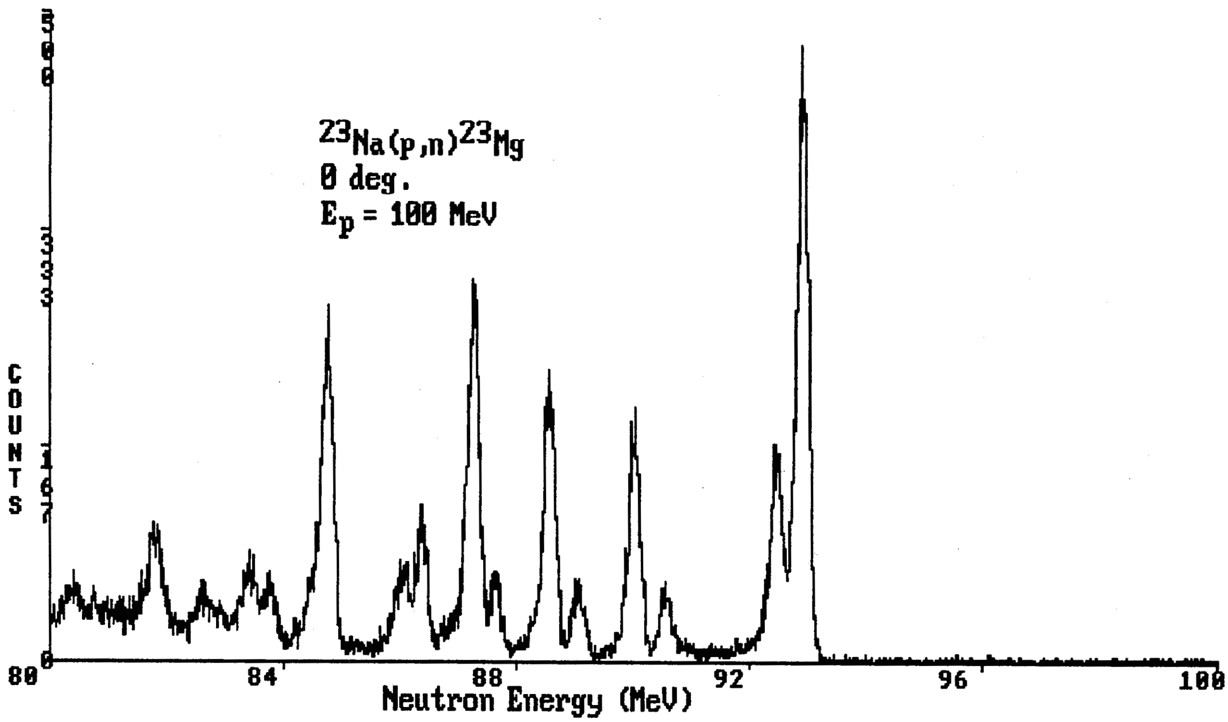

Figure 2. Neutron energy spectrum from $^{23}Na(p,n)^{23}Mg$.

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