WEAK INTERACTION MATRIX ELEMENTS AND (p,n) CROSS SECTIONS

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The purpose of experiment 320 is to investigate the relationship between the forward angle (p,n) cross sections and GT (Gamow-Teller) and F (Fermi) beta decay matrix elements and to use such a relationship to determine matrix elements relevant to the capture cross section of neutrino detectors. Our initial measurements at 160 MeV reported last year suggested that the ratio $R^2 = \hat{\sigma}_{GT}/\hat{\sigma}_F$ for medium-to-heavy odd-mass nuclei had a value consistently higher than anticipated from the systematics of previous studies based primarily on even-mass nuclei.[1] The dependence of R on the proton beam energy E_p for the latter nuclei has been successfully represented by R $= E_p/E_o$, where E_o is constant at a value of 55 MeV. We have continued these studies with measurements at $E_p = 120$ MeV and a neutron flight path of 121 m using the stripper loop to obtain large pulse separation to minimize the background from low-energy "wraparound" neutrons. In addition we have measured at 120 MeV the forward-angle cross sections on additional targets related to neutrino detection.

We report extension of experiment 320 to an additional energy and greater precision. Targets of ^{51}V, ^{87}Rb, ^{113}In, ^{118}Sn and ^{141}Pr have again been studied, as they provide transitions with known GT strength from beta decay which can be resolved from nearby GT transitions within the limits of our energy resolution. We measured (p,n) spectra at $E_p = 120$ MeV and at 0°, 3.0° and 6.0°. The angular distribution of the differential cross sections is used to estimate the size of $\Delta L > 0$ contributions at 0°. Such $\Delta L > 0$ contributions were found to be small and were neglected. The extracted E_o value of 43 ± 2 MeV at $E_p = 120$ MeV is consistent with that obtained previously at 160 MeV, indicating no significant energy-dependence in the small value of E_o for these odd-mass nuclei. The E_o extracted from the ^{118}Sn data, measured under the same conditions as the odd-mass nuclei, is again consistent with the even-mass value of $E_o = 55$ MeV. The experimental situation associated with the value of E_o for medium-to-heavy odd-mass is presented in Fig. 1. The cause of the smaller E_o value for odd-mass nuclei is not understood and shall be the subject of further investigation.

By scaling the B(GT) strengths obtained from lower-mass nuclei, Haxton recently suggested that a solar neutrino detector using the $^{127}\mathrm{I}(\mu, e)^{127}\mathrm{Xe}$ reaction might be an order of magnitude more efficient than the present ^{37}Cl detector.[2] We measured the 0° cross section and converted it to a B(GT) spectrum using the techniques described by Taddeucci,

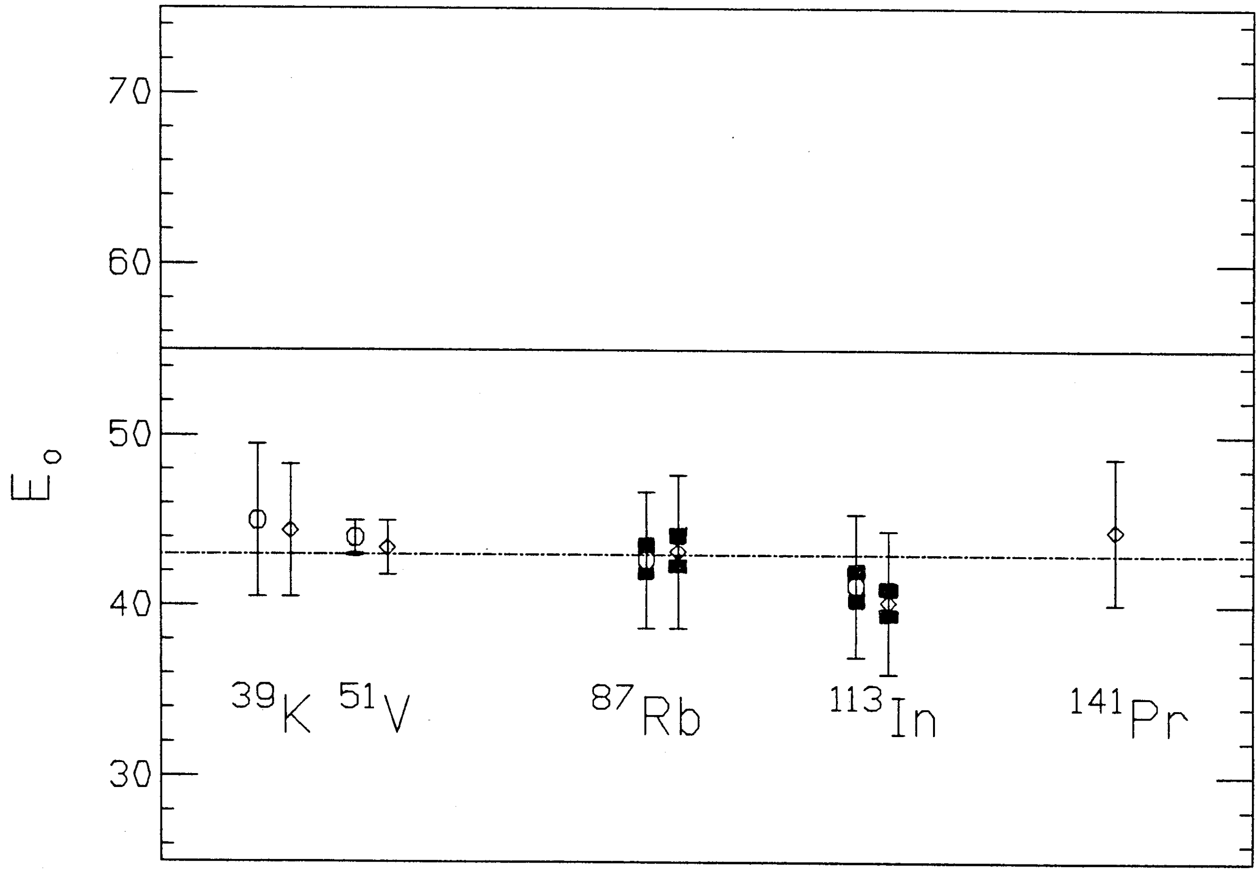

Figure 1. The E_o for medium- to-heavy odd-mass nuclei ($A \geq 39$). The open circles are the E_o from $E_p = 120$ MeV and the diamond symbols from $E_p = 160$ MeV. The E_o for Targets of ^{51}V, ^{87}Rb, ^{113}In, and ^{141}Pr are extracted from 0°(p,n) spectra. The E_o for ^{39}K are extracted from D_{NN} measurement reported in Ref. 7. The solid line refers the $E_o = 55$ MeV and the dot-dashed line indicates the average value of these data points here. The length of the thick black bars on ^{87}Rb and ^{113}In data points indicates the uncertainties if one does not consider the uncertainties contributed by B(GT).

et al.[1] The result for the region below the particle emission threshold (PET) is shown in Fig. 2. Using an $E_o = 50$ MeV to normalize the GT strength against the N$-$Z Fermi strength located in the IAS resonance, the integrated GT strength below the PET is 3.5, with as much as a $\pm$20% uncertainty due to the above mentioned present difficulty establishing the appropriate value of E_o for this odd-mass nucleus. With a resolution of about 300 keV, we were not able to resolve the lowest lying GT transitions recently identified.[3] However, a fit to the low-excitation region of the B(GT) spectrum constrained to these transitions suggests approximate values of 10 and 17 mB(GT) associated with the regions centered at 125 and 350 keV, respectively. The observed B(GT) strength

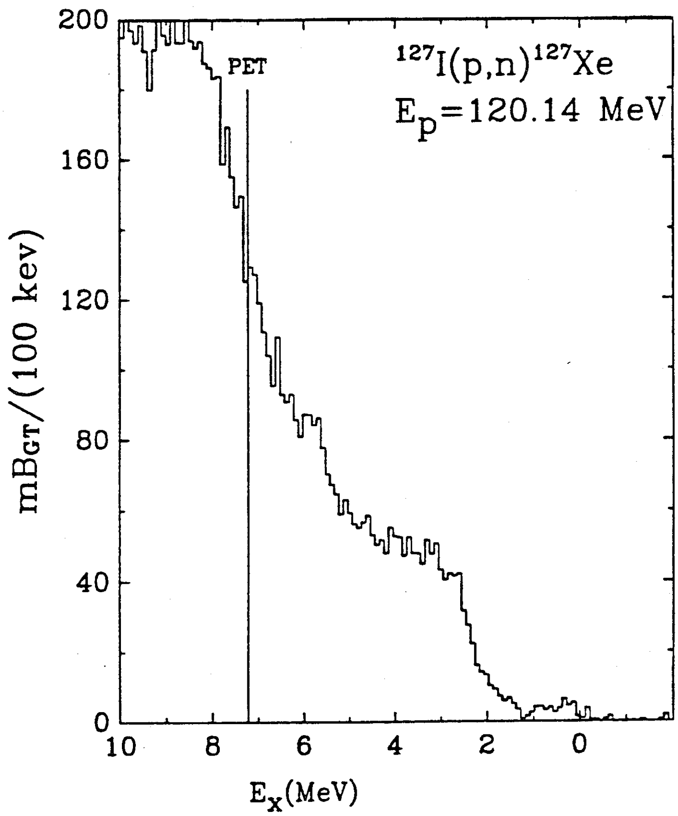

Figure 2. The B(GT) spectrum of ^{127}Xe below the particle emission threshold (PET) extracted from the 0° (p,n) cross sections measured at 120 MeV. A value of $E_o = 50$ MeV was assumed.

distribution is significantly lower than that estimated by Haxton, suggesting that the response of such a detector would not differ much from that of the present ^{37}Cl detector.

Zero-degree (p,n) cross section measurements were also made for targets of ^{69}Ga and ^{97}Mo, with comparison spectra obtained for previously studied targets of ^{71}Ga and ^{98}Mo.[4,5] In each case the prior nuclei are significant "contaminants" in current solar neutrino experiments utilizing the latter nuclei. Knowledge of the B(GT) spectrum for the prior nuclei may assist in understanding the contribution of galactic neutrinos to the signal obtained in these detectors.[6]

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