Table I.
Laboratory cross sections for producing 6^+ ^{13}C recoils from the $^{12}C(p,\pi^+)^{13}C$ reaction (high momentum branch – see Fig. 1)

Target Thickness $\mu g/cm^2$	Cross Section $\mu b/sr$
46	11.6 ± 1.2
20	12.4 ± 1.5
5.4	10.5 ± 1.8

POLARIZATION TRANSFER IN ^{19}F AND ^{39}K(p,n)

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The nuclei ^{19}F and ^{39}K play unusually important roles in the saga of the missing GT strength. According to the shell model ^{39}K has a very simple structure – a single $d_{3/2}$ hole in the doubly magic ^{40}Ca core. However, it has been know for many years that the beta decay transition rate from ^{39}Ca to ^{39}K is significantly slower than the value that is uniquely specified by that simple structure model. The interpretation given to that fact is that the Gamow-Teller component of the decay is quenched to about 45% of the shell model value.

The transition rate from ^{19}Ne to ^{19}F, on the other hand, in the absence of any other information, might not seem anomalous, because the model of three particles outside a doubly magic closed shell allows enough uncertainty to accomodate it. However, we have previously measured $^{19}F(p,n)^{19}Ne$ and shown that essentially all of the GT strength up to at least 15 MeV of excitation is in the ground state transition, leading to the conclusion that the GT strength is quenched to about 66% of the shell model value.[1] The fact that almost all of the GT strength is in the isospin mirror transition also demonstrated that this nucleus has a special structure symmetry.

Our previous measurement of ^{39}K(p,n)^{39}Ca showed that the GT strength in excited state transitions is very much smaller than expected.[1]

A problem that pervades all (p,n) studies of odd-mass nuclei is that the IAS transition that contains all of the Fermi strength may also contain some GT strength. The GT strength is usually unknown except as can be deduced from (p,n) measurements. In the cases of ^{19}F and ^{39}K, however, the measured beta decay tells us what the mixture should be. Thus it is possible to use these nuclei to test our assumptions about the interaction strengths for the two components. What is needed is a method of disentangling the Fermi and GT strengths that does not depend on our deductions from (p,n) on even-mass nuclei. Measurements of the polarization transfer coefficient, D_{nn}, can tell us the relative weighting for the two components in a mixed transition.

Measurements have been made with a polarimeter consisting of our reworked neutron detectors (see another section in this annual report). The beam polarization was about 75%. The polarimeter was calibrated with ^{14}C(p,n)^{14}N $0^+ \rightarrow 0^+$. Preliminary analysis of the data using on-line analysis cuts yielded an effective analyzing power >0.3, consistent

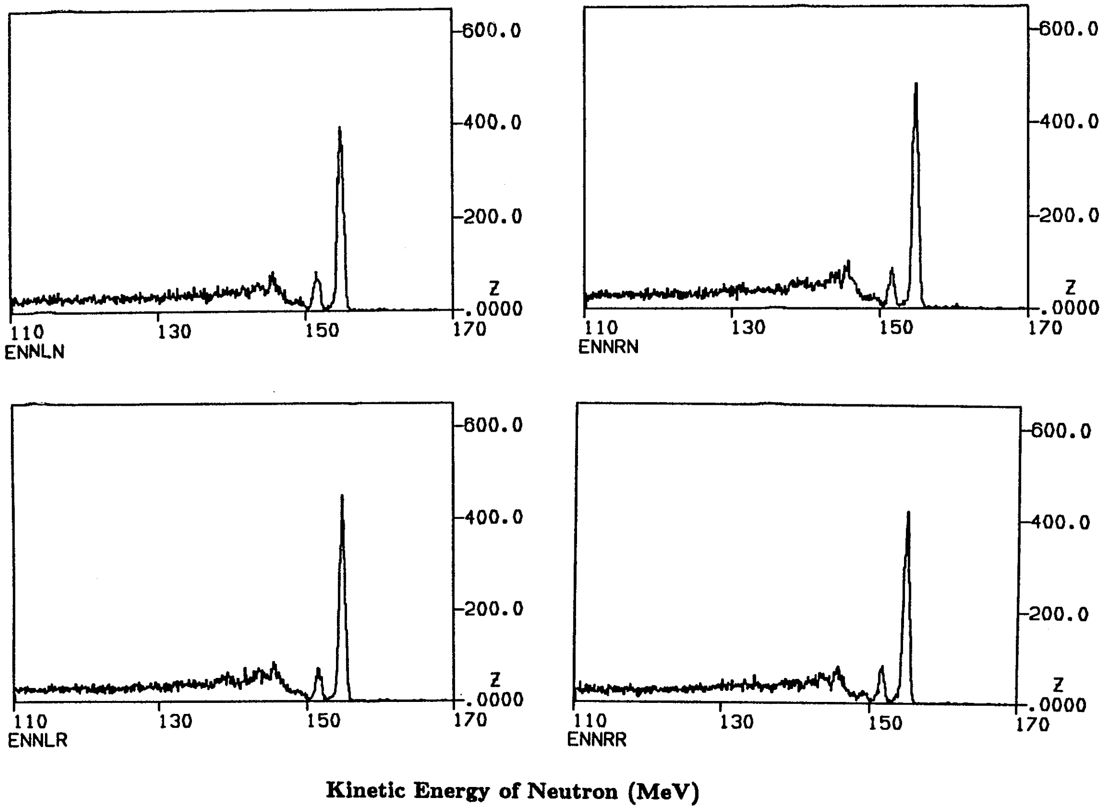

Figure 1. The four polarimeter neutron energy spectra for spin up left scattering (ENLN), spin up right scattering (ENRN), spin down left scattering (ENLR), and spin down right scattering (ENRR).

with our expectations from previous experience. The preliminary results with these cuts suggest that the GT to Fermi interaction strength ratios for ^{19}F(p,n) and ^{39}K(p,n) are consistent with the ratios obtained from ^{14}C(p,n)^{14}N, using the $0^+ \rightarrow 1^+$ and $0^+ \rightarrow 0^+$ transitions as the references.

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

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A proportionality between zero-degree (p,n) cross sections and GT (Gamow-Teller) and F (Fermi) beta decay matrix elements was demonstrated about a decade ago and has since been exploited as a quantitative measure of GT strength functions in order to better understand nuclear structure and to calibrate neutrino detectors. The (p,n) reaction can be used as a quantitative probe because the specific cross sections,[1] $\hat{\sigma}_{GT}$ and $\hat{\sigma}_F$, show very little dependence on the structure details of the nucleus under study ($\hat{\sigma}_{GT}=\sigma_{GT}(p,n)/$B(GT); $\hat{\sigma}_F=\sigma_F(p,n)/$B(F)) corrected for phase space and momentum transfer). The general trend of the mass dependence of the specific cross sections is understood in terms of an inceasing distortion with higher mass. However, in detail fluctuations of as much as ±50% have been observed betweeen adjacent masses. These fluctuations are not understood.

Only with the use of an empirically discovered relationship between the GT and F strengths in the reaction has it been possible to infer GT transition probabilities with greater precision than implied by the fluctuations. This relationship may be described as $R^2 = \hat{\sigma}_{GT}/\hat{\sigma}_F$ and $R = E_p/E_o$ where E_p is the proton beam energy and E_o is a constant,