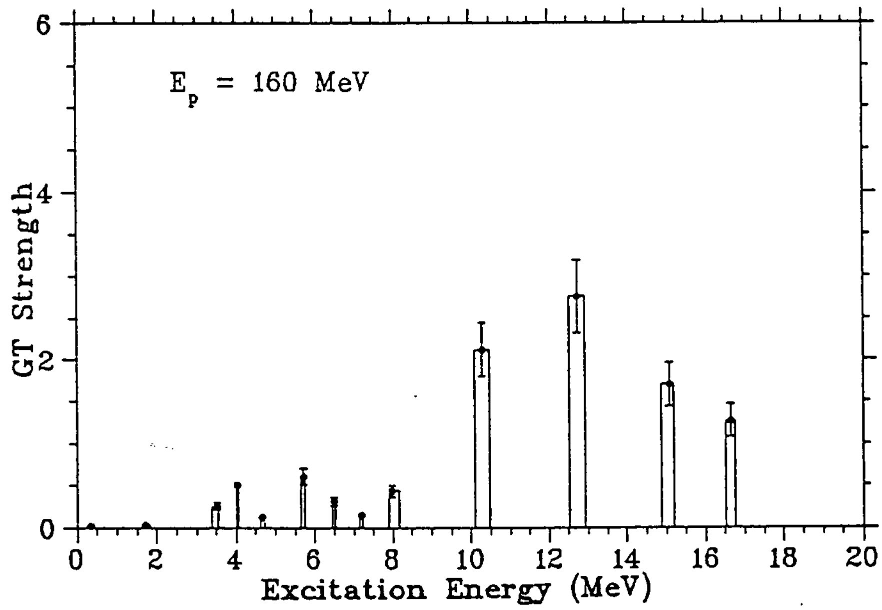

Figure 4.20: *Gamow-Teller strength distribution: E_p=160 MeV. The histograms represents the location of the peaks identified in Figure 4.13. The width of the histograms corresponds to the uncertainties in the excitation energies observed. The histograms up to $E_x \sim$3.5 MeV represents single transitions, while the histograms at higher excitation energy represents the approximate location of the unresolved states as well as the GTGR.*

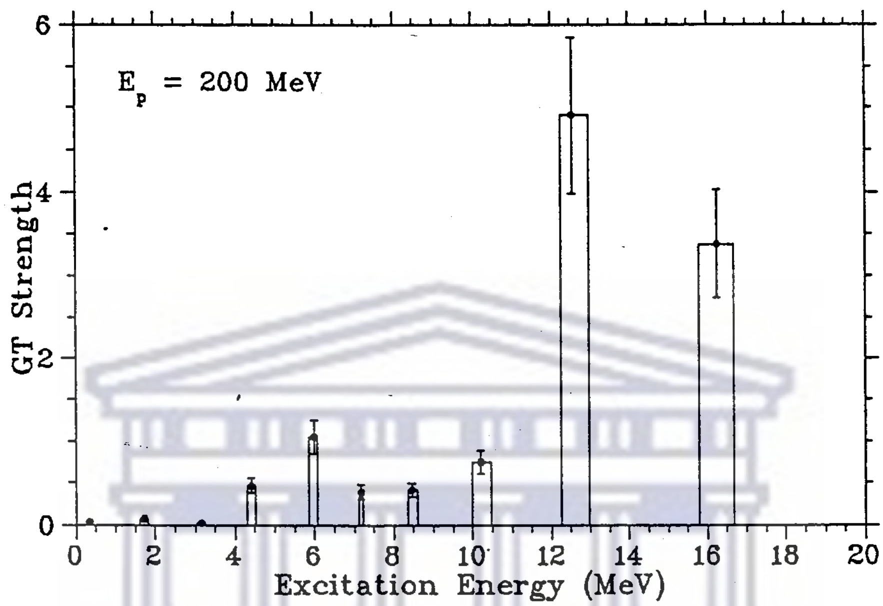

Figure 4.21: *Gamow-Teller strength distribution: E_p=200 MeV. The histograms represents the location of the peaks identified in Figure 4.14. The width of the histograms corresponds to the uncertainties in the excitation energies observed. The histograms up to E_x ~3.5 MeV represents single transitions, while the histograms at higher excitation energy represents the approximate location of the unresolved states as well as the GTGR.*

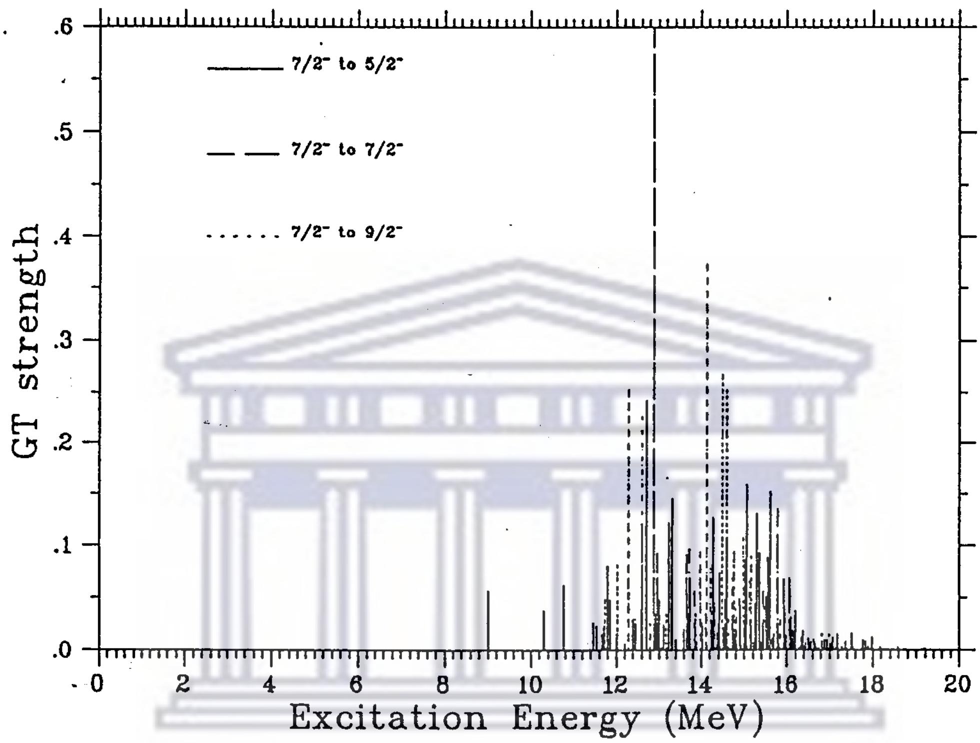

Figure 4.22: *Gamow-Teller strength distribution: Shell-Model calculations. Note the difference in scales between this plot and the previous plots.*

Proton energy (MeV)	Excitation energy (MeV)		Cross sections (mb/sr)		GT strength	
E_p	E_x	$\triangle E_x$	σ	$\triangle\sigma$	GT	$\triangle GT$
90	0.45	0.09	0.018	0.018	-	-
	0.61	0.09	0.112	0.008	0.046	0.011
	2.52	0.06	0.153	0.011	0.064	0.015
	3.44	0.04	0.711	0.020	0.297	0.065
	5.33	0.04	0.867	0.034	0.362	0.081
	6.16	0.06	0.442	0.022	0.185	0.042
	7.18†	0.09	4.208	0.114	0.49	0.11
	12.00	0.22	13.804	0.398	5.768	1.283
120	0.34	-	0.114	0.015	0.029	0.006
	1.63	0.08	0.186	0.022	0.048	0.011
	3.58	0.27	0.352	0.038	0.090	0.015
	4.06	0.08	1.354	0.143	0.347	0.057
	4.85	0.12	0.795	0.085	0.204	0.034
	5.63	0.08	0.916	0.100	0.235	0.040
	6.20	0.21	2.597	0.270	0.667	0.110
	7.17†	0.08	3.833	0.395	0.04	0.01
	7.55	0.08	2.964	0.306	0.760	0.125
	10.51	0.08	12.616	1.297	3.235	0.532
	12.98	0.12	7.309	0.752	1.874	0.308
	14.63	0.21	0.511	0.053	0.131	0.022
	15.53	0.21	9.650	0.992	2.474	0.407

Table 4.8: *The differential cross sections for the peaks observed at 0° scattering angle and at 90 and 120 MeV proton energies. The isobaric analogue state (IAS) is indicated by the dagger, †.*

Proton energy (MeV) E_p	Excitation energy (MeV) E_x	$\triangle E_x$	Cross sections (mb/sr) σ	$\triangle\sigma$	GT strength GT	$\triangle GT$
160	0.34	-	0.117	0.015	0.023	0.004
	1.71	0.12	0.176	0.021	0.035	0.006
	3.52	0.16	1.309	0.162	0.057	0.011
	4.03	0.12	0.290	0.046	0.257	0.044
	4.66	0.13	0.663	0.104	0.130	0.025
	5.71	0.12	3.105	0.327	0.609	0.096
	6.49	0.13	1.616	0.171	0.317	0.050
	7.19†	0.12	3.895	0.401	0.148	0.026
	7.97	0.16	2.227	0.231	0.437	0.069
	10.29	0.16	10.818	1.113	2.121	0.324
	12.72	0.16	14.051	1.445	2.755	0.430
	15.08	0.16	8.670	0.891	1.700	0.266
	16.64	0.16	6.440	0.662	1.263	0.197
200	0.34	0.09	0.174	0.020	0.034	0.007
	1.73	0.16	0.389	0.053	0.076	0.016
	3.16	0.16	0.147	0.018	0.029	0.006
	4.40	0.16	2.353	0.262	0.461	0.089
	5.99	0.16	5.348	0.576	1.049	0.200
	7.18†	0.09	3.782	0.426	0.387	0.090
	8.45	0.16	2.110	0.239	0.414	0.080
	10.21	0.24	3.793	0.399	0.744	0.141
	12.53	0.24	25.091	2.675	4.920	0.933
	16.24	0.24	17.253	1.944	3.383	0.653

Table 4.9: *The differential cross sections for the peaks observed at 0° scattering angle and at 160 and 200 MeV proton energies. The isobaric analogue state (IAS) is indicated by the dagger, †.*

Chapter 5

CONCLUDING SUMMARY

Charge-exchange (p,n) reaction measurements with good energy resolution have been carried out on ^{59}Co in the energy range 90 MeV $\leq E_p \leq$ 200 MeV. We measuared excitation energies, cross sections, and subsequently calculated the GT strength distributions.

We found that the excitation energy of the IAS corresponds with previous measurements by other researchers and also confirmed predictions made that the first excited state would be the first GT transition.

This experminent has yielded the first detailed view of the dominant portion of the GT transition strengths for ^{59}Co. The GT strengths obtained at 120, 160, and 200 MeV were on average up to 69% of the value predicted by the model independent sum rule. This can be compared with a theoretical value, obtained by a Shell-Model calculation, of about 61%. At 90 MeV about 48% of the predicted value was observed. The summed GT strength does not include the strength in the continuum region since it is difficult to disentangle from the background. The Shell-Model calculation that reproduced the profile of strength distribution of the GTGR predicts that no strength remains within the conventional Shell-Model space above 19 MeV.

The other strength that is predicted by the sum rule lies most probably in the continuum region. Various reasons, such as configuration mixing and Δ-hole excitations, have been given over the years why the undetected strength has shifted into the high excitation energy continuum. It is, however, not a straightfoward procedure to extract these strengths since the continuum is a collective excitation of both $L = 0$ transition as well as $L > 0$ transitions. To extract the strengths from these giant resonances, will require an additional project requiring multi decomposition of the cross sections.

The reason why the unit cross sections for odd-mass nuclei is larger than those for even-mass nuclei is still unsolved but this study has once again shown that the (p,n) reaction is an invaluable complement to weak-interaction decay studies. However, the way to proceed with this study lies with polarization transfer measurements since these provides a direct measure of the relative Gamow-Teller contribution in the isobaric analogue state, subsequently giving us a much better understanding of the nuclear structure.

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