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Gamow-Teller strength as a probe of proton-neutron pairing



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Examples of GT transitions with large B(GT)







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Examples of transitions with large B(GT) and B(M1)

B(C	TC (TC	ble 1: Strong	GT b	etween low-lyi	ng states		
0+ T=1	1^{+} T=0	experiment	$0\hbar\omega$	$R(\exp/0\hbar\omega)$	GFMC	$R(GFMC/0\hbar\omega)$	
⁶ He	⁶ Li	4.72(2)	5.54	0.85	4.65	0.84	
18 Ne	^{18}F	3.146(23)	5.06	0.62			
¹⁸ O	^{18}F	3.118(11)	5.06	0.62 ←		- GT quenching	
⁴² Ti	^{42}Sc	2.14(6)	4.20	0.51			

B(M1)

Table 2: Strong M1 between low-lying states

0^{+} T=1	1^{+} T=0	experiment	$0\hbar\omega$	$R(exp/0\hbar\omega)$	GFMC R(GFMC/0			
		μ_N^2	μ_N^2		μ_N^2			
⁶ Li	⁶ Li	15.6(3)	15.0	1.04(2)	13.1	0.87		
18 F	18 F	19.7(35)	16.4	1.20(21)				
$^{42}\mathrm{Sc}$	$^{42}\mathrm{Sc}$	19(10)	22.0	0.8(4)				





Is the B(GT) an observable?

$$\begin{split} B(GT) &= |\langle \Psi_f \mid O(GT) \mid \Psi_i \rangle|^2 \\ O(GT) &= \vec{\sigma} \tau_{\pm} \quad \Delta S = 1 \quad \Delta T = 1 \\ \langle \Psi_f \mid O(GT) \mid \Psi_i \rangle &= \sum_{\alpha, \beta} \langle \Psi_f \mid a_{\alpha}^+ a_{\beta} \mid \Psi_i \rangle \langle \alpha \mid O(GT) \mid \beta \rangle \end{split}$$

Calculation with GFMC

 $<\Psi_f\mid O(GT)\mid \Psi_i>$

agrees with experiment in light nuclei.





Calculation in a truncated space

$$< \tilde{\Psi}_f \mid O(GT) \mid \tilde{\Psi}_i >$$

when compared with experiment requires quenching.

To understand the quenching one needs to evaluate the effective operator for the finite model space which includes an SRG Λ -dependent truncation

 $< \tilde{\Phi}_f \mid \tilde{O}(GT) \mid \tilde{\Phi}_i > .$

Done in the 1980's but needs to be redone with modern methods. This in principle requires effective two-body GT operators - but in practice an effective one-body operator may be sufficient.

Is the "quenching" of B(GT) connected to the quenching one one-nucleon spectroscopic factors.

For charge exchange reactions we need the radial overlap function F(r) associated with O(GT).









Typical sd-shell results for A=18

0+T=1 79.9 % (d5/2)^2 86.1 % L=0, S=0 1+T=0 28.6 % (d5/2)^2 90.6 % L=0, S=1













sd-shell (0+, T=1) to (1+, T=0) Full mixing with USDA $\frac{10}{223} = \frac{10}{223} =$		Ca 40 96.941	Ca 39 860 ms	Ca 38 439 ms β ⁺ 5.6 γ 1568	Ca 37 181 ms ^{8⁺} ⁸⁰ 3.10: 0.87; 3.17 7 3239; 2750;	Ca 36 102 ms ^{B⁺} ^{Bp 2.550} _{7 1619: 1113:}	Ca 35 50 ms		Ca 40.078	20					
Full mixing with USDA P7 100 1301 P43 Ar 33 P44 m P70 m P10 m<		К 39 93.2581 « 2.1 « 0.0043 « 0.0043	Y (2522) K 38 924.6 ms 7.6 m	M K 37 1.22 s β ⁺ 5.1	K 36 342 ms \$*9.9. \$*0.9. \$*0.02433.2208 \$p 0.970: 0.693	1184* K 35 190 ms β ⁺ γ 2983; 2590 βp 1.425;	¥810* K 34 <40 ns	K 33 <25 ns	=0)	+,T=	o (1	=1) t	, T=	$1(0^{+})$	sd-shel
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		Ar 38 0.0532	Ar 37 35.0 d	Ar 36 0.3365	Ar 35 1.78 s	Ar 34 844 ms	Ar 33 174.1 ms	Ar 32 98 ms		Full mixing with USDA					
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		or 0.8	ε πο γ σ _{π, α} 1080 σ _{π, p} 37	α 5 σ _{n, α} 0.0054 σ _{n, p} <0.0015	β ⁺ 4.9 γ1219; (1763)	β ⁺ 5.0 γ666; 3129 9	β ⁺ 9.8; 10.6 γ810; 1542; 2231* βp 3.17	β ⁺ 9.0 βp 3.35; 2.42 γ461; 707	βp 2.08; 1.43 β2p 7.16 β3p 4.40	or 0.66	10				
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		CI 37 24.24	Cl 39 3.0 · 10 ⁵ a	CI 35 75.76 ar 43.7 aft, a ~ 8.E-5 of 44	CI 34 32.0 m 1.53 s ^{p+2.5} 72127 1176 3203 p+4.5	CI 33 2.51 s 2(841; 1966;	CI 32 291 ms p*95.117 y2201.4770 ps 220.1.67	CI 31 150 ms \$\$^{\$ 8.7; 10.9 \$2235; 1249; 3536; 4045	CI 30 <30 ns	CI 29 <20 ns	Cl 35.453	17			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	1	=34	A	S 30 425	S 33 0.75	S 32 94.99	S 31 2.58 s	S 30 1.18 s	S 29 187 ms β ⁺	S 28 125 ms	S 27 21 ms	S 32.065	16		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	لم ا	P 35 47.4 s	P 34 12.4 s	P 33 25.34 d	en, p.0.002 P.32 14.26 d	^{σ_{n,α} <0.0005 P 31 100}	P 30 2.50 m	P 29 4.1 s	P 28 268 ms 9 [†] 11.5 γ1779; 4497	P 27 260 ms	β ^{pp} β2p 5.94 P 26 20 ms β ⁺	σ0.54 P 25 <30 ns	P 30.973761	15	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		γ1572 Si 34 2.77 s β ^{-3.1} γ1179: 429	\$127 Si 33 6.18 s	=30		σ 0.17 Si 30 3.052	Si 29 4.685	Si 28 92.223	Ba 2.105: 1.434 Si 27 4.16 s	β ² βp 0.73; 0.61 Si 26 2.21 s β ⁺ 3.8	B2P 4.92 Bp 7.27; 6.84 Si 25 218 ms B ⁺ Bp 4.09; 0.39;	p 7 Si 24 140 ms	σ 0.17 Si 23 42.3 ms	Si 22 29 ms	
p ? μs 3 27' μs 0 83 μs 1 40		AI 33 41.7 ms β ⁻ βn γ1941*: 4341;	Al 32 33 ms γ1941: 3042:	Al 31 644 ms	Al 30 3.60 s	Al 29 6.6 m 8° 2.5	0.12 Al 29 2.245 m	or 0.17 Al 27 100	γ (2210) AI 26 6.35 s 7.15 · 10 ⁵ a γ 1809; 1130	Al 25 7.18 s	γ 1369* Al 24 129 ms 2.07 s β*4.8 9*4.48 1369 2.07 s 1369 2.07 s	βp 1.51; 4.09 Al 23 470 ms	β2p 5.86; 6.18 Al 22 59 ms β ⁺ βp 1.32; 0.72	βp 1.99; 1.63 Al 21 <35 ns	
Sp 1.50. 100 1.17. 100 <t< td=""><td></td><td>1010 Mg 32 120 ms β⁺ γ 2765; 736; 2467</td><td>4230 Mg 31 230 ms β⁻ γ 1613; 947; 1826: 866</td><td>Mg 30 335 ms</td><td>3498 Mg 29 1.30 s</td><td>=26</td><td>γ.1779 β⁻ Α</td><td>m0.230 Mg 20 11.01</td><td>Mg 25 10.00</td><td>Y(1612) Mg 24 78.99</td><td>Mg 23 11.3 s</td><td>Mg 22 3.86 s</td><td>Bα 3.27 Mg 21 122.5 ms B⁺ γ332; 1384;</td><td>p ? Mg 20 95 ms β⁺ γ984; 275*;</td><td></td></t<>		1010 Mg 32 120 ms β ⁺ γ 2765; 736; 2467	4230 Mg 31 230 ms β ⁻ γ 1613; 947; 1826: 866	Mg 30 335 ms	3498 Mg 29 1.30 s	=26	γ.1779 β ⁻ Α	m0.230 Mg 20 11.01	Mg 25 10.00	Y(1612) Mg 24 78.99	Mg 23 11.3 s	Mg 22 3.86 s	Bα 3.27 Mg 21 122.5 ms B ⁺ γ332; 1384;	p ? Mg 20 95 ms β ⁺ γ984; 275*;	
βa 2 15; 4.44. β ² 2.5 σ _{h p} 28000 σ 0.43 + 0.1 f ² 2 g ² 1/2734, y 1/5/390, β 7.4 y 1/60, 1696 y 1/4/4; 2389 14/4 po 0.08 (051) pr 0		βn Na 31 17.0 ms β ⁻ 15.4 γ51: 1482* 2244	Bn Na 30 48 ms β ⁻ 12.2; 15.7 γ 1482; 1040°;	γ244; 444 Na 29 44.9 ms β ⁻ 10.8; 13.4 γ55; 2560;	Na 28 30.5 ms	Na 27 304 ms β ⁻ 8.0.,	Na 26 1.07 s	σ 0.038 Na 25 59.6 s β ⁻ 3.8	σ 0.20 Na 21 20 ms 114.96 h	α 0.053 Na 23 100	B * 3.1 γ 440 Na 22 2.603 a β* 0.5; 1.8 γ 1275-	Na 21 22.48 s	¹⁶³⁴ βp 1.94; 1.77 Na 20 446 ms β ⁺ 11.2	Bp 0.77; 1.59 Na 19 <40 ns	
$A = 22 b_{\beta^{-}} b_{\beta^{-$		Ne 30 5.8 ms	βr; β2n; βα Ne 29 15.8 ms β ⁻ 15.3 γ72; 1516;	Ne 28 20.0 ms β ⁻	γ14/4; 2389 βn Ne 27 31.5 ms β ⁻ 12.6 γ63; 3019;	Ne 26 197 ms	Ne 25 602 ms	=22	A	9.73	^{σ_{n, p} 28000 σ_{n, a} 260 Ne 21 0.27}	Ne 20 90.48	βα 2.15; 4.44 γ1634 Ne 19 17.22 s	P Ne 18 1.67 s	
β*3.4. γ1042 γ(10; 197; 1357) σ 0.039 σ 0.051 β - γ4 7.3. γ4 7.3. β0; 820 2736; 2225 βn; 823 2736; 2225 βn; 823 1244; 1588 βn; 823 1751 βn; 823 F 17 64.8 s F 18 109.7 m F 20 100 F 21 11 s F 22 4.16 s F 22 4.23 s F 23 2.23 s F 24 0.34 s F 25 50 ms F 26 10.2 ms F 28 4.9 ms F 29 < 40 ns		F 29 2.6 ms	F 28 <40 ns	γ2063; 863 βn; β2n F 27 4.9 ms	F 26 10.2 ms	γ83; 233 βn F 25 50 ms β ⁻ γ1703; 1613	F 24 0.34 s	F 23 2.23 s	F 22 4.23 s	φ 0.051 F 21 4.16 s	0.7 σ _{n.4} 0.00018 F 20 11.7 s	^{ره 0.039} F 19 100	F 18 109.7 m	β ⁺ 3.4 γ1042 F 17 64.8 s	
$ \int_{0}^{\frac{1}{7}} \frac{17}{70} \frac{p^{+} 0.6}{90} \frac{1}{7} \frac{100095}{1007} + \frac{164}{100095} + \frac{p^{-} 53:57.}{164} + \frac{17}{1276:208:} \frac{1}{7} \frac{1770:2129}{1822:3431.} + \frac{p^{-}}{7182} + \frac{575.}{pn} + \frac{7}{9n} + \frac{7}{9n} + \frac{7}{9n} + \frac{1}{9n} + \frac{1}{92018} + \frac$), 2011	βn β2n 7 20	n?	βn γ2018* 18	γ2018; 1673 βn	575 βn Ο 24 61 ms	β ⁻ γ 1982 Ο 23 82 ms	γ1701; 2129; 1822; 3431 Ο 22 2.25 s β ⁻ γ72; 637; 1862	21275; 2083; 2166 O 21 3.4 s 6.4 1730; 3517; 280; 1767	=18	A	or 0.0095	β* 0.6 no γ O 17 0.038 σ 0.00054 σ ₀ 0.257	в+ 1.7 по у О 16 99.757	9





















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