Gamow-Teller decay of $N=51$ nuclei

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Gamow-Teller decays of $N=51$ nuclei are calculated, taking into account core polarization corrections. Results are in fair agreement with experiment, but predict much more strength in the decay of ^{96}Rh than has been observed experimentally. [S0556-2813(98)04402-1]

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In an earlier paper we reported calculations of the Gamow-Teller (GT) decay of $N=50$ nuclei [1]. These made use of an effective interaction deduced from the spectra of $N=51$ nuclei and were successful in accounting for the GT strength observed in a range of nuclei. Core polarization was taken into account by evaluating various first-order diagrams, and effects of pairing correlations were included by making use of the pairing hindrance factors of Towner [2]. Higher-order correlations were assumed to produce an effective g_A/g_V of unity, hence causing calculated strengths $B(\mathrm{GT})$ to be reduced by a factor of 1.6. In the present paper we extend these calculations to the decay of $N=51$ nuclei.

Our model space for $N=51$ and $N=52$ nuclei allows $Z-38$ protons to span the $p_{1/2}$ and $g_{9/2}$ shells, while $N-50$ neutrons occupy the $d_{5/2}$, $s_{1/2}$, $d_{3/2}$, and $g_{7/2}$ shells. The interactions used were the JS4 and JS6 interactions of Johnstone and Skouras [3]. The former is essentially the same as that used for $N=51$ nuclei in the earlier paper [1], while the latter is JS4 augmented by a volume delta force and $d_{5/2}^2$ matrix elements chosen to reproduce the ^{92}Zr spectrum. Dimensions are reasonable, being less than 700 for all cases considered.

For the decay of $N=50$ nuclei, there are four first-order core polarization diagrams, of which two are one-body corrections to the $g_{9/2}\rightarrow g_{7/2}$ reduced matrix element. The other two give two-body matrix elements. For the decay of $N>50$ nuclei, there are an additional two diagrams, which are shown in Fig. 1. We have included all these diagrams in our calculations, together with the pairing hindrance factors of Towner [2] and a reduction factor of 1.6 to simulate effects of higher-order correlations.

Calculated strength distributions for the decay of ^{94}Tc(2^+), ^{95}Ru$(5/2^+)$, ^{96}Rh (6^+ and 3^+), and ^{97}Pd$(5/2^+)$ are shown in Figs. 2–6. In each case experimental strengths

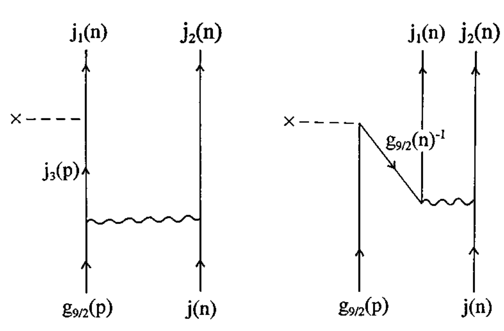

FIG. 1. First-order core polarization diagrams.

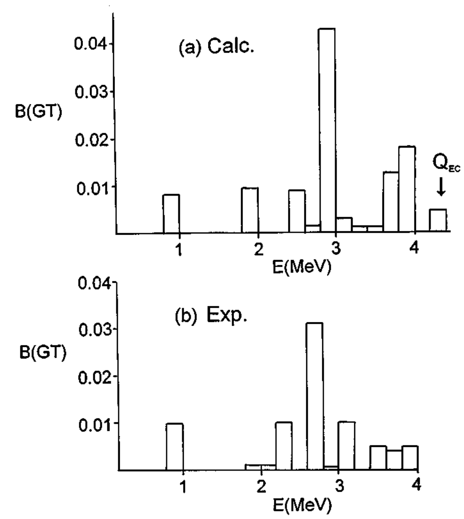

FIG. 2. (a) Calculated and (b) experimental [4] GT strengths in the decay of ^{94}Tc(2^+).

are also given. The percentage of total strength lying below the electron-capture Q value is calculated to be 9%, 44%, 84%, 83%, and 94% for the five cases. Calculated half-lives are 56 min, 3.0 h, 4.8 min, 3.2 min, and 3.5 min, while experiment gives 52 min, 1.64 h, 9.25 min, 3.8 min, and 3.1 min. The mass 94 and 95 strengths are in quite good agree-

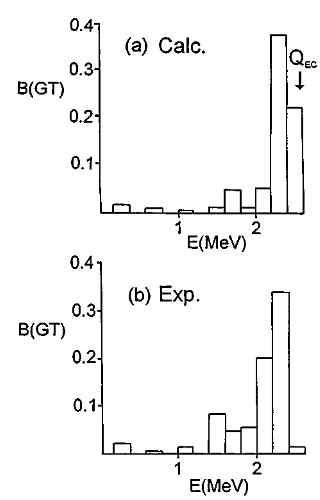

FIG. 3. (a) Calculated and (b) experimental [5] GT strengths in the decay of ^{95}Ru$(5/2^+)$.

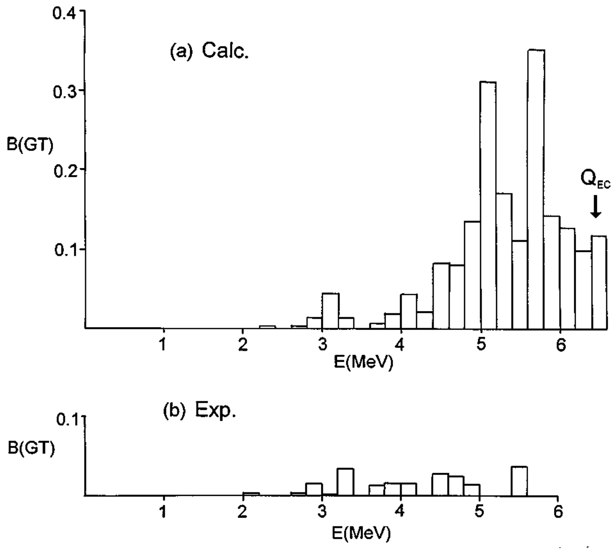

FIG. 4. (a) Calculated and (b) experimental [6] GT strengths in the decay of ^{96}Rh(6^+).

ment with experiment, but in the case of mass 96 it seems clear that there is appreciable strength lying above 5 MeV which experiment has to date not isolated. The calculation suggests that 14% of the 6^+ decay and 10% of the 3^+ decay should feed states above 5 MeV.

The 7^+ ground state of ^{94}Tc is observed to decay to four 6^+ states and one 8^+ state of ^{94}Mo [4]. Their energies and logft values are given in Table I, together with the calculated

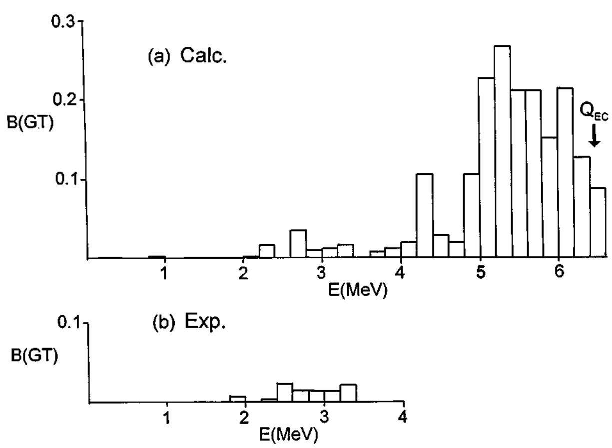

FIG. 5. (a) Calculated and (b) experimental [6] GT strengths in the decay of ^{96}Rh(3^+).

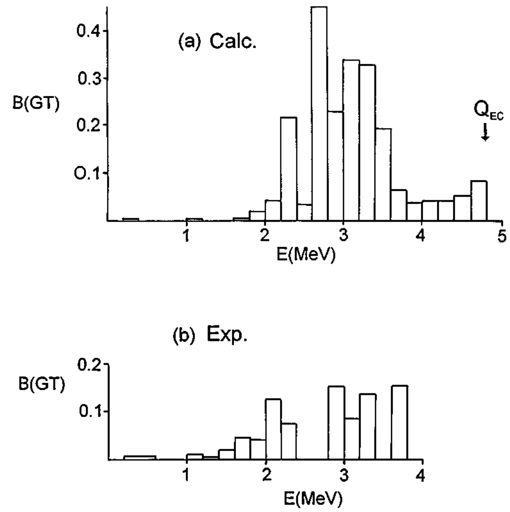

FIG. 6. (a) Calculated and (b) experimental [7] GT strengths in the decay of ^{97}Pd($5/2^+$).

values.

The $21/2^+$ isomer in ^{93}Mo is observed to decay to two states at 2.75 and 2.18 MeV in ^{93}Nb, with logft values of about 5.1 and 7.5. It has been proposed that these states have spins and parities $21/2^+$ and $19/2^+$ [8]. The calculations do indeed give $19/2^+$ and $21/2^+$ states below 3 MeV, with the $19/2^+$ lower, but at much higher energy than 2.18 MeV. Moreover, the predicted logft value to the $19/2^+$ is 4.85. We therefore propose that the 2.75 MeV state is the $19/2^+$, while calculations suggest that the state at 2.18 MeV is a $17/2-$.

In summary, we have calculated Gamow-Teller decay strengths for a range of $N=51$ nuclei, with fair agreement with experiment. In the case of ^{96}Rh, appreciable unobserved strength is predicted above 5 MeV.

TABLE I. Decay of ^{94}Tc(7^+).

	Expt. [4]		Calc.	
	E	log ft	E	log ft
6_1	2.42	5.06	2.45	4.90
6_2	2.87	6.43	2.82	5.79
6_3	3.17	5.91	3.17	5.94
6_4	3.34	5.40	3.41	5.65
8_1	2.96	6.01	2.83	6.52

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