^{252}Cf SF decay 2006Hw04,1997Ha64,2002Sm10

History

Type	Author	Citation	Literature Cutoff Date
Update	Balraj Singh and Jun Chen	ENSDF	12-Dec-2022

Parent: ^{252}Cf: E=0.0; $J^\pi=0^+$; $T_{1/2}$=2.645 y *8*; %SF decay=3.092 *8*

^{252}Cf-%SF decay: %SF=3.092 *8* for ^{252}Cf SF decay from the Adopted Levels of ^{252}Cf.

2006Hw04 and Erratum published in PRC 106, 069901(E) (2022): ^{252}Cf source was sandwiched between two Fe foils at the Lawrence Berkeley National Laboratory. γ rays were detected with the Gammasphere array of 102 Ge detectors. Measured Eγ, Iγ, $\gamma\gamma$-coin. Deduced levels, band structures.

1997Ha64 (also 1995HaZT,1995HaZZ): three measurement were carried out at Oak Ridge with 20 Ge detectors, at Gammasphere and at Idaho with two LEPS and two large Ge detectors, respectively. Measured Eγ, Iγ, $\gamma\gamma$-coin. Deduced levels, band structures. This work is from the same group as 2006Hw04 and superseded by latter.

2006Hw01: measured level lifetimes by time-gated triple γ coincidence method using Gammasphere array with 72 Ge detectors.

2002Sm10: measured lifetimes by differential plunger method using the EUROBALL and SAPHIR arrays consisting of 48 square solar cells. Data for g.s. band up to 12^+.

2004Sm04 (also 2005Sm08): measured g factor of first 2^+ state by integral perturbed angular correlation method (IPAC) using Gammasphere array.

2005Ja12: measured Eγ, Iγ, $\alpha\gamma$ and $\gamma\gamma$ coin for α-accompanied ternary fission, deduced intensity ratios.

2010SmZZ: measured Eγ, $\gamma(\theta)$.

2008RaZY: measure g factor of first 2^+ state by integral perturbed angular correlation method (IPAC) using Gammasphere array.

2008GoZL: measured g factor by IPAC method using Gammasphere.

Other: ^{254}Cf SF decay: 1980ChZM.

Earlier references:
1974KhZV, 1974JaYY, 1974ClZX, 1972Wi15, 1972ClZN, 1972Ho08, 1971Ho29, 1971Ch44, 1970Ch11, 1970Jo20, 1966WaZX. Others: 1983MaYT, 1987BoZN, 1992ZhZT.

In pre 1990 papers, the following measurements were reported for four γ rays linking g.s. band members up to (8^+): prompt and delayed γ rays and conversion electrons; coincidence measurements using (x ray)γ, $\gamma\gamma$, (fragment)(γ), (fragment)(fragment)(γ) techniques; lifetime measurements by recoil-distance Doppler-shift and delayed coincidence methods. But the 614.2γ from (8^+) level is not confirmed in later studies. According to 1997Ha64, a 625.0γ deexcites the 8^+ level, instead.

Level scheme is as proposed in 2006Hw04, with revisions in Erratum to this work published in Phys. Rev. C 106, 069901(E).

^{100}Zr Levels

A 2496 level decaying by a 1434.7γ in 2006Hw04 is omitted in the Erratum in PRC 106, 069901(E) (2022).

Q_t=Transition quadrupole moment given under comments are deduced by 2002Sm10 from their measured lifetimes.

E(level)[†]	J^π[‡]	$T_{1/2}$[#]	Comments
0.0[@]	0^+		
212.4[@] *3*	2^+	0.68 ns *3*	g=+0.30 *3* (2004Sm04) $T_{1/2}$: weighted average of 0.64 ns *5* (2002Sm10), 0.71 ns *3* (1974JaYY), 0.62 ns *10* (1980ChZM), and 0.52 ns *10* (1970Ch11,1972Wi15), all measured using Doppler-shift recoil distance method (RDM). Others: 0.20 ns *3* (1983MaYT,RDM). The (fragment)(γ)(t) method gives poor results: 7 ns *2* (1970Jo20), 2.8 ns *9* (1972ClZN), <3 ns (1974ClZX). g factor measured by $\gamma(\theta$,H) technique (IPAC) using 352γ-213γ and 497γ-213γ correlations. Other: +0.32 *5* (2008RaZY), 0.33 *7* (2008GoZL). Both 2004Sm04 and 2008RaZY have used a lifetime of 0.78 ns *3* (1997Si09 evaluation) for deducing the g factor, while 2008GoZL use $T_{1/2}$=0.59 ns *3* from 2008Si01 evaluation. Q_t=3.19 *14* (2002Sm10).
330.9[a] *4*	0^+		
564.3[@] *4*	4^+	37.0 ps *4*	Q_t=3.16 *2* (2002Sm10). Uncertainty of 0.14 in table 1 of 2002Sm10 is a misprint as confirmed in an e-mail reply of July 4, 2002 from one of the authors (A.G. Smith) of 2002Sm10.
878.5[a] *4*	2^+		

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^{252}Cf SF decay 2006Hw04,1997Ha64,2002Sm10 (continued)

^{100}Zr Levels (continued)

E(level)[†]	Jπ[‡]	$T_{1/2}$[#]	Comments
1061.6[@] *4*	6^+	4.9 ps *11*	Q_t=3.50 *40* (2002Sm10).
1414.6[a] *4*	4^+		
1687.1[@] *5*	8^+	1.73 ps *17*	Q_t=3.23 *16* (2002Sm10).
1855.9 *5*			
1910.9 *5*			
1961.6[a] *4*	(6^+)		
2259.6[&] *4*	(6^+)	2.5 ns *7*	Jπ: (5^-) suggested for this band head in earlier work (1997Ha64). $T_{1/2}$: from time-gated triple γ coin method (2006Hw01). The authors quote also an uncertainty of 0.4 ns in the text of the paper.
2315.6 *5*			
2426.2[@] *5*	10^+		
2467.0 *5*			
2478.9[&] *5*	(7^+)		
2525.9 *5*			
2579.2[a] *5*	(8^+)		
2729.1[&] *6*	(8^+)		
2754.4[b] *6*			
2859.0 *5*			
3013.4[&] *6*	(9^+)		
3019.3 *5*			
3021.6[b] *6*			
3268.0[@] *6*	12^+		
3323.3[b] *7*			
3328.4[&] *6*	(10^+)		
3635.0 *6*			
3659.4[b] *7*			
3672.0[&] *6*	(11^+)		
4205.7[@] *7*	14^+		

[†] From least-squares fit to Eγ data, assuming Δ(Eγ)=0.3 keV for γs with definite placaments, and 1.0 keV for γs with uncertain placements.
[‡] As given in Fig. 1 of 2006Hw04 and its Erratum in Phys. Rev. C 106, 069901(E) (2022). See also Adopted Levels for revised values for some of the levels.
[#] From differential plunger method (Doppler-shift recoil-distance method) in 2002Sm10, unless otherwise stated. The uncertainties are purely statistical.
[@] Band(A): g.s. band.
[&] Band(B): $K^\pi=(6^+)$, ν9/2[404]⊗ν3/2[411]. Probable configuration from 2004Hu02 in (α,Fγ) and 1995Du10 in ^{248}Cm SF decay. Earlier in 1997Ha64 this band was interpreted as $K^\pi=5^-$ band with configuration=π5/2[422]⊗π5/2[303].
[a] Band(C): Excited 0^+ band.
[b] Band(D): Band based on 2754 level.

γ(^{100}Zr)

Following γ rays are removed by authors of 2006Hw04 in Erratum published in Phys. Rev. C 106, 069901(E) (2022): 438.8γ from 2755 level, 1434.7γ from 2497 level, and 1698.9γ from 1911 level.

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^{252}Cf SF decay 2006Hw04,1997Ha64,2002Sm10 (continued)

γ(^{100}Zr) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	Comments
118.4		330.9	0^+	212.4	2^+			E_γ: from Erratum to 2006Hw04.
212.4	100	212.4	2^+	0.0	0^+	(E2)		I_γ: 1.7 *3* per 100 fissions of ^{252}Cf (1971Ch44). Mult.: from γ(θ) and RUL. A_2=+0.46 *9*, A_4=+0.56 *19*, or A_2=+0.33 *18* with A_4=0 in (fragment)γ(θ) (1972Wi15); A_2=+0.192 *29* with A_4=0 (2010SmZZ); A_2=+0.26 *4*, A_4=+0.02 *5* (1976Wo04).
219.3	5.5	2478.9	(7^+)	2259.6	(6^+)			
250.1	2.4	2729.1	(8^+)	2478.9	(7^+)			
267.2	1.0	3021.6		2754.4				
275.5	2.6	2754.4		2478.9	(7^+)			
284.1	2.1	3013.4	(9^+)	2729.1	(8^+)			
301.9	0.8	3323.3		3021.6				
314.6	1.0	3328.4	(10^+)	3013.4	(9^+)			
336.3	0.3	3659.4		3323.3				
343.3	0.5	3672.0	(11^+)	3328.4	(10^+)			
351.8	84	564.3	4^+	212.4	2^+			I_γ: 1.26 *19* per 100 fissions of ^{252}Cf (1971Ch44). A_2=+0.085 *6*, A_4=+0.010 *10* from 352γ-213γ-correlation (2008GoZL).
391.9	0.3	2859.0		2467.0				
403.7	0.5	2259.6	(6^+)	1855.9				
440.0	0.4	3019.3		2579.2	(8^+)			
441.1[#]	0.9	1855.9		1414.6	4^+			
469.5[#]	0.1	2729.1	(8^+)	2259.6	(6^+)			
495.6[#]		3021.6		2525.9				
496.3[#]	0.9	1910.9		1414.6	4^+			
497.3	65	1061.6	6^+	564.3	4^+			Iγ(497)/Iγ(352)=0.47 (2005Ja12). I_γ: 0.57 *14* per 100 fissions of ^{252}Cf (1971Ch44). A_2=+0.095 *8*, A_4=+0.013 *13* from 497γ-352γ-correlation (2008GoZL).
534.7	0.5	3013.4	(9^+)	2478.9	(7^+)			
536.0	6.8	1414.6	4^+	878.5	2^+			
547.0	3.0	1961.6	(6^+)	1414.6	4^+			
547.6	1.1	878.5	2^+	330.9	0^+			E_γ: from Erratum to 2006Hw04. I_γ: from 1997Ha64 and 1995HaZT; not listed in 2006Hw04.
556.0	0.5	2467.0		1910.9				
564.4	0.3	2525.9		1961.6	(6^+)			
569.1[#]	0.1	3323.3		2754.4				
599.3	0.2	3328.4	(10^+)	2729.1	(8^+)			
615.7	0.1	3635.0		3019.3				
617.6	0.6	2579.2	(8^+)	1961.6	(6^+)			
625.6	26	1687.1	8^+	1061.6	6^+			Iγ(625)/Iγ(352)=0.19 (2005Ja12).
637.6	0.1	3659.4		3021.6				E_γ: from Table 1 in Erratum, 638.2 in Fig. 1 of Erratum. (Eγ confirmed with author of Erratum, Dec 12, 2022).
658.9	0.2	3672.0	(11^+)	3013.4	(9^+)			
666.1	7.0	878.5	2^+	212.4	2^+			
739.1	5.2	2426.2	10^+	1687.1	8^+			E_γ: 738.6 (2002Sm10).
841.8	2.1	3268.0	12^+	2426.2	10^+			E_γ: other: 846.6 (2002Sm10).
845.0	8.8	2259.6	(6^+)	1414.6	4^+			E_γ: from Level-scheme Fig. 1 in Erratum, not listed in Table I of Erratum. (Eγ confirmed with author of Erratum, Dec 12, 2022).
850.2	9.5	1414.6	4^+	564.3	4^+	(M1+E2)	+1.4 *+4−2*	Mult.,δ: 2008GoZL report δ(E2/M1)=+1.4 *+4−2*

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^{252}Cf SF decay 2006Hw04,1997Ha64,2002Sm10 (continued)

γ(^{100}Zr) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Comments
						from 850γ-352γ-correlation with A_2=−0.156 *22*, A_4=+0.082 *34*. Large mixing ratio and in−band transition favors M1+E2 over E1+M2.
892.1	1.0	2579.2	(8$^+$)	1687.1	8$^+$	
900.0	2.3	1961.6	(6$^+$)	1061.6	6$^+$	
937.7	0.5	4205.7	14$^+$	3268.0	12$^+$	
1171.9	0.8	2859.0		1687.1	8$^+$	
1197.9	1.8	2259.6	(6$^+$)	1061.6	6$^+$	
1202.3	1.9	1414.6	4$^+$	212.4	2$^+$	
1208.9	0.5	3635.0		2426.2	10$^+$	
1254.0	2.0	2315.6		1061.6	6$^+$	
1291.6	0.2	1855.9		564.3	4$^+$	
1332.2	1.1	3019.3		1687.1	8$^+$	
1346.6	2.9	1910.9		564.3	4$^+$	
1397.3[#]	0.7	1961.6	(6$^+$)	564.3	4$^+$	This γ is not confirmed in ^{248}Cm,^{252}Cf SF decay (2019Ur02), also not reported in ^{100}Y β^- decay (0.94 s); thus omitted in the Adopted dataset.
1405.4	1.1	2467.0		1061.6	6$^+$	
1464.3	1.8	2525.9		1061.6	6$^+$	
1695.4	4.9	2259.6	(6$^+$)	564.3	4$^+$	
1751.3	1.7	2315.6		564.3	4$^+$	

[†] From Erratum to 2006Hw04, published in Phys. Rev. C 106, 069901(E) (2022). Values are also available in 1997Ha64, but superseded by those from 2006Hw04 and Erratum to 2006Hw04 of the same group.

[‡] From 2006Hw04, unless otherwise stated. Intensity uncertainties vary from 5% for strong transitions to 30% for weak ones, as stated by 2006Hw04. Values are also available in 1997Ha64 and superseded by those from 2006Hw04 of the same group.

[#] Placement of transition in the level scheme is uncertain.

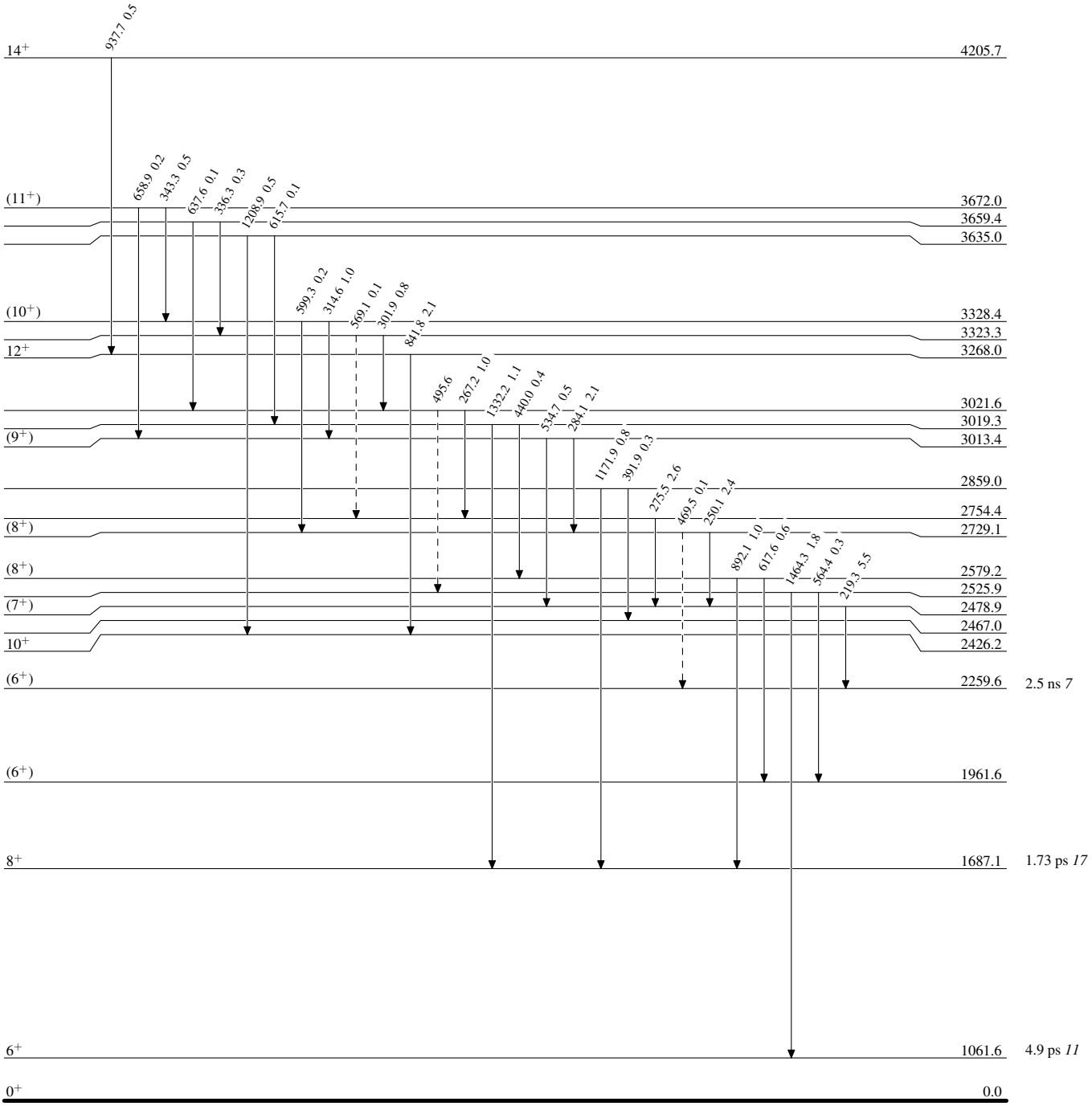
^{252}Cf SF decay 2006Hw04,1997Ha64,2002Sm10

Level Scheme

Intensities: Relative I_γ

Legend

- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$
- γ Decay (Uncertain)



$^{100}_{40}Zr_{60}$

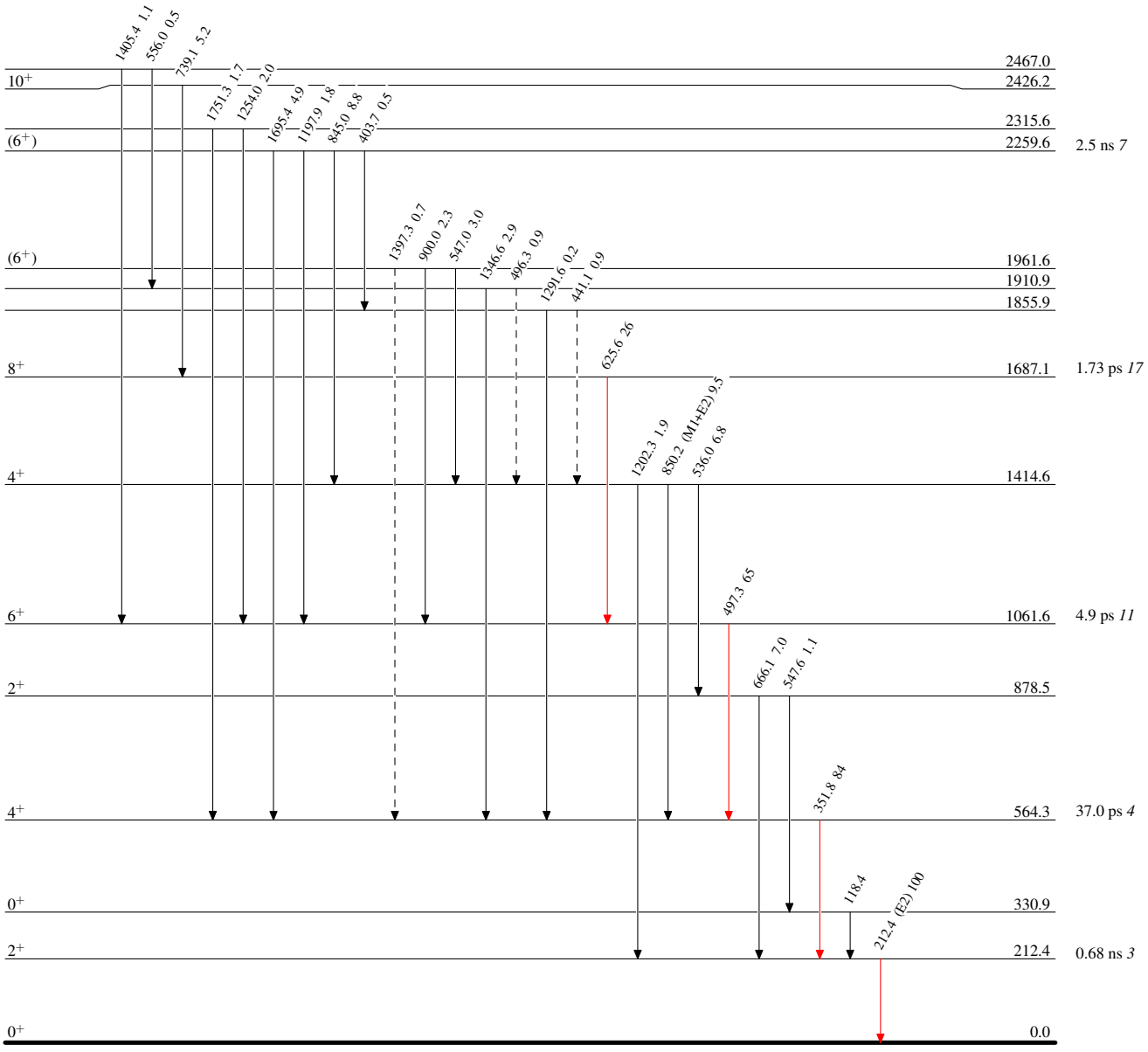
^{252}Cf SF decay 2006Hw04,1997Ha64,2002Sm10

Level Scheme (continued)

Intensities: Relative I_γ

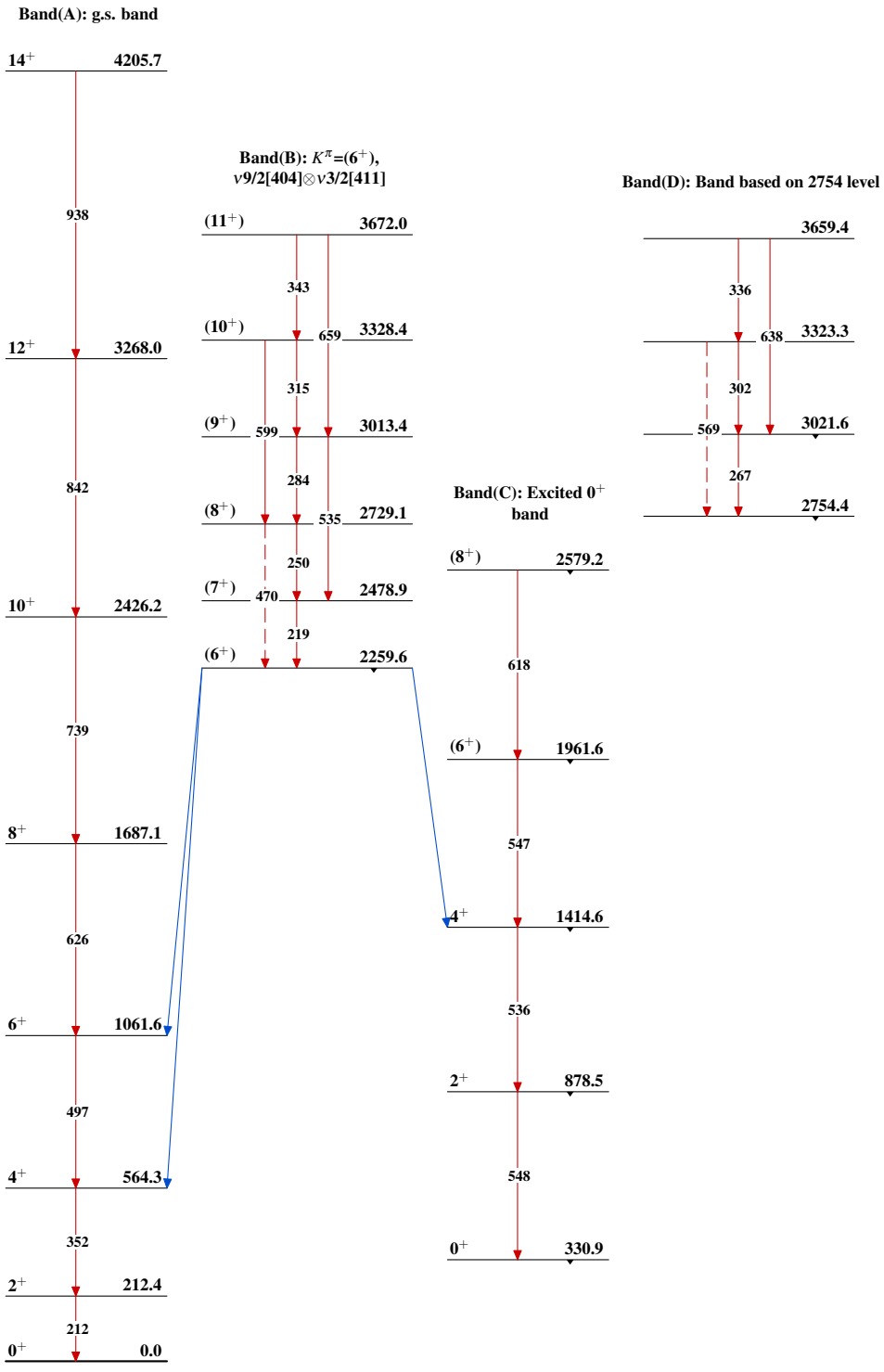
Legend

$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$
γ Decay (Uncertain)



$^{100}_{40}Zr_{60}$

^{252}Cf SF decay 2006Hw04,1997Ha64,2002Sm10



$^{100}_{40}Zr_{60}$