^{252}Cf SF decay 2017Wi15,2017Wa50,1999Zh05

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	N. Nica and B. Singh	NDS 181, 1 (2022)	9-Mar-2022

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

^{252}Cf-J^π,$T_{1/2}$: From Adopted Levels of ^{252}Cf.

Dataset based on the following xundl compilations: 2017Wi15 compiled by C.D. Nesaraja (ORNL); 2017Wa50 compiled by J. Chen (NSCL/MSU); 1999Zh05 compiled by J. Chenkin and B. Singh (McMaster).

2017Wi15,2018WiZY: measured Eγ, Iγ, γγγ coin using the Gammasphere array of anti-Compton spectrometers. Multipolarities deduced from angular correlation measurements. Excited levels with a parity-doublet structure suggests presence of octupole correlations. Obtained B(E1)/B(E2) branching ratios and calculated dipole moment D_0 using the formula $D_0=[(5B(E1))/(16B(E2))]^{1/2}\times Q_0$ with Q_0=411 efm^2 (from interpolation of neighboring even-even nuclei).

2017Wa50: measured Eγ, Iγ, γγ-coin, γγγ-coin, γγγγ-coin, γγ(θ) using the Gammasphere array of 101 Ge detectors. Deduced levels, J, π, band structures, B(E1)/B(E2) ratios and dipole moments of bands. Calculated dipole moment using the formula given in the descriptor of 2017Wi15) with Q_0=368 efm^2 *13*. Comparisons with neighboring nuclei.

1999Zh05 (superseding 2000HaZW, 1999Ha10, 1999Ha18, 1999Zh08, 1998HaZX): measured Eγ, Iγ, γγ using Gammasphere array with 72 Compton-suppressed Ge detectors. The width of coincidence time window was about 1 μs, with most analyzed data selected with 100 ns time gate (by analysis procedure).

^{147}La Levels

2017Wa50 indicate that the 15.5, 74.4, 121.0, 167.7 and 233.1 levels were previously identified in β decay measurements of which only 15.5 appears as unobserved by the present ^{252}Cf SF studies.

E(level)[†]	J^π[‡]	Comments
0.0	(5/2$^+$)	
15.5		
74.29 *8*	(7/2$^+$)	
120.99 *22*	(5/2$^+$)	
167.59 *8*	(7/2$^-$)	
229.49[a] *12*	(11/2$^-$)	J^π: E2 γ to (7/2$^-$) and compatible with (5/2$^+$) for g.s.
233.06 *13*	(9/2$^+$)	
371.69[c] *11*	(11/2$^+$)[&]	
441.49[a] *14*	(15/2$^-$)[#]	
589.50 *16*	(13/2$^+$)	
610.93[d] *18*	(13/2$^-$)	
697.5[b] *4*	(13/2$^+$)	
785.99[c] *13*	(15/2$^+$)[&]	
787.55[a] *15*	(19/2$^-$)[#]	
954.18[d] *15*	(17/2$^-$)	
1030.43[b] *16*	(17/2$^+$)[@]	
1207.60[c] *14*	(19/2$^+$)	B(E1)/B(E2)=0.20×10^{-6} fm^{-2} *1*, dipole strength D_0=0.103 e fm *3* (2017Wi15). B(E1)/B(E2)=0.24×10^{-6} fm^{-2} *2*, dipole strength D_0=0.101 e fm *6* (2017Wa50).
1241.88[a] *17*	(23/2$^-$)[#]	
1347.2 *6*		
1357.88[b] *16*	(21/2$^+$)[@]	
1390.72[d] *16*	(21/2$^-$)	
1557.5 *6*		
1589.18[c] *15*	(23/2$^+$)	B(E1)/B(E2)=0.57×10^{-6} fm^{-2} *3*, dipole strength D_0=0.173 e fm *5* (2017Wi15). B(E1)/B(E2)=0.30×10^{-6} fm^{-2} *3*, dipole strength D_0=0.113 e fm *7* (2017Wa50).
1729.73[b] *17*	(25/2$^+$)	B(E1)/B(E2)=0.27×10^{-6} fm^{-2} *2*, dipole strength D_0=0.119 e fm *4* (2017Wi15).

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^{252}Cf SF decay 2017Wi15,2017Wa50,1999Zh05 (continued)

^{147}La Levels (continued)

E(level)[†]	J$^{\pi}$[‡]	Comments
		B(E1)/B(E2)=0.24×10^{-6} fm^{-2} *2*, dipole strength D$_0$=0.101 e fm *6* (2017Wa50).
1770.47[a] *18*	(27/2$^-$)[#]	
1795.3 *6*		
1884.5 *8*		
1895.4[d] *3*	(25/2$^-$)	
1964.30[c] *17*	(27/2$^+$)	
2115.95[b] *18*	(29/2$^+$)	B(E1)/B(E2)=0.29×10^{-6} fm^{-2} *3*, dipole strength D$_0$=0.111 e fm *7* (2017Wa50).
2309.27[a] *19*	(31/2$^-$)[#]	B(E1)/B(E2)=3.96×10^{-6} fm^{-2} *36*, dipole strength D$_0$=0.457 e fm *21* (2017Wi15). B(E1)/B(E2)=1.3×10^{-6} fm^{-2} *1*, dipole strength D$_0$=0.235 e fm *12* (2017Wa50).
2310.99[c] *23*	(31/2$^+$)	
2427.6 *5*		
2519.31[b] *19*	(33/2$^+$)	B(E1)/B(E2)=0.29×10^{-6} fm^{-2} *6*, dipole strength D$_0$=0.111 e fm *12* (2017Wa50).
2731.9[c] *3*	(35/2$^+$)	
2752.64[a] *23*	(35/2$^-$)	B(E1)/B(E2)=1.04×10^{-6} fm^{-2} *15*, dipole strength D$_0$=0.234 e fm *17* (2017Wi15). B(E1)/B(E2)=0.11×10^{-6} fm^{-2} *2*, dipole strength D$_0$=0.068 e fm *7*, (2017Wa50).
2989.6[b] *3*	(37/2$^+$)	
3176.1[a] *3*	(39/2$^-$)	
3549[b] *1*	(41/2$^+$)	
3675.6[a] *4*	(43/2$^-$)	
4267.7[a] *10*	(47/2$^-$)	

[†] From least-squares fit to Eγ data.
[‡] As given in 2017Wa50 (all assignmets are tentative because g.s. J^{π} assignment is tentative) and in good agreement with 1999Zh05 and 2017Wi15 (which however list most J^{π} values as certain).
[#] Consistent with stretched quadrupole nature of transitions in the 212.0-346.1-keV, 346.1-454.4-keV, 528.7-sum, and 538.8-sum cascades.
[@] Consistent with dipole nature of 570.3- and 588.9-keV transitions.
[&] Consistent with stretched quadrupole nature of transitions in the 297.4-414.3-keV cascade.
[a] Band(A): Band s=+i, π=−.
[b] Band(a): Band s=+i, π=+.
[c] Band(B): Band s=−i, π=+.
[d] Band(b): Band s=−i, π=−. Tentative negative parity branch proposed by 2017Wi15 due to close proximity to the 697.5, 1030.4 and 1357.9 keV levels.

γ(^{147}La)

E$_\gamma$[†]	I$_\gamma$[‡#]	E$_i$(level)	J$_i^{\pi}$	E$_f$	J$_f^{\pi}$	Mult.[@&]	Comments
46.6[ea]	[e]	120.99	(5/2$^+$)	74.29	(7/2$^+$)		
46.6[e] *2*	4[e] *1*	167.59	(7/2$^-$)	120.99	(5/2$^+$)	D+Q[d]	Mult.: final assignment of 2017Wi15 is E1+M2.
61.9 *1*	13 *2*	229.49	(11/2$^-$)	167.59	(7/2$^-$)	E2	Mult.: from α(exp)=11.8 *15* (2017Wi15).
74.3 *1*	6 *1*	74.29	(7/2$^+$)	0.0	(5/2$^+$)	M1(+E2)[d]	Mult.: from α(exp)=2.4 *3* (2017Wa50).
93.3 *1*	5 *1*	167.59	(7/2$^-$)	74.29	(7/2$^+$)	D+Q[d]	Mult.: final assignment of 2017Wi15 is E1+M2.
105.5[a] *1*		120.99	(5/2$^+$)	15.5			
121.0[a] *5*		120.99	(5/2$^+$)	0.0	(5/2$^+$)		
138.6 *2*	4 *1*	371.69	(11/2$^+$)	233.06	(9/2$^+$)	(D+Q)	
158.8 *2*	7 *1*	233.06	(9/2$^+$)	74.29	(7/2$^+$)	(D+Q)	

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^{252}Cf SF decay 2017Wi15,2017Wa50,1999Zh05 (continued)

γ(^{147}La) (continued)

E_γ[†]	I_γ[‡#]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[@&]	Comments
166.7 *2*	3 *1*	954.18	(17/2$^-$)	787.55	(19/2$^-$)	(D+Q)	Mult.: assignment of 2017Wi15 is M1+E2.
167.6 *1*	54 *2*	167.59	(7/2$^-$)	0.0	(5/2$^+$)	D	The 167.6-212.0 keV cascade is not analyzed due to the multiplet nature of the 167γ and high conversion coefficient of the 61.9γ. Mult.: final assignment of 2017Wi15 is E1.
169.0[c] *3*	2 *1*	954.18	(17/2$^-$)	785.99	(15/2$^+$)	(D+Q)[d]	Mult.: final assignment of 2017Wi15 is E1+M2.
169.5[c] *2*	3 *1*	610.93	(13/2$^-$)	441.49	(15/2$^-$)	(E2)	
175.0[c] *2*	2 *1*	785.99	(15/2$^+$)	610.93	(13/2$^-$)	(D+Q)[d]	Mult.: final assignment of 2017Wi15 is E1+M2.
177.0[c] *2*	2 *1*	1207.60	(19/2$^+$)	1030.43	(17/2$^+$)	(D+Q)	Mult.: assignment of 2017Wi15 is M1+E2.
183[cf] *1*	1 *1*	1390.72	(21/2$^-$)	1207.60	(19/2$^+$)	(D)	Mult.: assignment of 2017Wi15 is (E1).
193.3 *1*	8 *1*	2309.27	(31/2$^-$)	2115.95	(29/2$^+$)	(D)	Mult.: assignment of 2017Wi15 is E1.
195.0 *3*	2 *1*	2310.99	(31/2$^+$)	2115.95	(29/2$^+$)	(D+Q)	Mult.: assignment of 2017Wi15 is M1+E2.
197.2[b] *5*		785.99	(15/2$^+$)	589.50	(13/2$^+$)		
198.5 *1*	12 *1*	1589.18	(23/2$^+$)	1390.72	(21/2$^-$)	(D)	Mult.: assignment of 2017Wi15 is E1.
210.0 *1*	3.2 *5*	2519.31	(33/2$^+$)	2309.27	(31/2$^-$)	(D)	Mult.: assignment of 2017Wi15 is E1.
212.0 *1*	70 *3*	441.49	(15/2$^-$)	229.49	(11/2$^-$)	E2	A_2=+0.102 *9*, A_4=+0.025 *16* for 212.0-346.1γ cascade (2017Wi15).
231.3 *1*	3.0 *3*	1589.18	(23/2$^+$)	1357.88	(21/2$^+$)	(D+Q)	Mult.: assignment of 2017Wi15 is M1+E2.
233.0 *2*	2.0 *5*	233.06	(9/2$^+$)	0.0	(5/2$^+$)	(E2)	
233.3 *2*	2.1 *4*	2752.64	(35/2$^-$)	2519.31	(33/2$^+$)	(D+Q)[d]	Mult.: final assignment of 2017Wi15 is E1+M2.
234.7 *2*	4.0 *4*	1964.30	(27/2$^+$)	1729.73	(25/2$^+$)	D+Q	Mult.: assignment of 2017Wi15 is E2, ΔJ=2 transition although ΔJ(lev)=1. A_2=+0.10 *4*, A_4=−0.01 *6* for 234.8γ-487.9γ cascade δ=0.42 or 2.3 (2017Wa50).
237.8[b] *1*		1795.3		1557.5			
253.5 *1*	9 *1*	1207.60	(19/2$^+$)	954.18	(17/2$^-$)	(D)	Mult.: assignment of 2017Wi15 is E1.
297.4 *1*	8 *2*	371.69	(11/2$^+$)	74.29	(7/2$^+$)	E2	A_2=+0.110 *24*, A_4=+0.032 *36* for 297.4-414.3γ cascade (2017Wi15). A_2=−0.10 *6*, A_4=+0.06 *9* for 297.8γ-74.4γ cascade. (2017Wa50).
306.0[f] *4*	2 *2*	1895.4	(25/2$^-$)	1589.18	(23/2$^+$)	(D)	Mult.: assignment of 2017Wi15 is (E1).
327.4 *3*	2 *1*	1357.88	(21/2$^+$)	1030.43	(17/2$^+$)	(E2)	
333[f] *1*	1 *1*	1030.43	(17/2$^+$)	697.5	(13/2$^+$)	(E2)	
343.5[c] *3*	2 *1*	954.18	(17/2$^-$)	610.93	(13/2$^-$)	(E2)	
345.6 *1*	10 *1*	2115.95	(29/2$^+$)	1770.47	(27/2$^-$)	(D)	Mult.: assignment of 2017Wi15 is E1.
346.1 *1*	100 *3*	787.55	(19/2$^-$)	441.49	(15/2$^-$)	E2	A_2=+0.095 *11*, A_4=+0.00 *1* for 346.1-454.4γ cascade (2017Wi15). A_2=+0.07 *1*, A_4=−0.01 *2* for 346.2γ-212.1γ cascade (2017Wa50).
346.7 *2*	3.1 *6*	2310.99	(31/2$^+$)	1964.30	(27/2$^+$)	(E2)	
359.7[b] *1*		589.50	(13/2$^+$)	229.49	(11/2$^-$)		
371.8 *1*	1.9 *2*	1729.73	(25/2$^+$)	1357.88	(21/2$^+$)	E2	A_2=−0.075 *42*, A_4=−0.064 *61* for 371.8-570.3γ cascade δ=−0.10 *7* (2017Wi15).
375.1 *1*	8.3 *7*	1964.30	(27/2$^+$)	1589.18	(23/2$^+$)	(E2)	
381[cf] *1*	1 *1*	610.93	(13/2$^-$)	229.49	(11/2$^-$)	(D+Q)	Mult.: M1+E2 from email reply of first author, J. Wisniewski on 20 March, 2018.
381.5 *1*	17 *1*	1589.18	(23/2$^+$)	1207.60	(19/2$^+$)	(E2)	
386.1 *1*	5.5 *7*	2115.95	(29/2$^+$)	1729.73	(25/2$^+$)	(E2)	
403.4 *1*	5 *1*	2519.31	(33/2$^+$)	2115.95	(29/2$^+$)	E2	A_2=+0.11 *5*, A_4=+0.03 *8* for 403.3γ-386.6γ cascade (2017Wa50).
414.3 *1*	15 *3*	785.99	(15/2$^+$)	371.69	(11/2$^+$)	E2	A_2=+0.11 *4*, A_4=+0.03 *6* for 414.5γ-297.8γ cascade (2017Wa50).
420.9 *2*	3 *1*	2731.9	(35/2$^+$)	2310.99	(31/2$^+$)	(E2)	

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^{252}Cf SF decay 2017Wi15,2017Wa50,1999Zh05 (continued)

γ(^{147}La) (continued)

E_γ [†]	I_γ [‡#]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [@&]	Comments
421.5 *1*	21 *2*	1207.60	(19/2$^+$)	785.99	(15/2$^+$)	(E2)	
423.5 *1*	3 *1*	3176.1	(39/2$^-$)	2752.64	(35/2$^-$)	(E2)	
436.6 *1*	9 *9*	1390.72	(21/2$^-$)	954.18	(17/2$^-$)	(E2)	
443.4 *2*	3.7 *5*	2752.64	(35/2$^-$)	2309.27	(31/2$^-$)	E2	A_2=+0.14 *3*, A_4=+0.03 *5* for 443.3γ-539.0γ cascade (2017Wa50).
454.4 *1*	45 *2*	1241.88	(23/2$^-$)	787.55	(19/2$^-$)	(E2)	
468.0[c] *3*	5 *2*	697.5	(13/2$^+$)	229.49	(11/2$^-$)	(D)	Mult.: assignment of 2017Wi15 is (E1).
470.3 *2*	0.9 *3*	2989.6	(37/2$^+$)	2519.31	(33/2$^+$)	(E2)	
487.8 *1*	11 *1*	1729.73	(25/2$^+$)	1241.88	(23/2$^-$)	D	Mult.: assignment of 2017Wi15 is E1. A_2=−0.09 *2*, A_4=−0.01 *3* for 487.9γ-454.4γ cascade (2017Wa50).
499.5 *2*	3 *1*	3675.6	(43/2$^-$)	3176.1	(39/2$^-$)	(E2)	
512.7 *2*	13 *1*	954.18	(17/2$^-$)	441.49	(15/2$^-$)	D+Q	Mult.: stronger D+Q mixing found by 2017Wa50 suggests (M1+E2) compatible with level scheme. A_2=−0.19 *3*, A_4=−0.02 *4* for 512.8γ-212.1γ cascade δ=−0.19 or −6.5 (2017Wa50). A_2=−0.085 *15*, A_4=−0.009 *22* for 512.7-212.0γ cascade δ=−0.02 *3* (2017Wa50).
528.7 *1*	23 *1*	1770.47	(27/2$^-$)	1241.88	(23/2$^-$)	E2	A_2=+0.098 *9*, A_4=+0.008 *14* for 528.7- sum γ cascade (2017Wi15). A_2=+0.09 *2*, A_4=−0.01 *3* for 528.8γ-454.4γ cascade (2017Wa50).
537.3[b] *5*		1884.5		1347.2			
538.8 *1*	10 *1*	2309.27	(31/2$^-$)	1770.47	(27/2$^-$)	E2	A_2= 0.111 *18*, A_4= 0.076 *26* for 538.8- sum γ cascade (2017Wi15). A_2=+0.08 *2*, A_4=+0.00 *3* for 539.0γ-528.8γ cascade (2017Wa50).
559[f] *1*	1 *1*	3549	(41/2$^+$)	2989.6	(37/2$^+$)	(E2)	
560.5[b] *5*		1347.2		785.99	(15/2$^+$)		
570.3 *1*	11 *1*	1357.88	(21/2$^+$)	787.55	(19/2$^-$)	D	Mult.: assignment of 2017Wi15 is E1. A_2=−0.105 *42*, A_4=−0.043 *60* for 570.3-346.1γ cascade δ=−0.06 *7* (2017Wi15). A_2=−0.08 *3*, A_4=+0.08 *5* for 570.5γ-346.2γ cascade (2017Wa50).
588.9 *1*	6 *1*	1030.43	(17/2$^+$)	441.49	(15/2$^-$)	D	Mult.: assignment of 2017Wi15 is E1. A_2=−0.68 *23*, A_4=−0.082 *35* for 588.9-212.0γ cascade δ=−0.005 *38* (2017Wi15). A_2=−0.09 *6*, A_4=+0.10 *9* for 588.8γ-212.1γ cascade (2017Wa50).
591.0[b] *5*		4267.7	(47/2$^-$)	3675.6	(43/2$^-$)		
603.1 *2*	5 *1*	1390.72	(21/2$^-$)	787.55	(19/2$^-$)	D+Q	Mult.: assignment of 2017Wi15 is M1+E2.
653.5 *2*	2 *1*	1895.4	(25/2$^-$)	1241.88	(23/2$^-$)	(D+Q)	Mult.: assignment of 2017Wi15 is M1+E2.
656.3[b] *5*		2427.6		1770.47	(27/2$^-$)		
697.2[b] *5*		2427.6		1729.73	(25/2$^+$)		
769.4[b] *5*		1557.5		787.55	(19/2$^-$)		

[†] Unless noted otherwise, from 2017Wi15 that list ΔEγ for all values (while 2017Wa50 give unc based on qualitative "strong" or "weak" type of transitions).
[‡] Relative intensities from 2017Wi15, unless noted otherwise.
[#] Additional information 1.
[@] Unless noted otherwise from angular correlations measurements of 2017Wi15 and 2017Wa50 with theoretical values A_2=0.102

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^{252}Cf SF decay 2017Wi15,2017Wa50,1999Zh05 (continued)

$\gamma(^{147}La)$ (continued)

and A_4=0.009 for pure quadrupole-quadrupole (Q-Q) cascades, and A_2=−0.071 and A_4=0.00 for pure dipole-quadrupole (D-Q) cascades (values quoted are from 2017Wi15 with very similar ones in 2017Wa50). 2017Wi15 give definite electric and magnetic multipolarities for all the transitions observed, mentioning however that some were measured by 1996Ur02 and 1999Zh05 and some are new. 2017Wa50 adopted fewer values as Q or D based on their listed measured angular correlations. Based on the heavy-ion population mechanism where Q transitions are fast stretched E2′s, the evaluator adopted E2 for stretched Q transitions. Because many D+Q transitions were adopted by 2017Wi15 as M1+E2 and E1+M2 based rather on level scheme arguments, they were here adopted as D+Q. For the same reason, although 2017Wi15 adopted many E1 transitions, they were adopted as pure D. All assignments were adopted as tentative when no proof of measurement is given by authors.

[&] The xundl compiler noted discrepancies between several multipolarities and J^π assigned in 2017Wi15. Email reply from the first author addressed these issues and the multipolarites have been changed accordingly with the appropriate footnote.

[a] γ ray observed by 2017Wa50 and 1999Zh05 but not by 2017Wi15.

[b] γ ray observed by 2017Wa50 but not by 2017Wi15 and 1999Zh05.

[c] γ ray observed by 2017Wi15 but not by 2017Wa50 and 1999Zh05.

[d] From email reply of first author, J. Wisniewski on 13 March, 2018 (2017Wi15). The multipolarities have been changed from their original assignment in 2017Wi15 with the final assignment given in comments.

[e] Multiply placed with undivided intensity.

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

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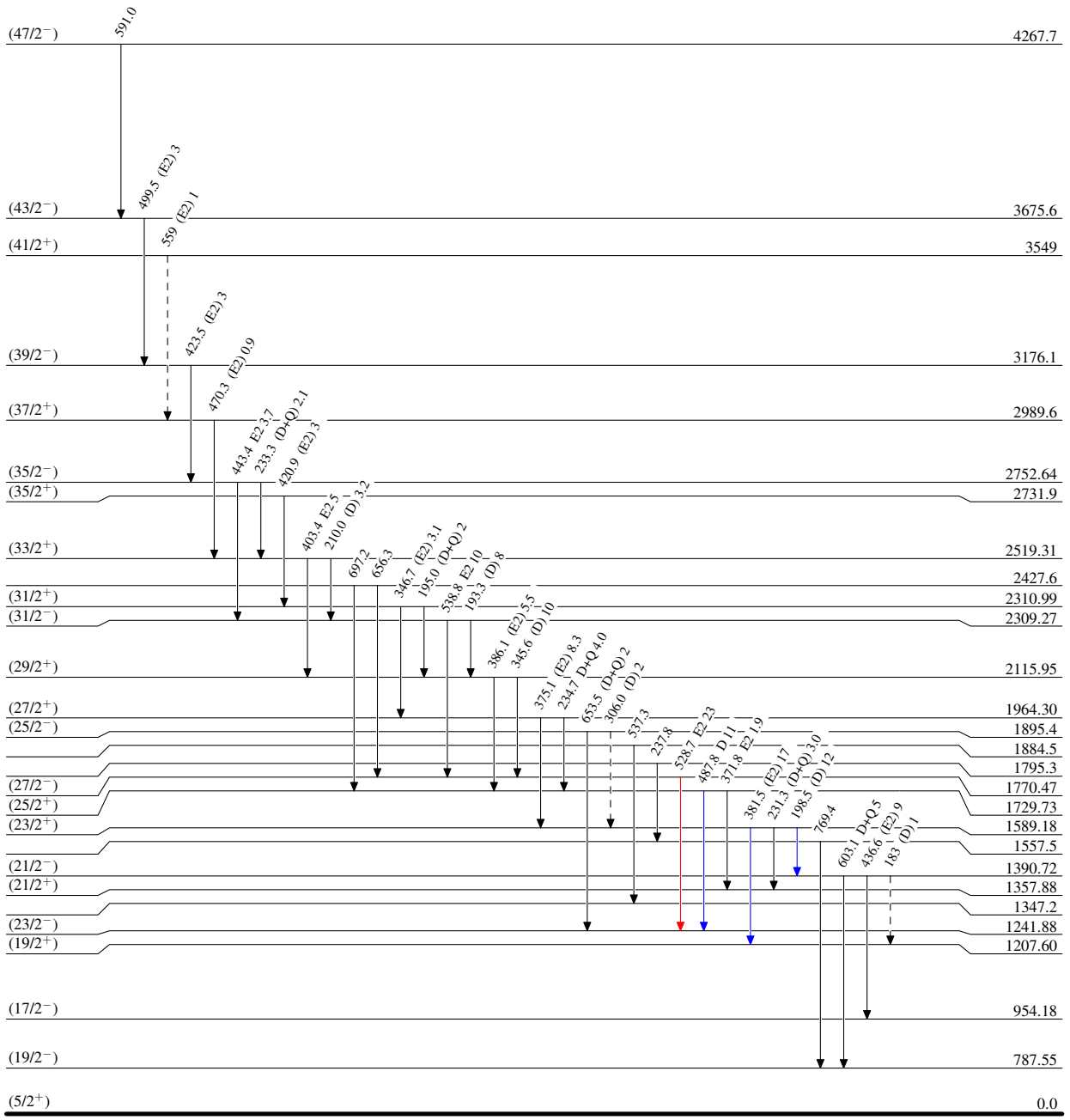
Legend

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

Level Scheme

Intensities: Relative I_γ



$^{147}_{57}La_{90}$

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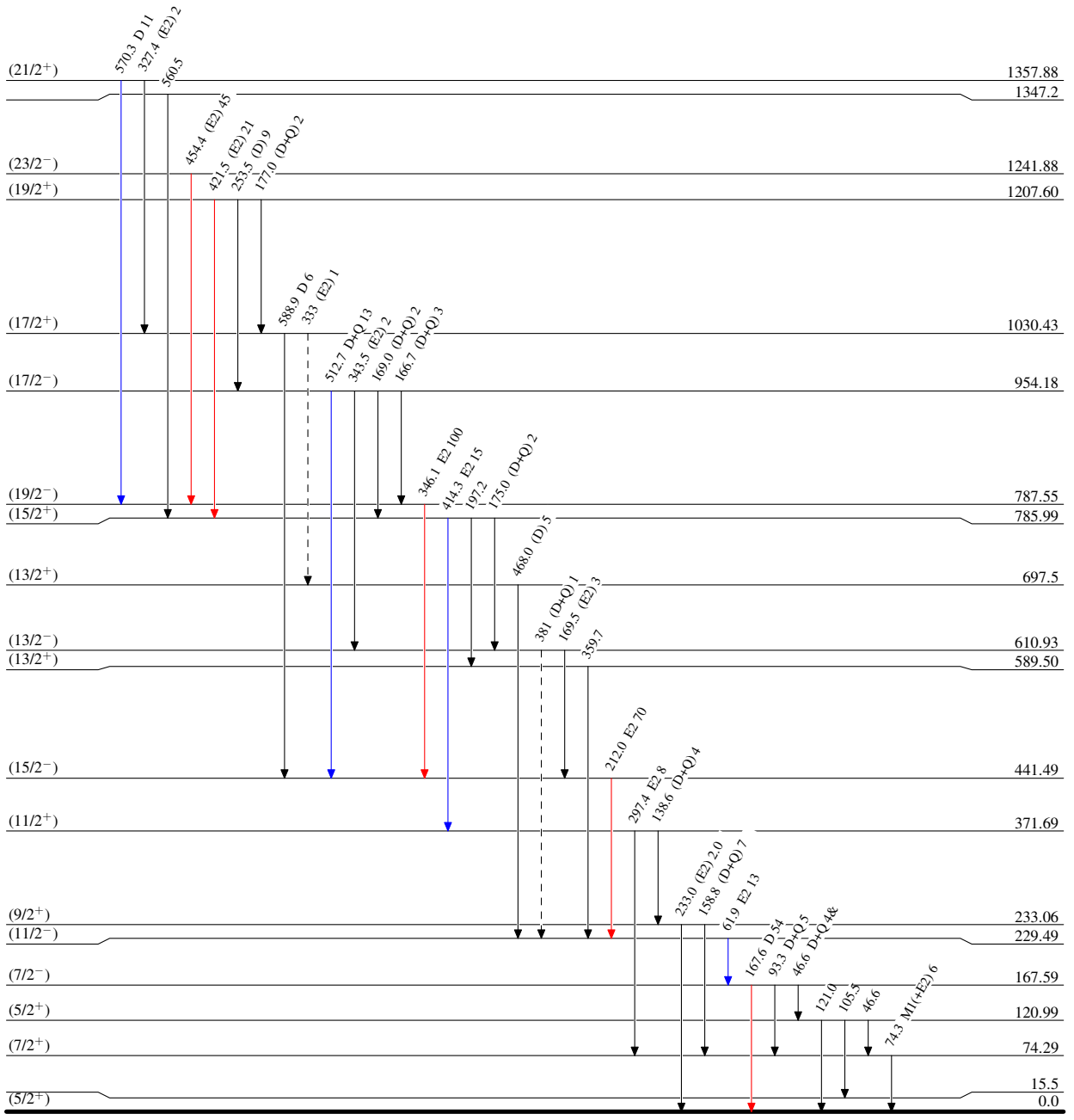
Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

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)



$^{147}_{57}La_{90}$

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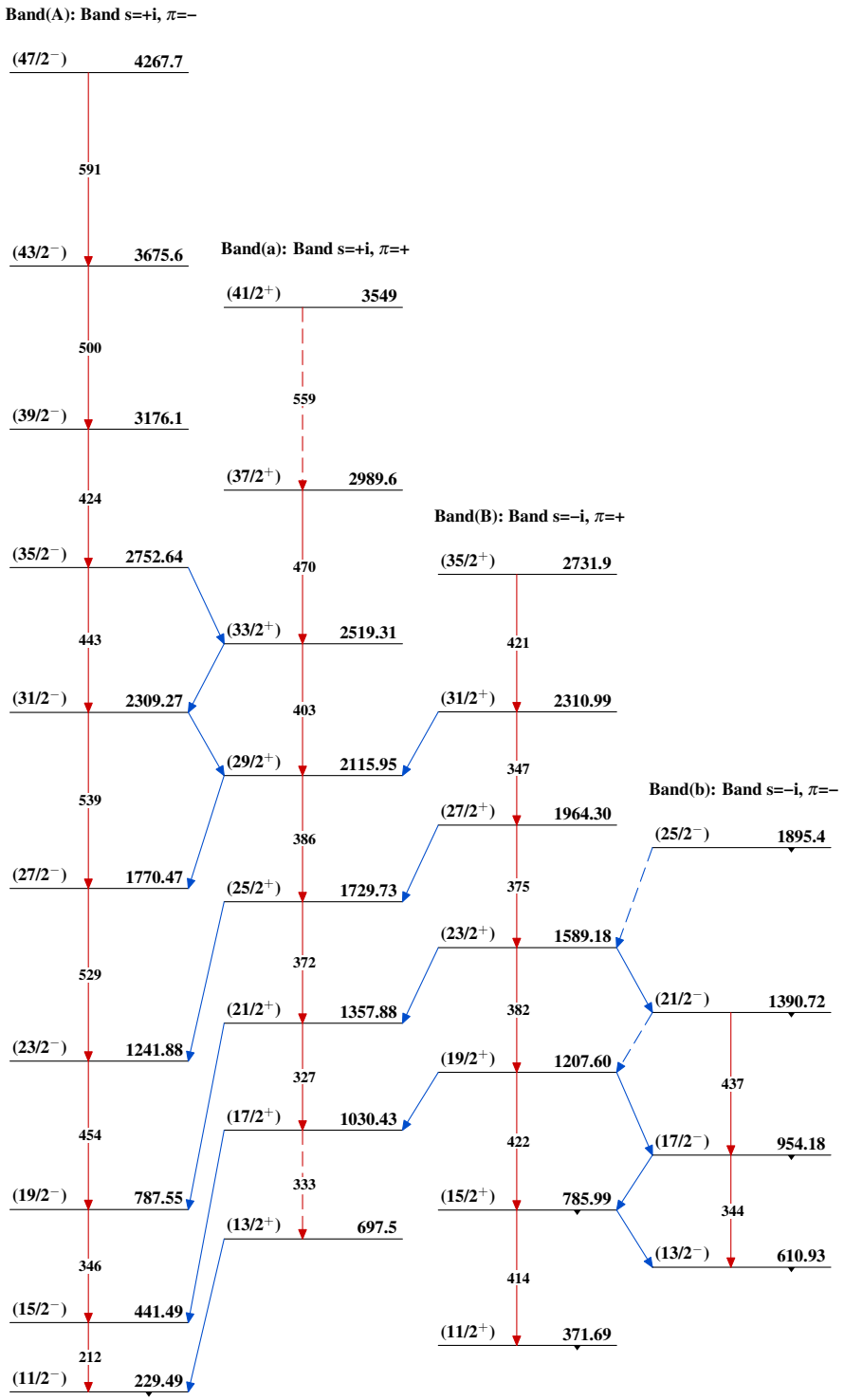

$^{147}_{57}La_{90}$