

Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	E. Browne	NDS 107,2579 (2006)	1-Nov-2004

$Q(\beta^-) = -2.75 \times 10^3$ syst; S(n)=7268 3; S(p)=6104.1 20; $Q(\alpha) = 5413.63$ 9 [2012Wa38](#)

Note: Current evaluation has used the following Q record -2750 syst 7268.0 28 6104 2 5413.63 9 [2003Au03](#).

$^{233}\text{U}(\gamma, n)$: measured cross-section ([1993De36](#)).

$T_{1/2}(^{24}\text{Ne})$: Others (mostly theoretical papers and systematic studies of cluster decay): [2004Re22](#), [2004He16](#), [2004Ba64](#), [2002Sa25](#), [2002Du16](#), [2002Ba80](#)), [2001St29](#), [1998Ro11](#), [1997Tr17](#), [1997Ro24](#), [1997MiZP](#), [1997Bu20](#), [1995Ar33](#), [1993Si26](#), [1993Ka21](#), [1993Go18](#), [1993Bu05](#), [1992Sa30](#), [1992Lu07](#), [1992Gu10](#), [1992Ar02](#), [1991Ro03](#), [1991Bu01](#), [1991Bl07](#), [1990Sh01](#), [1990Ka15](#), [1990Bu13](#), [1990Ba20](#).

 ^{232}U LevelsCross Reference (XREF) Flags

A	^{232}Pa β^- decay	D	$^{232}\text{Th}(\alpha, 4n\gamma)$, $^{230}\text{Th}(\alpha, 2n\gamma)$
B	^{232}Np ε decay	E	$^{234}\text{U}(\text{p}, \text{t})$
C	^{236}Pu α decay		

E(level) [†]	J ^π [#]	T _{1/2}	XREF	Comments
0 ^a	0+&	68.9 y 4	ABCDE	%α=100; %SF=2.7×10 ⁻¹² 6 % ²⁴ Ne=8.9×10 ⁻¹⁰ 7 T _{1/2} : Average of 69.00 y 40 (specific activity) and 68.81 y 38 (activity ratio relative to T _{1/2} =1.592×10 ⁵ y for ²³³ U, mass spectrometry (1979Ag04, 1986Ag01). Others: 73.6 y 10 (2π a counting, specific activity) (1954Se26); 71.4 y 6 (calorimetry) and 72.1 y 5 (2π a counting, specific activity)(1964Ch05). Others: 1949Go01, 1949Ja01). Analysis of alpha spectra: 2003Ba64, 1999Sa15, 1999Go26, 1999De51, 1996Ca30, 1994To17, 1993Ba72, 1991Kr18, 1990Ca43. %SF: From T _{1/2} (SF)=2.6×10 ¹⁵ y 5 (solid-state track detection corrected for cluster decay (2000Bo46). Other values: T _{1/2} (SF)>6.84×10 ¹⁵ y (1990Bo16); T _{1/2} (SF)=0.080×10 ¹⁵ y 55 (1957Hy90), this value may have been affected by detection of ²⁴ Ne (1990Bo16); T _{1/2} (SF)>0.008×10 ¹⁵ y (1952Se67). % ²⁴ Ne: From 1991Bo20. Other values:% ²⁴ Ne=8.5×10 ⁻¹⁰ 7, from T _{1/2} (²⁴ Ne)=8.1×10 ¹² y 7 (1990Bo16); % ²⁴ Ne=2.0×10 ⁻¹⁰ 5, from T _{1/2} (²⁴ Ne)=3.4×10 ¹³ y 8 (1985Ba18).
47.573 ^a 8	2+&	245 ps 20	ABCDE	J ^π : 47.57γ E2 to 0 ⁺ .
156.566 ^a 10	4+&		ABCDE	
322.69 ^a 7	6+&		ABCD	
541.1 ^a 1	8+&		CDE	
563.194 ^b 7	1-@		A CD	
628.965 ^b 8	3-@		A CD	J ^π : 563.197γ E1 to 0 ⁺ . J ^π : E1 to g.s.
691.42 ^c 9	0+		A CDE	J ^π : 581.398γ E1 to 2 ⁺ , 472.39γ E1 to 4 ⁺ . J ^π : E1 to 2 ⁺ , 4 ⁺ .
734.57 ^c 5	2+		A CDE	J ^π : 691.3γ E0 to 0 ⁺ , L=0 in ²³⁴ U(p,t).
746.8 ^b 1	(5-) [@]		CD	J ^π : 687.04γ E0 to 2 ⁺ .
805.88 ^a 16	10+&		D	
833.07 ^c 20	4+		A CDE	J ^π : 676.5γ E0 to 4 ⁺ .
866.790 ^d 8	2+		ABC E	J ^π : 866.760γ E2 to 0 ⁺ .
911.49 ^d 4	(3) ⁺		AB	J ^π : 176.3γ M1, E2 to 2 ⁺ , 754.8γ E2 to 4 ⁺ .
915.2 ^b 4	(7-) [@]		D	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{232}U Levels (continued)

E(level) [†]	J ^π #	T _{1/2}	XREF	Comments
927.3 ^g 1	(0 ⁺)		C E	J ^π : HF=15 in ^{236}Pu ($J^{\pi}=0^{+}$) α Decay.
967.6 ^g 1	(2 ⁺)		C E	J ^π : 920.23 γ M1+E2 to 2 ⁺ , 967.9 γ to 0 ⁺ .
970.71 ^d 7	(4 ⁺)		AB E	J ^π : Rotational structure, 923.1 γ to 2 ⁺ , 814.2 γ to 4 ⁺ .
984.9 ^c 2	6 ⁺		D	J ^π : 662.2 γ E0 to 6 ⁺ .
1016.850 ^e 8	2 ⁻	<50 ps	AB	J ^π : 1016.4 γ M2 to 0 ⁺ . Additional information 1.
1050.90 ^e 1	3 ⁻	<50 ps	AB E	J ^π : 1003.28 γ E1 to 2 ⁺ , 894.351 γ E1 to 4 ⁺ .
1098.2 ^e 4	(4 ⁻)		B	Additional information 2.
1111.6 ^a 2	12 ⁺ &		D	J ^π : 305.7 γ E2 to 10 ⁺ .
1131.1 ^b 6	(9 ⁻)@		D	
1132.97 10	(2 ⁺)		AB	J ^π : 1085.4 γ E1,E2 to 2 ⁺ , and 1132.7 γ E1,E2 to 0 ⁺ suggests $J^{\pi}=1^{+}$, 1 ⁻ , or 2 ⁺ . Level feeding from ^{232}Np ε decay suggests $J^{\pi}=2^{+}$. Additional information 3.
1173.06 ^f 17	(2 ⁻)		AB	J ^π : 1125.48 γ E1 to 2 ⁺ , no γ -ray decay observed to 0 ⁺ , 4 ⁺ . Additional information 4.
1186.6 ^c 4	8 ⁺		D	J ^π : 645.5 γ E0 to 8 ⁺ .
1194.0 2	(3 ⁺ ,4 ⁺)		B E	J ^π : log $ft=5.2$ in ^{232}Np ε decay suggests an allowed ε transition, thus $J^{\pi}=3^{+}, 4^{+}, 5^{+}$. 327.3 γ to 2 ⁺ suggests $J^{\pi}\leq 4$. Additional information 5.
				2-neutron level from low log ft in ^{232}Np ε decay; possible configuration=((ν 5/2[633])(ν 3/2[631])) resulting in $J^{\pi}=4^{+}$ (suggesting that the 1193.9 γ is misplaced). It compares with log ft' s ≈ 5.3 for analogous transitions in the decays of ^{233}Np and ^{235}Pu (π 5/2[642]) to (ν 5/2[633]). No other log ft' s in the actinide region are that low.
1211.3 ^f 3	3 ⁻		A E	Additional information 6.
				J ^π : 1054.5 γ E1 to 4 ⁺ , 1164.5 γ E1 to 2 ⁺ .
1227 [‡]			E	
1277.2 [‡] 4	0 ⁺		E	J ^π : L=0 in ^{234}U (p,t).
1301 [‡]			E	
1349 [‡]			E	
1390.9 ^b 6	11 ⁻ @		DE	
1434.3 ^c 5	10 ⁺		DE	J ^π : 628.4 γ E0 to 10 ⁺ .
1438 [‡]			E	
1453.8 ^a 3	14 ⁺ &		D	J ^π : 342.2 γ E2 to 12 ⁺ .
1482.0 [‡] 4	0 ⁺		E	J ^π : L=0 in ^{234}U (p,t).
1489 [‡]			E	
1520 [‡]			E	
1569.0 [‡] 4	0 ⁺		E	J ^π : L=0 in ^{234}U (p,t).
1600 [‡]			E	
1646 5			E	
1746 [‡]			E	
1772 [‡]			E	
1797.0 [‡] 4	0 ⁺		E	J ^π : L=0 in ^{234}U (p,t).
1822.1 [‡] 4	0 ⁺		E	J ^π : L=0 in ^{234}U (p,t).
1828.2 ^a 4	16 ⁺ &		D	J ^π : 374.4 γ E2 to 14 ⁺ .
1861.5 [‡] 4	0 ⁺		E	J ^π : L=0 in ^{234}U (p,t).
1872 [‡]			E	
1931.8 [‡] 4	0 ⁺		E	J ^π : L=0 in ^{234}U (p,t).

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Adopted Levels, Gammas (continued) ^{232}U Levels (continued)

E(level) [†]	J^π [#]	XREF	Comments
1972 [‡]		E	
1979 [‡]		E	
1998 [‡]		E	
2023.2 ^b 1	(15 ⁻) [@]	D	
2043 [‡]		E	
2061 [‡]		E	
2072 [‡]		E	
2147 [‡]		E	
2172 [‡]		E	
2204 [‡]		E	
2231.6 ^a 6	18 ⁺ &	DE	J^π : 403.4 γ E2 to 16 ⁺ .
2284 [‡]		E	
2333 [‡]		E	
2659.8 ^a 9	(20 ⁺)&	D	J^π : 428.2 γ (E2) to 18 ⁺ .

[†] Deduced by evaluator from a least squares fit of adopted γ -ray energies, unless otherwise specified.

[‡] From $^{234}\text{U}(\text{p,t})$.

[#] Most J^π assignments are based on rotational band structure. For some individual levels additional arguments based on γ -ray multipolarities are given.

[@] Rotational band structure, γ -ray deexcitation.

& Rotational band structure, γ -ray cascade of stretched E2 transitions in $^{232}\text{Th}(\alpha,4n\gamma)$ and Coulomb excitation.

^a Band(A): $K^\pi=0^+$ g.s. rotational band.

^b Band(B): $K^\pi=0^-$ Octupole vibrational band.

^c Band(C): $K^\pi=0^+$ Beta vibrational band.

^d Band(D): $K^\pi=2^+$ Gamma vibrational band.

^e Band(E): $K^\pi=2^-$.

^f Band(F): $K^\pi=(1)^-$.

^g Band(G): $K^\pi=(0^+)$ Two-phonon octupole vibrational band.

Adopted Levels, Gammas (continued)

$\gamma(^{232}\text{U})$									
$E_i(\text{level})$	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult.	$\alpha^{\&}$	$I_{(\gamma+ce)}$	Comments
47.573	2 ⁺	47.57 [‡] 2	100 [‡]	0	0 ⁺	E2	464		B(E2)(W.u.)=241 2/
156.566	4 ⁺	108.95 [‡] 2	100 [‡]	47.573	2 ⁺	E2	9.15		
322.69	6 ⁺	166.09 [‡] 7	100 [‡]	156.566	4 ⁺	E2	1.58		
541.1	8 ⁺	218.4 [#] 1	100 [#]	322.69	6 ⁺	E2	0.554		
563.194	1 ⁻	515.607 [†] 9	100 [†] 3	47.573	2 ⁺	E1	0.01274		
		563.197 [†] 7	69 [†] 2	0	0 ⁺	E1	0.01074		
628.965	3 ⁻	472.390 [†] 6	64 [†] 2	156.566	4 ⁺	E1	0.01516		
		581.398 [†] 8	100 [†] 3	47.573	2 ⁺	E1	0.01010		
691.42	0 ⁺	643.87 ^{‡a} 3	[‡]	47.573	2 ⁺	[E2]	0.027		
		691.3 [‡] 1	[‡]	0	0 ⁺	E0		100	
734.57	2 ⁺	577.95 [‡] 10	39 [‡] 7	156.566	4 ⁺				
		687.04 [‡] 10	75 [‡] 3	47.573	2 ⁺	E0+[E2]		100	
		(734.55 [‡] 10)	100 [‡] 4	0	0 ⁺	[E2]		<60	
746.8	(5 ⁻)	423.85 [‡] 20	35 [‡] 2	322.69	6 ⁺				
		590.28 [‡] 10	100 [‡] 6	156.566	4 ⁺				
805.88	10 ⁺	264.8 [#] 1	100 [#]	541.1	8 ⁺	E2	0.286		
833.07	4 ⁺	676.5 [#] 2	[#]	156.566	4 ⁺	E0+[E2]			
866.790	2 ⁺	132.5 [†] 2	0.13 [†] 6	734.57	2 ⁺	M1,E2	7 3		
		174.9 [†] 2	0.13 [†] 3	691.42	0 ⁺	[E2]	1.268		
		710.1 [†] 3	2.8 [†] 1	156.566	4 ⁺	E2	0.02206		
		819.187 [†] 13	100 [†] 1	47.573	2 ⁺	E2	0.017		
		866.760 [†] 19	77 [†] 2	0	0 ⁺	E2	0.01484		
911.49	(3) ⁺	176.3 [†]	0.2 [†] 1	734.57	2 ⁺	M1,E2	3.0 1/		
		754.8 [†] 2	28 [†] 2	156.566	4 ⁺	E2	0.01950		
		863.89 [†] 4	100 [†] 4	47.573	2 ⁺	E2	0.01494		
		911.4 ^{†a}	0.60 [†] 5	0	0 ⁺	[M3]	0.2282		
915.2	(7 ⁻)	374.2 [#] 5	[#]	541.1	8 ⁺				
		592.4 [#] 5	[#]	322.69	6 ⁺				
927.3	(0 ⁺)	364.0 [‡] 1	100 [‡] 14	563.194	1 ⁻	[E1]	0.0260		$\alpha(\text{K})=0.0208$; $\alpha(\text{L})=0.00392$; $\alpha(\text{M})=0.00094$; $\alpha(\text{N}+..)=0.00033$
		879.9 [‡] 1	0.19 [‡] 1	47.573	2 ⁺	[E2]	0.0144		$\alpha(\text{K})=0.0106$; $\alpha(\text{L})=0.00284$
967.6	(2) ⁺	338.5 [‡] 1	100 [‡] 2	628.965	3 ⁻	[E1]	0.0304		$\alpha(\text{K})=0.0243$; $\alpha(\text{L})=0.00462$; $\alpha(\text{M})=0.00110$; $\alpha(\text{N}+..)=0.00039$
		404.46 [‡] 10	76 [‡] 2	563.194	1 ⁻	[E1]	0.0209		$\alpha(\text{K})=0.0168$; $\alpha(\text{L})=0.00310$; $\alpha(\text{M})=0.00074$; $\alpha(\text{N}+..)=0.00026$

Adopted Levels, Gammas (continued)

$\gamma(^{232}\text{U})$ (continued)										
$E_i(\text{level})$	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult.	δ	$\alpha^{\&}$	$I_{(\gamma+ce)}$	Comments
967.6	(2) ⁺	811.26 [‡] 20	13.0 [‡] 2	156.566	4 ⁺	[E2]		0.0169		$\alpha(\text{K})=0.0123$; $\alpha(\text{L})=0.00348$
		920.23 [‡] 20	13.0 [‡] 2	47.573	2 ⁺	M1+E2	1.14 20	0.030 4		$\alpha(\text{K})=0.024$ 3; $\alpha(\text{L})=0.0049$ 6
		967.9 [‡] 3	5 [‡] 1	0	0 ⁺	[E2]		0.0120		$\alpha(\text{K})=0.0090$; $\alpha(\text{L})=0.00226$
970.71	(4) ⁺	814.2 [‡] 1	100 [‡] 30	156.566	4 ⁺					
		923.1 [‡]	45 [‡] 14	47.573	2 ⁺					
984.9	6 ⁺	662.2 [#] 2	[#]	322.69	6 ⁺	E0			100	
1016.850	2 ⁻	105.4 [‡] 1	3.5 [‡] 4	911.49	(3) ⁺	[E1]		0.1102		
		150.059 [‡] 3	24.7 [‡] 12	866.790	2 ⁺	E1		0.1962		
		282.2 1	0.023 12	734.57	2 ⁺	[E1]		0.0452		
		387.884 [‡] 4	15.2 [‡] 3	628.965	3 ⁻	E2+M1	4.6 5	0.111 5		
		453.655 [‡] 5	19.7 [‡] 5	563.194	1 ⁻	E2+M1	2.8 3	0.093 7		
		969.315 [‡] 11	100 [‡] 1	47.573	2 ⁺	E1		0.00397		
		1016.4 [‡] 4	0.030 [‡] 5	0	0 ⁺	M2		0.0915		
		80.23 [‡] 10	2.7 [‡] 4	970.71	(4) ⁺	[E1]		0.2255		
1050.90	3 ⁻	139.2 [‡] 1	4.7 [‡] 3	911.49	(3) ⁺	[E1]		0.2327		
		184.101 [‡] 9	11.8 [‡] 3	866.790	2 ⁺	[E1]		0.1208		
		421.932 [‡] 7	12.7 [‡] 10	628.965	3 ⁻	E2+M1	1.96 15	0.145 1		
		894.351 [‡] 12	100.0 [‡] 15	156.566	4 ⁺	E1		0.00457		
		1003.28 [‡] 4	0.80 [‡] 4	47.573	2 ⁺	E1		0.00373		
		1051.4 [‡] 1	0.087 [‡] 10	0	0 ⁺	[E3]		0.026		
1098.2	(4) ⁻	941.6 [‡] 4	100 [‡]	156.566	4 ⁺					
1111.6	12 ⁺	305.7 [#] 1	100 [#]	805.88	10 ⁺	E2		0.182		
1131.1	(9) ⁻	590.0 [#] 5	100 [#]	541.1	8 ⁺					
1132.97	(2) ⁺	1085.4 [‡] 1	100 [‡] 8	47.573	2 ⁺	(E2)				Mult.: E1 or E2. Decay scheme requires E2.
		1132.7 [‡] 7	38 [‡] 12	0	0 ⁺	(E2)				Mult.: E1 or E2. Decay scheme requires E2.
1173.06	(2) ⁻	1125.48 [‡] 17	100 [‡]	47.573	2 ⁺	E1		0.003		
1186.6	8 ⁺	645.5 [#] 3	[#]	541.1	8 ⁺	E0			100	
1194.0	(3 ⁺ , 4 ⁺)	143.4 [@] 5	0.8 [@] 2	1050.90	3 ⁻	[E1]		0.22		
		223.6 [@] 4	4.3 [@] 3	970.71	(4) ⁺	[E2]		0.51		
		282.0 [@] 4	38 [@] 2	911.49	(3) ⁺	[E2]		0.23		
		327.3 [@] 3	100 [@]	866.790	2 ⁺	[E2]		0.148		
		1037.4 [@] 5	6.3 [@] 4	156.566	4 ⁺					
		1146.3 [@] 5	0.7 [@] 1	47.573	2 ⁺					

Adopted Levels, Gammas (continued)

$\gamma(^{232}\text{U})$ (continued)								
$E_i(\text{level})$	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult.	$\alpha^\&$	$I_{(\gamma+ce)}$
1194.0	(3 ⁺ ,4 ⁺)	1193.9@ ^a 6	0.7@ ^a 2	0	0 ⁺			
1211.3	3 ⁻	1054.5 [†] 3	100 [†] 6	156.566	4 ⁺	E1	0.00342	
		1164.5 [†] 5	23 [†] 4	47.573	2 ⁺	E1	0.00289	
1390.9	11 ⁻	585.0 [#] 5	100 [#]	805.88	10 ⁺			
1434.3	10 ⁺	628.4 [#] 4	[#]	805.88	10 ⁺	E0		100
1453.8	14 ⁺	342.2 [#] 2	100 [#]	1111.6	12 ⁺	E2	0.1297	
1828.2	16 ⁺	374.4 [#] 2	100 [#]	1453.8	14 ⁺	E2	0.1007	
2023.2	(15 ⁻)	569.4 [#]	100 [#]	1453.8	14 ⁺	[E1]		
2231.6	18 ⁺	403.4 [#] 5	100 [#]	1828.2	16 ⁺	E2		
2659.8	(20 ⁺)	428.2 [#] 6	100 [#]	2231.6	18 ⁺	(E2)		

[†] From ²³²Pa β^- decay.

[‡] From ²³⁶Pu α decay.

[#] From ²³²Th(α ,4n γ), ²³⁰Th(α ,2n γ).

@ From ²³²Np ε decay.

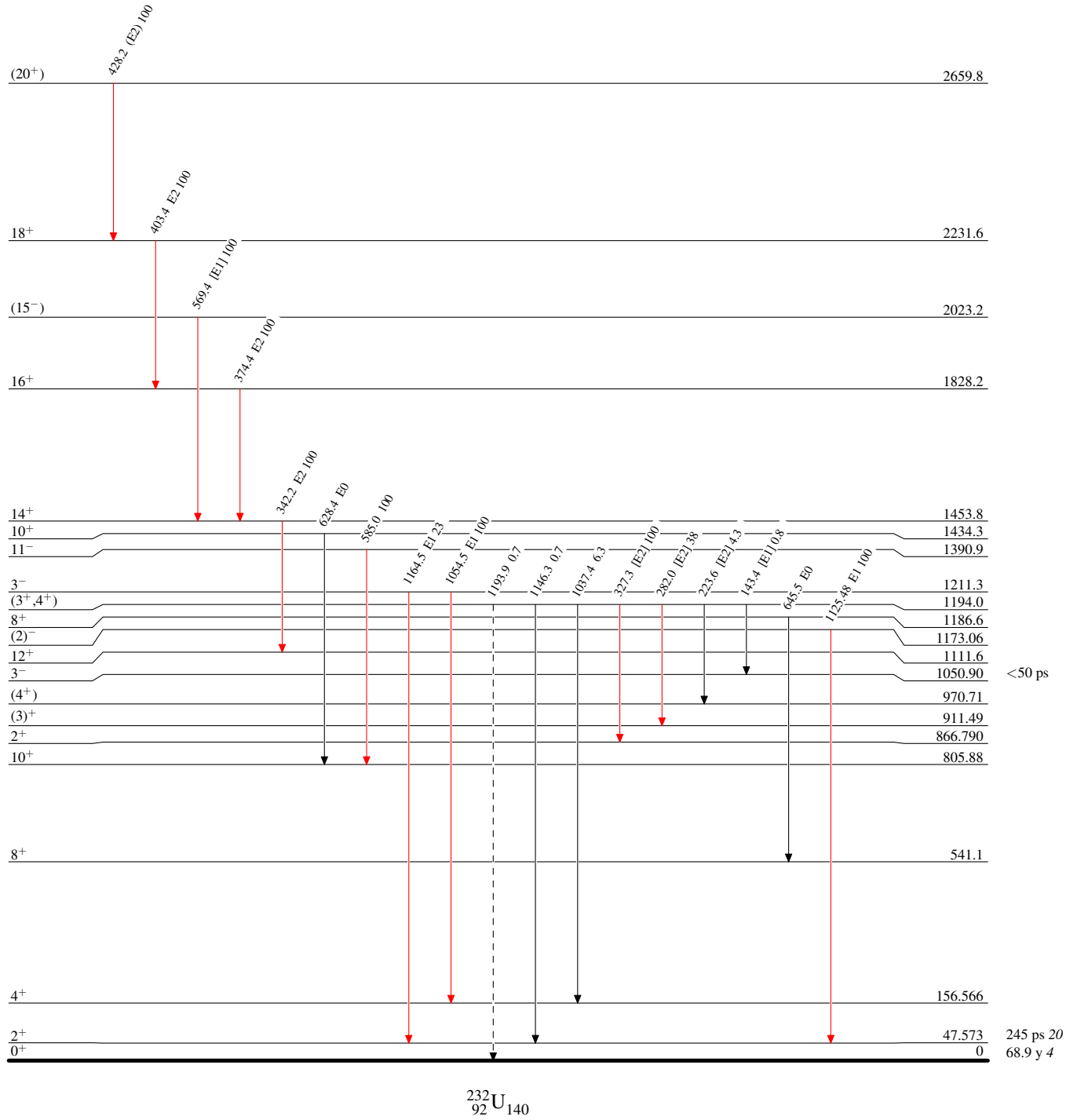
& Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ -ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

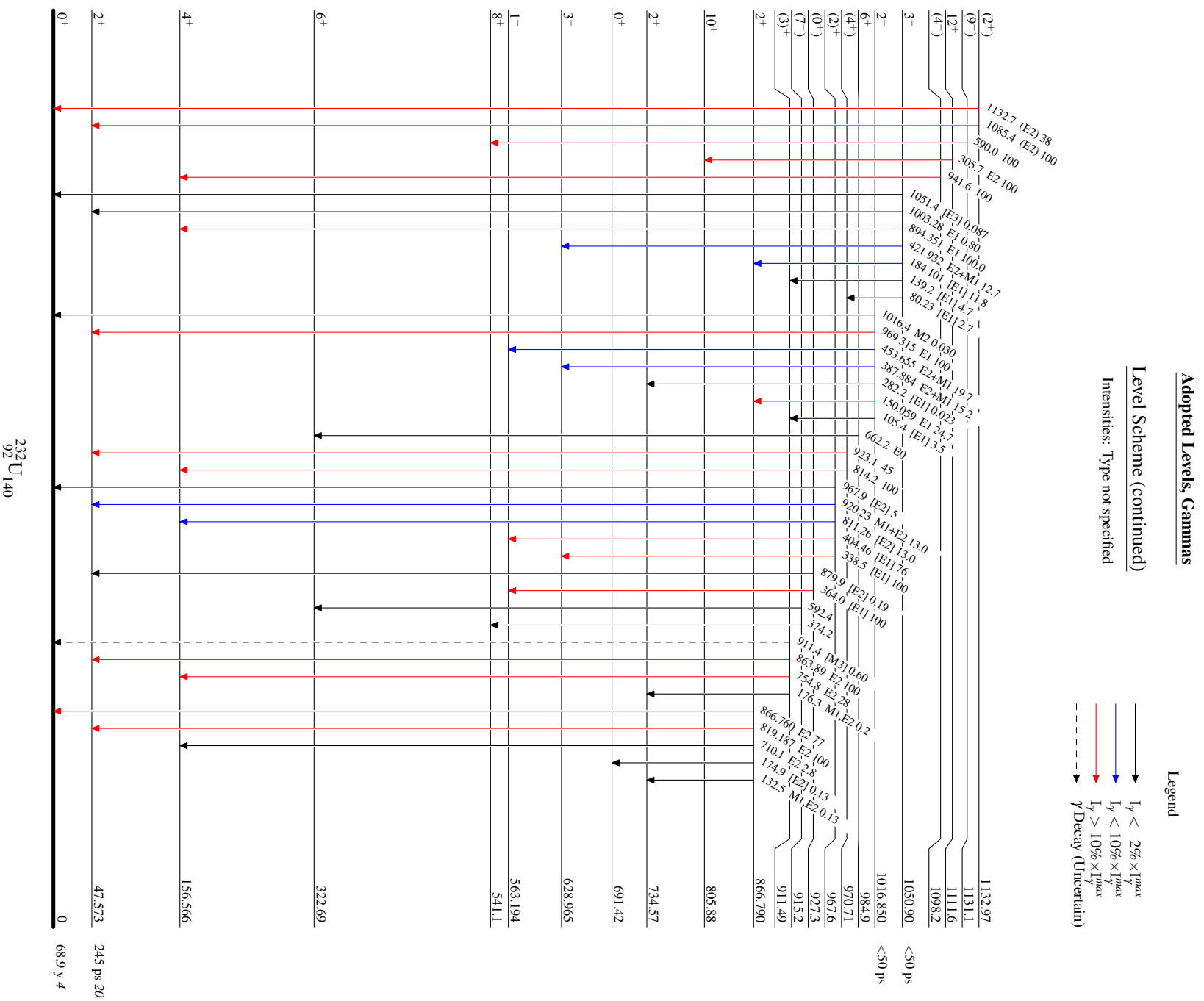
^a Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas**Legend****Level Scheme**

Intensities: Type not specified

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





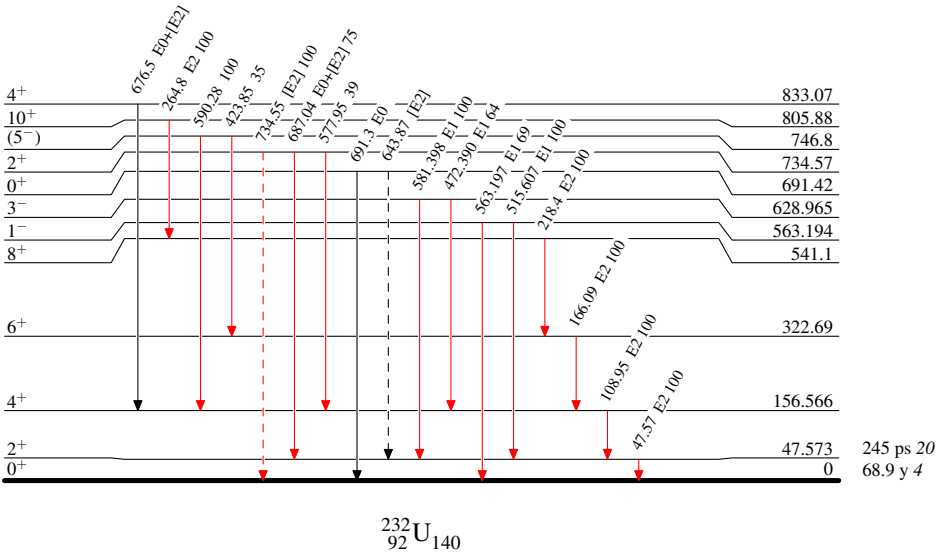
Adopted Levels, Gammas

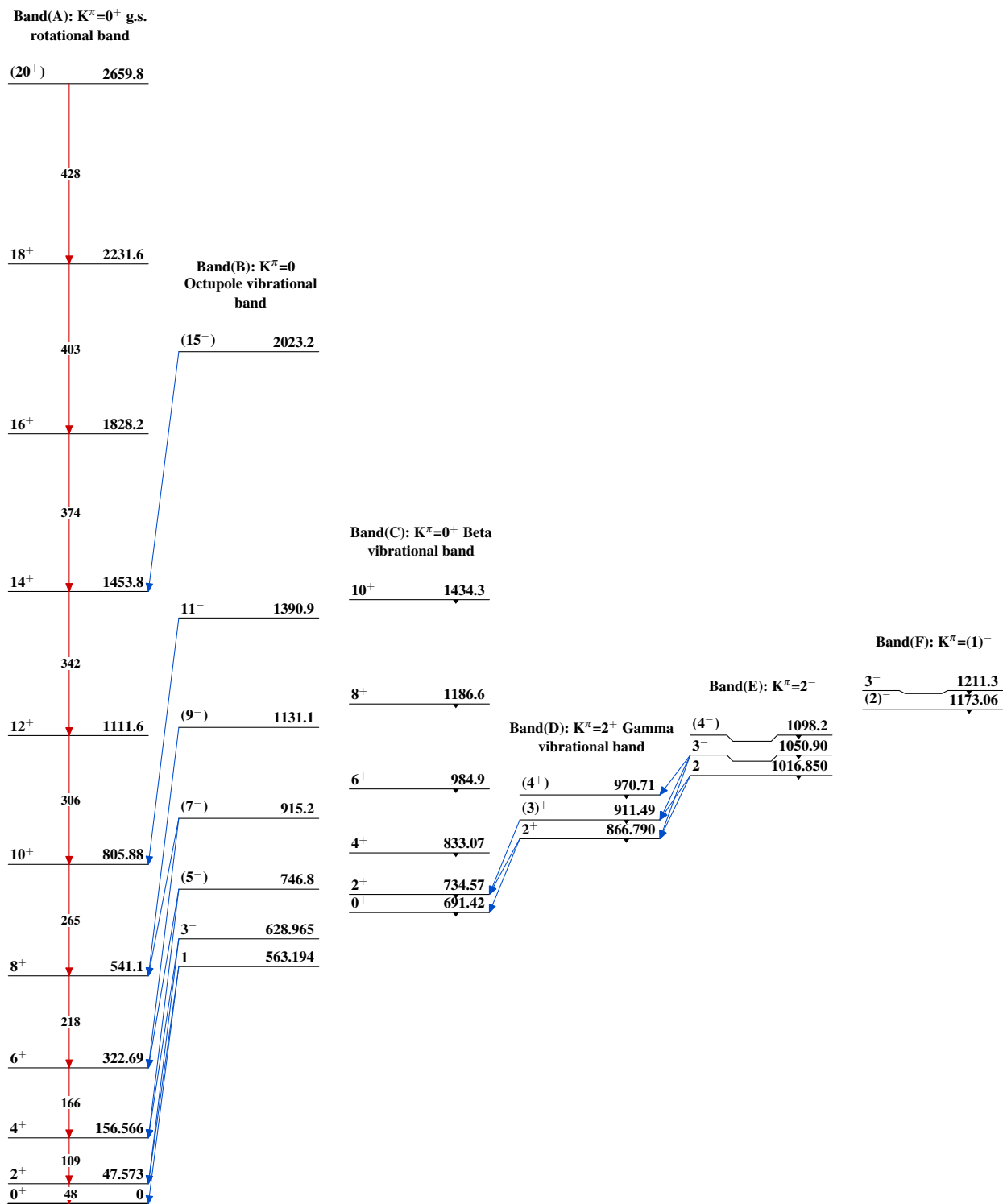
Legend

Level Scheme (continued)

Intensities: Type not specified

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



Adopted Levels, Gammas

Adopted Levels, Gammas (continued)

Band(G): K^π=(0⁺)
Two-phonon octupole
vibrational band

<u>(2)⁺</u>	<u>967.6</u>
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<u>(0⁺)</u>	<u>927.3</u>
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²³²₉₂U₁₄₀