

Adopted Levels, Gammas

Type	History		Literature Cutoff Date
	Author	Citation	
Full Evaluation	Balraj Singh	ENSDF	30-Sep-2020

$Q(\beta^-)=2703.5$ 17; $S(n)=6071.29$ 5; $S(p)=12205.2$ 20; $Q(\alpha)=-8044.4$ 19 [2017Wa10](#)

$S(2n)=15498.53$ 7, $S(2p)=23231.9$ 20 ([2017Wa10](#)).

[1939Sa02](#), [1941Se03](#): ^{77}Ge isotope identified and produced in bombardment of Ge by deuterons and Se by slow and fast neutrons, and subsequent counting of β spectra.

[Additional information 1](#).

Theoretical calculations: consult the NSR database at www.nndc.bnl.gov for 11 primary theory references dealing with nuclear structure calculations.

 ^{77}Ge LevelsCross Reference (XREF) Flags

A	^{77}Ga β^- decay (13.2 s)	E	$^{76}\text{Ge}(\text{pol d,p}),(\text{d,p})$
B	^{77}Ge IT decay (53.7 s)	F	$^{76}\text{Ge}(\alpha,^3\text{He})$
C	$^{76}\text{Ge}(n,\gamma)$ E=thermal	G	$^{76}\text{Ge}(^{13}\text{C},^{12}\text{C}\gamma)$
D	$^{76}\text{Ge}(n,n), (n,\gamma)$: resonances		

E(level) [†]	J ^π	T _{1/2}	XREF	Comments
0.0	7/2 ⁺	11.211 h 3	ABC E G	$\% \beta^- = 100$ J ^π : octupole transition from 159.7, 1/2 ⁻ level; $\log ft = 8.64$ ($\log f^{\text{th}} t = 9.87$) to 215.5, 3/2 ⁻ level in ^{77}As . T _{1/2} : from time decay of ten different γ rays from the decay of ^{77}Ge followed over ≈ 10 half-lives (2007Li06). Others: 11.248 h 2 (1995An38), 11.30 h 1 (1968Re04 , earlier reports: 11.30 h 3 in 1965Em03 , 12 h 1 in ORNL-867, 24 (1950)), 11.3 h 3 (1957Ly49), ≈ 11 h (1950St02), ≈ 12 h (1941Se03), ≈ 8 h (1939Sa02). Values from 2007Li06 , 1995An38 and 1968Re04 present a discrepant set of data, the weighted average giving a reduced $\chi^2 = 70$. The value from 2007Li06 is adopted here as it represents a largest set of measurements (56 spectra, 10 γ rays, followed over 10 half-lives). Weighted average of all three values is 11.238 h 11 with reduced $\chi^2 = 72$, unweighted average = 11.253 h 26.
159.71 6	1/2 ⁻	53.7 s 6	ABC EFG	$\% \beta^- = 81$ 2; $\% \text{IT} = 19$ 2 J ^π : L(d,p)=1 and Ay(θ) in (pol d,p). T _{1/2} : weighted average of 52.9 s 6 (1974Gr29), 56 s 2 (1970Me20), 54.0 s 6 (1970OsZZ), 55.5 s 10 (1969Im02), 53.5 s 5 (1968Ma12), 53.6 s 9 (1957Ly49) and 52 s 2 (1954Bu94). Others: 59 s 2 (1965Va12) and 59 s 2 (1947Ar01) are omitted since these seem discrepant.
224.96 7	9/2 ⁺		C EFG	J ^π : L(d,p)=4 and Ay(θ) in (pol d,p).
421.39 6	5/2 ⁺		A C E G	XREF: A(?)E(428). J ^π : L(d,p)=2, $\Delta J = 1$ γ to 7/2 ⁺ .
492.05 6	5/2 ⁻		C EFG	XREF: E(?). J ^π : L($\alpha,^3\text{He}$)=3 dominant with some mixture of L=2; $\Delta J = 1$, dipole γ to 7/2 ⁺ . L=2 component is probably contributed by 505, 5/2 ⁺ level.
504.76 6	5/2 ⁺		C E G	XREF: E(510). J ^π : L=2 and Ay(θ) in (pol d,p).
618.86 6	(3/2 ⁺)		A C G	J ^π : gammas to 7/2 ⁺ ; $\Delta J = 1$, dipole γ to 1/2 ⁻ .
629.68 7	3/2 ⁻		A C E G	J ^π : L=1 and Ay(θ) in (pol d,p).
760.53 6	7/2 ⁽⁺⁾		C G	J ^π : $\Delta J = 1$, (M1+E2) gammas to 5/2 ⁺ and 9/2 ⁺ .
809.09 17			G	
884.19 9	5/2 ⁺		C E G	J ^π : L=2 and Ay(θ) in (pol d,p).
910.61 9	(5/2 ⁺ , 7/2 ⁺)		C G	J ^π : gammas to (3/2 ⁺) and 9/2 ⁺ .

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{77}Ge Levels (continued)

E(level) [†]	J ^π	XREF	Comments
1021.58 6	3/2 ⁻	A C E G	J ^π : L(d,p)=1; strong primary γ from 1/2 ⁺ ; not 1/2 from 862γ(θ).
1048.05 8	(1/2,3/2)	A C	J ^π : gammas to 1/2 ⁻ and (3/2 ⁺); γ from 1/2 ⁺ .
1052.73 8	1/2 ⁻ ,3/2 ⁻	C E G	J ^π : L(d,p)=1; primary γ from 1/2 ⁺ .
1110.68 17		EFG	XREF: F(1100).
1189? 10	(7/2 ⁺ ,9/2 ⁺)	E	J ^π : L(d,p)=(4).
1247.00 8	1/2 ⁺	C E G	J ^π : L(d,p)=0; primary γ from 1/2 ⁺ .
1275.41 13		G	
1286.53 13		G	
1344.67 21		G	
1359.08 13	(1/2,3/2,5/2)	A C G	J ^π : gammas to 3/2 ⁻ and (3/2 ⁺).
1385.28 6	5/2 ⁺	C EFG	XREF: E(1386). J ^π : L(d,p)=2 and Ay(θ) in (pol d,p). There is severe disagreement in gamma-ray branching ratios between the values given here from (n,γ) (2012Me04) and those from $^{76}\text{Ge}(^{13}\text{C},^{12}\text{C}\gamma)$ (2009Ka22). For example Iγ(893)/Iγ(880)=1.75 in (n,γ) whereas it is 0.144 in ($^{13}\text{C},^{12}\text{C}\gamma$). The evaluators adopt branching ratios from the latter work due to better statistics and γγ coin data using the Gammasphere array.
1408.46 21		G	
1535.28 10	1/2 ⁺	C E	J ^π : L(pol d,p)=0; primary γ from 1/2 ⁺ .
1610 10		E	
1663.76 8	(1/2 ⁺ ,3/2)	A C EF	XREF: E(1655). J ^π : primary γ from 1/2 ⁺ ; gammas to 1/2 ⁺ and 5/2 ⁺ . L(α, ^3He)=(3) is inconsistent, which either implies a different level in (α, ^3He) or incorrect L-transfer.
1775.34 9	1/2 ⁺	C E	J ^π : L(pol d,p)=0; primary γ from 1/2 ⁺ .
1804 10	3/2 ⁺	E	J ^π : L(d,p)=2 and Ay(θ) in (pol d,p).
1834.96 10	(1/2,3/2)	C	J ^π : primary γ from 1/2 ⁺ .
1836.08 21	(1/2 ⁺)	E G	J ^π : L(d,p)=(0).
1879.25 8	(1/2 ⁺ ,3/2)	C E	J ^π : strong primary γ from 1/2 ⁺ ; gammas to 1/2 ⁻ and 5/2 ⁺ .
1901.09 12	(1/2,3/2)	C	J ^π : weak primary γ from 1/2 ⁺ ; γ to 1/2 ⁻ .
1951.79 11	(3/2 ⁺)	C EF	J ^π : L(d,p)=(2); primary γ from 1/2 ⁺ favors 3/2.
2063.28 8	(3/2)	C E	J ^π : primary γ from 1/2 ⁺ ; gammas to 1/2 ⁻ , 5/2 ⁺ and 5/2 ⁻ .
2088 10	(7/2 ⁺ ,9/2 ⁺)	EF	J ^π : L(d,p)=(4).
2118.81 10	(3/2 ⁺)	C E	J ^π : L(d,p)=(2); primary γ from 1/2 ⁺ favors 3/2.
2178.12 12	(1/2 ⁺ ,3/2)	C	J ^π : primary γ from 1/2 ⁺ ; γ to 5/2 ⁺ .
2195.22 8	(1/2,3/2)	C	J ^π : primary γ from 1/2 ⁺ ; γ to 1/2 ⁻ .
2260 10		E	
2305 10	(3/2 ⁺ ,5/2 ⁺)	E	J ^π : L(d,p)=(2).
2368.38 11	(1/2,3/2)	C	J ^π : primary γ from 1/2 ⁺ ; γ to 1/2 ⁻ .
2442 10	(3/2 ⁺ ,5/2 ⁺)	E	J ^π : L(d,p)=(2).
2479 10	(1/2 ⁺)	E	J ^π : L(d,p)=(0).
2506.82 10	(1/2,3/2)	C E	J ^π : primary γ from 1/2 ⁺ .
2556 10		E	
2783 10		E	
2814.31 13	(1/2 to 7/2 ⁻)	A C	J ^π : γ to 3/2 ⁻ .
2873 10	(1/2 ⁺)	E	J ^π : L(d,p)=(0).
2929 10		E	
2960 10	(1/2 ⁺)	E	J ^π : L(d,p)=(0).
2998 10		E	
3090 15		E	
3135 10		E	
3147 10		E	
3242 10	(3/2 ⁺ ,5/2 ⁺)	E	J ^π : L(d,p)=(2).
3257 10	(1/2 ⁺)	E	J ^π : L(d,p)=(0).
3287.2? 10	(1/2 ⁺ ,3/2)	C	E(level): ordering of the 2785.11-2782.91 cascade is not established. Reverse ordering gives a level at 3288 keV. Due to the poor energy fit of the 2785γ and 2783γ, level energy uncertainty is inflated by 1 keV.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{77}Ge Levels (continued)

<u>E(level)[†]</u>	<u>J^π</u>	<u>XREF</u>	<u>Comments</u>
3364 15	(3/2 ⁺ , 5/2 ⁺)	E	J ^π : primary γ from 1/2 ⁺ ; γ to 5/2 ⁺ . J ^π : L(d,p)=(2).
3388 15		E	
3443 15		E	
3496 15		E	
3547 15		E	
(6071.44 6)	1/2 ⁺	C	E(level): S(n)=6071.29 5 (2017Wa10). J ^π : s-wave capture in ^{76}Ge .
6071.83 5	1/2 ⁺ [‡]	D	
6076.11 5	1/2 ⁺ [‡]	D	
6077.39 5	1/2 ⁺ [‡]	D	
6085.28 5	1/2 ⁺ [‡]	D	
6086.22 5	1/2 ⁺ [‡]	D	
6092.08 5	1/2 ⁺ [‡]	D	
6093.70 5	1/2 ⁺ [‡]	D	
6100.50 6	1/2 ⁺ [‡]	D	
6119.0 6	1/2 ⁺ [‡]	D	

[†] From least-squares fit to E_γ data for levels populated in γ -ray studies. Others are from (α , ^3He) and (d,p).

[‡] s-wave resonance in (n,n),(n, γ).

Adopted Levels, Gammas (continued)

$\gamma(^{77}\text{Ge})$									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult.#	$\delta^\#$	$\alpha^@$	Comments
159.71	1/2 ⁻	159.66 10	100	0.0	7/2 ⁺	(E3)		0.837	B(E3)(W.u.)=0.0025 3 $\alpha(K)=0.710$ 11; $\alpha(L)=0.1101$ 16; $\alpha(M)=0.01631$ 24; $\alpha(N)=0.000756$ 11 E_γ : from weighted average of values from (n, γ) E=thermal, ⁷⁶ Ge IT decay and ⁷⁶ Ge(¹³ C, ¹² C γ). Mult.: ce data in ⁷⁷ Ge IT decay give E3 or M3; however, ΔJ^π consistent with E3.
224.96	9/2 ⁺	224.89 10	100	0.0	7/2 ⁺	(M1+E2)			
421.39	5/2 ⁺	421.37 10	100	0.0	7/2 ⁺	(M1+E2)	-0.10		
492.05	5/2 ⁻	332.34 10	8 2	159.71	1/2 ⁻				
		492.0 1	100 7	0.0	7/2 ⁺	(E1)			
504.76	5/2 ⁺	83.5 1	37.0 14	421.39	5/2 ⁺				
		279.78 10	4.8 5	224.96	9/2 ⁺				
		504.79 10	100 4	0.0	7/2 ⁺	(M1+E2)			
618.86	(3/2 ⁺)	114.0 2	0.44 9	504.76	5/2 ⁺				E_γ : γ not in (n, γ).
		126.84 13	1.15 16	492.05	5/2 ⁻				
		197.47 10	15 5	421.39	5/2 ⁺				I_γ : unweighted average of 9.5 5 and 19.7 24.
		459.18 10	100 5	159.71	1/2 ⁻	D			
		618.89 10	19 6	0.0	7/2 ⁺				I_γ : unweighted average of 12.4 11 and 25 6.
629.68	3/2 ⁻	469.99 10	100	159.71	1/2 ⁻	(M1+E2)			
760.53	7/2 ⁽⁺⁾	255.7 1	56 6	504.76	5/2 ⁺	D(+Q)	≈0.0		
		535.54 10	100 6	224.96	9/2 ⁺	(M1+E2)	+0.2		
		760.6 1	34 5	0.0	7/2 ⁺	(M1+E2)	-0.55		
809.09		809.1 2	100	0.0	7/2 ⁺				
884.19	5/2 ⁺	884.24 10	100	0.0	7/2 ⁺	(M1+E2)			
910.61	(5/2 ⁺ , 7/2 ⁺)	291.80 16	34 5	618.86	(3/2 ⁺)				
		418.5 1	100 10	492.05	5/2 ⁻				
		685.6 2	45 6	224.96	9/2 ⁺				E_γ : γ not in (n, γ).
1021.58	3/2 ⁻	392.01 10	15.2 6	629.68	3/2 ⁻				
		402.63 10	7.9 3	618.86	(3/2 ⁺)				
		861.88 10	100 4	159.71	1/2 ⁻	(M1+E2)			
1048.05	(1/2, 3/2)	429.10 14	4.3 3	618.86	(3/2 ⁺)				
		888.34 15	100 4	159.71	1/2 ⁻				
1052.73	1/2 ⁻ , 3/2 ⁻	423.00 11	91 35	629.68	3/2 ⁻				
		560.9 2	100 5	492.05	5/2 ⁻				E_γ : γ in (¹³ C, ¹² C γ); not in (n, γ).
1110.68		301.6 2	9 4	809.09					
		885.7 2	100 19	224.96	9/2 ⁺				
1247.00	1/2 ⁺	825.68 13	35.9 24	421.39	5/2 ⁺				
		1087.26 10	100 4	159.71	1/2 ⁻				
1275.41		364.6 2	27 6	910.61	(5/2 ⁺ , 7/2 ⁺)				
		656.6 2	50 35	618.86	(3/2 ⁺)				
		783.5 2	100 50	492.05	5/2 ⁻				

Adopted Levels, Gammas (continued)

$\gamma(^{77}\text{Ge})$ (continued)						
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. #
1286.53		657.1 2	100 44	629.68	3/2 ⁻	
		667.6 2	56 31	618.86	(3/2 ⁺)	
		794.3 2	73 13	492.05	5/2 ⁻	
1344.67		839.9 2	100	504.76	5/2 ⁺	
1359.08	(1/2,3/2,5/2)	729.1 2	39 8	629.68	3/2 ⁻	E_γ : γ from ($^{13}\text{C}, ^{12}\text{C}\gamma$); not reported in (n, γ) and β^- decay.
		740.38 15	100 5	618.86	(3/2 ⁺)	
1385.28	5/2 ⁺	363.7 1	0.18 8	1021.58	3/2 ⁻	E_γ : γ in ($^{13}\text{C}, ^{12}\text{C}\gamma$); not in (n, γ).
		624.71 10	100 7	760.53	7/2 ⁽⁺⁾	
		755.56 12	77 6	629.68	3/2 ⁻	(M1+E2)
		766.52 10	44 3	618.86	(3/2 ⁺)	
		880.37 17	92 7	504.76	5/2 ⁺	(M1+E2)
		893.23 10	13.3 17	492.05	5/2 ⁻	
		963.90 10	28 3	421.39	5/2 ⁺	
		1385.0 &		0.0	7/2 ⁺	Uncertain γ from ($^{13}\text{C}, ^{12}\text{C}\gamma$) only.
1408.46		916.4 2	100	492.05	5/2 ⁻	
1535.28	1/2 ⁺	487.24 10	11 5	1048.05	(1/2,3/2)	
		1113.64 18	100 30	421.39	5/2 ⁺	
1663.76	(1/2 ⁺ ,3/2)	642.19 12	17 8	1021.58	3/2 ⁻	
		1242.24 18	100 17	421.39	5/2 ⁺	
		1504.05 12	37.5 25	159.71	1/2 ⁻	
1775.34	1/2 ⁺	1145.53 18	28.0 17	629.68	3/2 ⁻	
		1353.94 10	100 4	421.39	5/2 ⁺	
1834.96	(1/2,3/2)	1216.06 12	100	618.86	(3/2 ⁺)	
1836.08	(1/2 ⁺)	450.8 2	100	1385.28	5/2 ⁺	
1879.25	(1/2 ⁺ ,3/2)	831.22 10	64 3	1048.05	(1/2,3/2)	
		1249.43 18	62 3	629.68	3/2 ⁻	
		1457.84 10	100 4	421.39	5/2 ⁺	
		1719.6 3	6 3	159.71	1/2 ⁻	
1901.09	(1/2,3/2)	1741.35 11	100	159.71	1/2 ⁻	
1951.79	(3/2 ⁺)	1067.66 11	97 12	884.19	5/2 ⁺	
		1446.87 16	100 12	504.76	5/2 ⁺	
2063.28	(3/2)	1558.48 10	100 4	504.76	5/2 ⁺	
		1571.09 15	5.4 4	492.05	5/2 ⁻	
		1641.85 23	62.8 23	421.39	5/2 ⁺	
		1903.55 18	35 12	159.71	1/2 ⁻	
2118.81	(3/2 ⁺)	1697.40 12	100	421.39	5/2 ⁺	
2178.12	(1/2 ⁺ ,3/2)	1673.22 15	80 13	504.76	5/2 ⁺	
		1756.9 4	100 28	421.39	5/2 ⁺	
2195.22	(1/2,3/2)	1142.45 11	70 3	1052.73	1/2 ⁻ ,3/2 ⁻	
		1146.95 18	100 9	1048.05	(1/2,3/2)	
		1173.68 12	79 5	1021.58	3/2 ⁻	
		2035.48 13	76 7	159.71	1/2 ⁻	
2368.38	(1/2,3/2)	1315.59 11	100 4	1052.73	1/2 ⁻ ,3/2 ⁻	

Adopted Levels, Gammas (continued)

$\gamma(^{77}\text{Ge})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Comments
2368.38	(1/2,3/2)	2208.76 23	75 19	159.71	1/2 ⁻	
2506.82	(1/2,3/2)	1877.02 11	100	629.68	3/2 ⁻	
2814.31	(1/2 to 7/2 ⁻)	2184.60 11	100	629.68	3/2 ⁻	
3287.2?	(1/2 ⁺ ,3/2)	2782.91 [‡] 11	100	504.76	5/2 ⁺	E_γ : level-energy difference=2782.40.
(6071.44)	1/2 ⁺	2785.11 [‡] 15	1.30 14	3287.2? (1/2 ⁺ ,3/2)		E_γ : level-energy difference=2784.17.
		3564.44 11	2.62 11	2506.82 (1/2,3/2)		
		3702.92 15	4.4 11	2368.38 (1/2,3/2)		
		3875.97 15	4.72 22	2195.22 (1/2,3/2)		
		3893.12 15	6.8 3	2178.12 (1/2 ⁺ ,3/2)		
		3952.53 11	1.25 7	2118.81 (3/2 ⁺)		
		4007.96 10	21.0 15	2063.28 (3/2)		
		4119.53 24	1.90 9	1951.79 (3/2 ⁺)		
		4170.2 3	0.54 10	1901.09 (1/2,3/2)		
		4192.00 20	38.5 12	1879.25 (1/2 ⁺ ,3/2)		
		4236.33 11	4.14 21	1834.96 (1/2,3/2)		
		4295.92 11	7.0 10	1775.34 1/2 ⁺		
		4407.53 11	2.45 21	1663.76 (1/2 ⁺ ,3/2)		
		4535.81 18	3.9 9	1535.28 1/2 ⁺		
		4824.31 11	5.6 3	1247.00 1/2 ⁺		
		5018.75 16	0.53 4	1052.73 1/2 ⁻ ,3/2 ⁻		
		5049.69 10	56.0 23	1021.58 3/2 ⁻		
		5442.06 18	0.30 7	629.68 3/2 ⁻		
		5649.71 11	1.94 9	421.39 5/2 ⁺		
		5911.33 10	100.0	159.71 1/2 ⁻		

[†] Weighted averages of values available from (n, γ) E=thermal, and ⁷⁶Ge(¹³C,¹²C γ). Values in ⁷⁷Ga β^- decay are in agreement but much less precise and incomplete.

[‡] Ordering of the 2785.11-2782.91 cascade is not established.

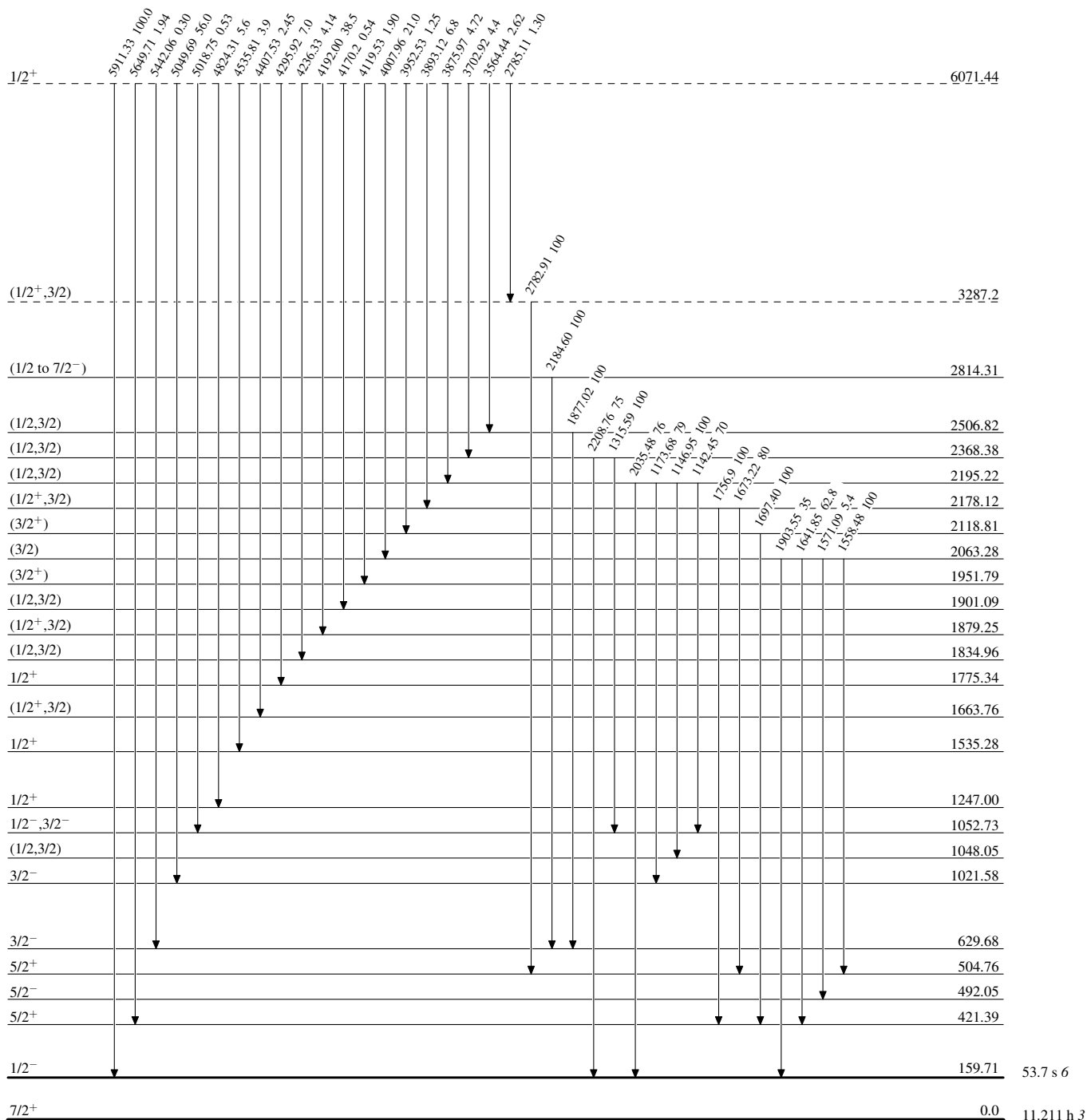
From $\gamma\gamma(\theta)$ in ⁷⁶Ge(¹³C,¹²C γ), and ΔJ^π known from particle-transfer reactions.

@ 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.

& Placement of transition in the level scheme is uncertain.

Adopted Levels, GammasLevel Scheme

Intensities: Relative photon branching from each level

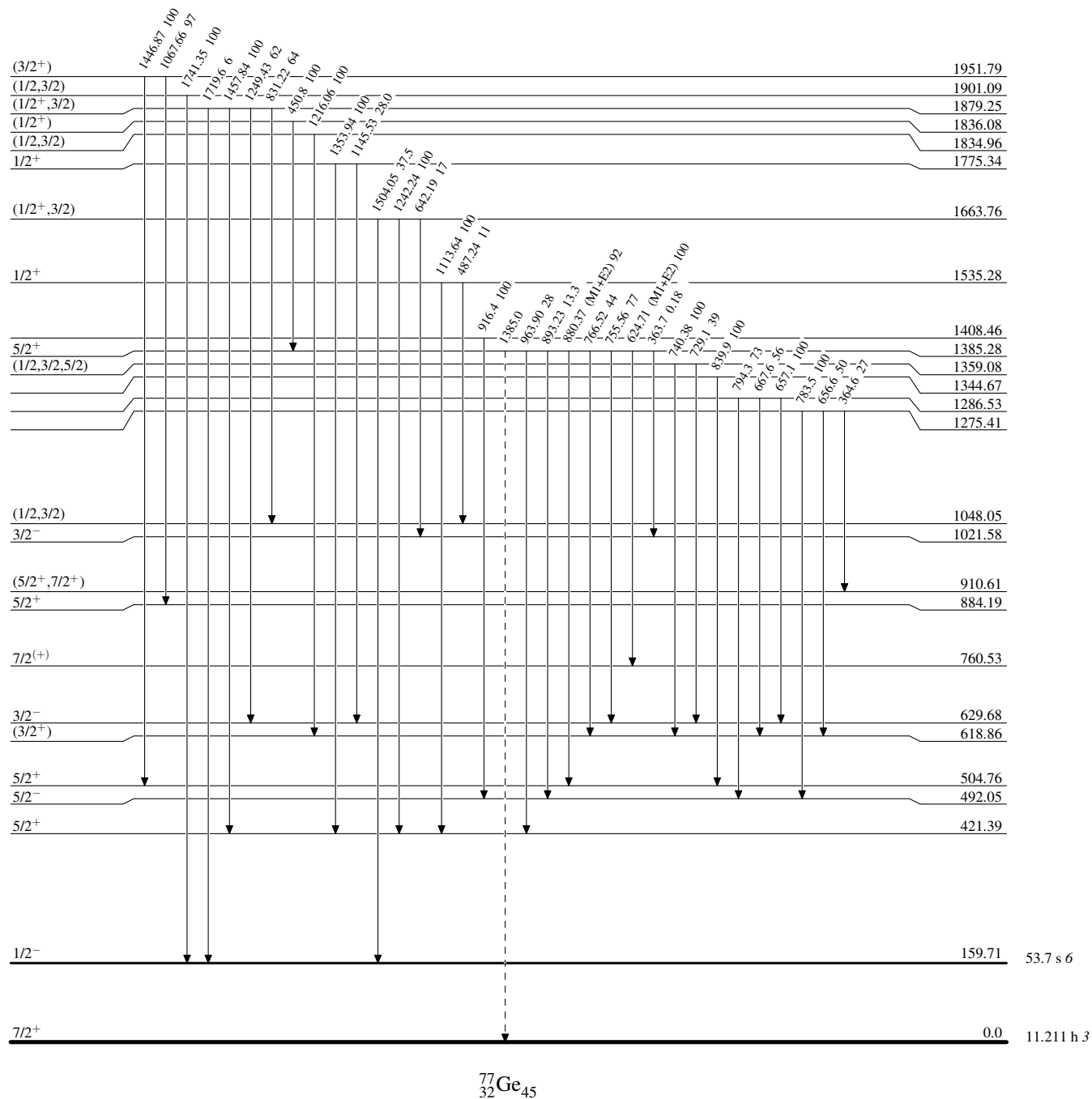


Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

-----► γ Decay (Uncertain) $^{77}\text{Ge}_{45}$

