^{76}Ge(n,γ) E=thermal 2012Me04

History

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

2012Me04: E(n)(average)=0.00183 eV, cold neutrons from reactor at PGAA research reactor facility in Garching. Measured Eγ, Iγ, $\gamma\gamma$ coin using two Compton suppressed HPGe detectors. Sample was enriched to 87.0% in ^{76}Ge. Also 2009Me06 from the same group, who reported capture cross sections.

Additional information 1.

Others:

1972Gr34, 1972Ha74: measured Eγ, Iγ.

2007ChZX: Budapest, LBNL and IAEA collaboration. Measured Eγ, Iγ for elemental prompt gamma activation analysis (PGAA). Consult webpage http://ie.lbl.gov/pgaadatabase/ for details of these measurements and analyses. A total of four secondary and two primary γ rays are reported in these measurements.

^{77}Ge Levels

E(level)†	J$^\pi$‡	T$_{1/2}$‡	Comments
0.0	7/2$^+$	11.211 h *3*	
159.69 *7*	1/2$^-$	53.7 s *6*	
224.90 *8*	9/2$^+$		
421.40 *7*	5/2$^+$		
492.03 *8*	5/2$^-$		
504.65 *7*	5/2$^+$		
618.87 *8*	(3/2$^+$)		
629.64 *8*	3/2$^-$		
760.38 *11*	7/2$^{(+)}$		
884.03 *12*	5/2$^+$		
910.67 *16*	(5/2$^+$,7/2$^+$)		
1021.55 *8*	3/2$^-$		
1048.05 *9*	(1/2,3/2)		
1052.67 *10*	1/2$^-$,3/2$^-$		
1246.97 *9*	1/2$^+$		
1359.34 *14*	(1/2,3/2,5/2)		
1385.18 *9*	5/2$^+$		There is severe disagreement in gamma-ray branching ratios between the values given here from (n,γ) (2012Me04) and those from ^{76}Ge(^{13}C,^{12}Cγ) (2009Ka22). For example Iγ(893)/Iγ(880)=1.75 in (n,γ) whereas it is 0.144 in (^{13}C,^{12}Cγ). The evaluators adopt branching ratios from the latter work due to better statistics and $\gamma\gamma$ coin data using the Gammasphere array.
1535.32 *11*	1/2$^+$		
1663.74 *9*	(1/2$^+$,3/2)		
1775.33 *9*	1/2$^+$		
1834.95 *11*	(1/2,3/2)		
1879.25 *9*	(1/2$^+$,3/2)		
1901.07 *12*	(1/2,3/2)		
1951.66 *12*	(3/2$^+$)		
2063.23 *8*	(3/2)		
2118.79 *10*	(3/2$^+$)		
2178.06 *12*	(1/2$^+$,3/2)		
2195.19 *9*	(1/2,3/2)		
2368.34 *11*	(1/2,3/2)		
2506.78 *11*	(1/2,3/2)		
2814.27 *14*	(1/2 to 7/2$^-$)		
3287.1? *10*	(1/2$^+$,3/2)		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.
(6071.41 *7*)	1/2$^+$		E(level): S(n)=6071.29 *5* (2017Wa10). J$^\pi$: s-wave capture in ^{76}Ge.

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^{76}Ge(n,γ) E=thermal 2012Me04 (continued)

^{77}Ge Levels (continued)

† From least-squares fit to Eγ data.
‡ From the Adopted Levels.

$\gamma(^{77}Ge)$

Iγ normalization: From 2012Me04. Total σ=155 mb *17* (2012Me04).
Following γ rays reported in 1972Gr34 not seen in 2012Me04: Eγ=808.2, Iγ(absolute)=2.25; Eγ=850.8, Iγ(absolute)=1.62; Eγ=4514.3, Iγ(absolute)=0.24. 2012Me04 suggest 808γ belongs to ^{74}Ge. No evidence was found by 2012Me04 for 850γ and 4514γ.

E$_\gamma$ †	I$_\gamma$ [a]	E$_i$(level)	J$_i^\pi$	E$_f$	J$_f^\pi$	Mult.	α [b]	Comments
83.5	6.12 *23*	504.65	5/2$^+$	421.40	5/2$^+$			E$_\gamma$: from 2009Ka22.
126.85 *13*	0.25 *12*	618.87	(3/2$^+$)	492.03	5/2$^-$			
159.62 *10*	28.9 *11*	159.69	1/2$^-$	0.0	7/2$^+$	(E3)	0.839	α(K)=0.711 *11*; α(L)=0.1103 *17*; α(M)=0.01634 *25*; α(N)=0.000757 *12* Mult.: from the Adopted Gammas. Others: Eγ=159.5 (1972Gr34), 159.61 *17* (2007ChZX). Iγ(absolute)=0.32 (1972Ha74).
197.2 *3*	1.25 *7*	618.87	(3/2$^+$)	421.40	5/2$^+$			Eγ=195.6, Iγ(absolute)=0.15 (1972Gr34).
224.88 *10*	1.94 *9*	224.90	9/2$^+$	0.0	7/2$^+$			
255.8 *4*	0.36 *10*	760.38	7/2$^{(+)}$	504.65	5/2$^+$			
279.74 *11*	0.82 *10*	504.65	5/2$^+$	224.90	9/2$^+$			
291.80 *16*	0.19 *9*	910.67	(5/2$^+$,7/2$^+$)	618.87	(3/2$^+$)			
332.32 *11*	0.76 *13*	492.03	5/2$^-$	159.69	1/2$^-$			
392.04 *10*	7.8 *3*	1021.55	3/2$^-$	629.64	3/2$^-$			
402.59 *10*	4.05 *15*	1021.55	3/2$^-$	618.87	(3/2$^+$)			
418.6 *3*	0.84 *8*	910.67	(5/2$^+$,7/2$^+$)	492.03	5/2$^-$			
421.34 *10*	60.9 *21*	421.40	5/2$^+$	0.0	7/2$^+$			
423.00 *11*	2.8 *4*	1052.67	1/2$^-$,3/2$^-$	629.64	3/2$^-$			
429.10 *14*	0.65 *4*	1048.05	(1/2,3/2)	618.87	(3/2$^+$)			Eγ=431.5, Iγ(absolute)=0.82 (1972Gr34).
[x]449.72 *11*	1.09 *5*							
459.15 *10*	13.2 *6*	618.87	(3/2$^+$)	159.69	1/2$^-$			
469.99 *10*	34.3 *12*	629.64	3/2$^-$	159.69	1/2$^-$			
487.24 *10*	0.43 *20*	1535.32	1/2$^+$	1048.05	(1/2,3/2)			
491.98 *24*	7.6 *19*	492.03	5/2$^-$	0.0	7/2$^+$			
504.79 *10*	16.7 *6*	504.65	5/2$^+$	0.0	7/2$^+$			
535.48 *11*	0.85 *5*	760.38	7/2$^{(+)}$	224.90	9/2$^+$			
[x]600.33 *11*	1.00 *5*							
618.86 *24*	1.64 *15*	618.87	(3/2$^+$)	0.0	7/2$^+$			
624.73 *18*	0.37[&] *20*	1385.18	5/2$^+$	760.38	7/2$^{(+)}$			
642.19 *12*	0.40 *19*	1663.74	(1/2$^+$,3/2)	1021.55	3/2$^-$			
740.46 *11*	1.44 *7*	1359.34	(1/2,3/2,5/2)	618.87	(3/2$^+$)			
755.2 *3*	0.72[&] *22*	1385.18	5/2$^+$	629.64	3/2$^-$			
760.2 *3*	0.40 *25*	760.38	7/2$^{(+)}$	0.0	7/2$^+$			
766.64 *23*	0.37[&] *7*	1385.18	5/2$^+$	618.87	(3/2$^+$)			
[x]794.44 *21*	0.28 *4*							
825.55 *10*	2.99 *12*	1246.97	1/2$^+$	421.40	5/2$^+$			
831.22 *10*	11.1 *5*	1879.25	(1/2$^+$,3/2)	1048.05	(1/2,3/2)			
861.82 *15*	51.4 *18*	1021.55	3/2$^-$	159.69	1/2$^-$			E$_\gamma$: other: 862.0 *5* (2007ChZX).

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^{76}Ge(n,γ) E=thermal 2012Me04 (continued)

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

E_γ †	I_γ [a]	E_i(level)	J_i^π	E_f	J_f^π	Comments
880.37 *17*	0.69& *10*	1385.18	5/2$^+$	504.65	5/2$^+$	
884.09 *15*	5.0 *6*	884.03	5/2$^+$	0.0	7/2$^+$	
888.34 *15*	15.1 *6*	1048.05	(1/2,3/2)	159.69	1/2$^-$	
893.15 *11*	1.21& *5*	1385.18	5/2$^+$	492.03	5/2$^-$	
x897.00 *22*	0.99 *11*					
x935.80 *10*	2.69 *11*					
963.88 *17*	0.24& *12*	1385.18	5/2$^+$	421.40	5/2$^+$	
x1042.09 *12*	1.26 *9*					
1067.66 *11*	1.02 *5*	1951.66	(3/2$^+$)	884.03	5/2$^+$	
1087.31 *10*	8.6 *3*	1246.97	1/2$^+$	159.69	1/2$^-$	
1113.84 *18*	4.0 *12*	1535.32	1/2$^+$	421.40	5/2$^+$	
1142.45 *11*	0.98 *4*	2195.19	(1/2,3/2)	1052.67	1/2$^-$,3/2$^-$	
1145.53 *18*	1.70 *10*	1775.33	1/2$^+$	629.64	3/2$^-$	
1146.95 *18*	1.40 *12*	2195.19	(1/2,3/2)	1048.05	(1/2,3/2)	
1173.68 *12*	1.11 *7*	2195.19	(1/2,3/2)	1021.55	3/2$^-$	
1216.06 *12*	2.07 *9*	1834.95	(1/2,3/2)	618.87	(3/2$^+$)	
1242.24 *18*	2.4 *4*	1663.74	(1/2$^+$,3/2)	421.40	5/2$^+$	
1249.43 *18*	10.7 *5*	1879.25	(1/2$^+$,3/2)	629.64	3/2$^-$	E_γ: 1250.55 *10* (2007ChZX, but placed from a 1250 level).
1315.59 *11*	1.60 *7*	2368.34	(1/2,3/2)	1052.67	1/2$^-$,3/2$^-$	
x1342.09 *12*	0.69 *11*					
1353.94 *10*	6.06 *22*	1775.33	1/2$^+$	421.40	5/2$^+$	
x1375.47 *11*	1.43 *20*					
1446.87‡ *16*	1.05 *13*	1951.66	(3/2$^+$)	504.65	5/2$^+$	
x1448.14 *13*	1.15 *13*					
1457.84 *10*	17.3 *7*	1879.25	(1/2$^+$,3/2)	421.40	5/2$^+$	
1504.05 *12*	0.90 *6*	1663.74	(1/2$^+$,3/2)	159.69	1/2$^-$	
1558.48 *10*	9.2 *4*	2063.23	(3/2)	504.65	5/2$^+$	
1571.09 *15*	0.50 *4*	2063.23	(3/2)	492.03	5/2$^-$	
x1608.7 *3*	0.60 *9*					
1641.85 *23*	5.78 *21*	2063.23	(3/2)	421.40	5/2$^+$	
1673.22 *15*	3.2 *5*	2178.06	(1/2$^+$,3/2)	504.65	5/2$^+$	
1697.40 *12*	1.08 *6*	2118.79	(3/2$^+$)	421.40	5/2$^+$	
1719.6 *3*	1.1 *6*	1879.25	(1/2$^+$,3/2)	159.69	1/2$^-$	Additional information 2.
1741.35‡ *11*	1.52 *7*	1901.07	(1/2,3/2)	159.69	1/2$^-$	
1756.9 *4*	4.0 *11*	2178.06	(1/2$^+$,3/2)	421.40	5/2$^+$	
1877.02 *11*	1.80 *7*	2506.78	(1/2,3/2)	629.64	3/2$^-$	
1903.55 *18*	3.2 *11*	2063.23	(3/2)	159.69	1/2$^-$	E_γ: 1903.7 *3* (2007ChZX).
x1953.52 *15*	0.84 *11*					
x1961.71 *15*	0.80 *25*					
x2026.37 *14*	0.55 *4*					
x2029.60 *11*	1.44 *8*					
2035.48 *13*	1.07 *10*	2195.19	(1/2,3/2)	159.69	1/2$^-$	
x2102.59 *15*	0.68 *7*					
x2150.67 *11*	3.21 *20*					
2184.60 *11*	1.38 *7*	2814.27	(1/2 to 7/2$^-$)	629.64	3/2$^-$	
2208.76 *23*	1.2 *3*	2368.34	(1/2,3/2)	159.69	1/2$^-$	
x2301.94 *12*	0.55 *22*					
x2321.6 *7*	1.6 *4*					
x2377.3 *4*	0.91 *17*					
x2399.2 *4*	0.88 *25*					
x2407.3 *3*	0.65 *24*					
x2509.51 *23*	1.7 *4*					
x2555.18 *11*	2.7 *7*					
x2559.48 *15*	3.10 *13*					

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^{76}Ge(n,γ) E=thermal 2012Me04 (continued)

γ(^{77}Ge) (continued)

E_γ [†]	I_γ [a]	E_i(level)	J_i^π	E_f	J_f^π	Comments
[x]2683.76 *15*	3.1 *4*					In coin with 470γ.
2782.91[#] *11*	3.00 *12*	3287.1?	(1/2$^+$,3/2)	504.65	5/2$^+$	
2785.11[#] *15*	1.30 *14*	(6071.41)	1/2$^+$	3287.1?	(1/2$^+$,3/2)	
[x]2806.1 *4*	0.34 *9*					
[x]2921.1 *3*	0.7 *6*					
[x]2941.2 *3*	1.15 *25*					
[x]3252.7 *10*	0.39 *11*					
[x]3285.11 *11*	1.6 *3*					
[x]3357.17 *11*	2.57 *25*					
[x]3410.85 *13*	1.28 *20*					
3564.44 *11*	2.62 *11*	(6071.41)	1/2$^+$	2506.78	(1/2,3/2)	
[x]3638.7 *4*	2.1 *10*					
[x]3689.1 *4*	0.52 *7*					
3702.92 *15*	4.4 *11*	(6071.41)	1/2$^+$	2368.34	(1/2,3/2)	
3875.97 *15*	4.72 *22*	(6071.41)	1/2$^+$	2195.19	(1/2,3/2)	
3893.12 *15*	6.8 *3*	(6071.41)	1/2$^+$	2178.06	(1/2$^+$,3/2)	Eγ=3895.2, Iγ(absolute)=1.08 in 1972Ha74.
3952.53 *11*	1.25 *7*	(6071.41)	1/2$^+$	2118.79	(3/2$^+$)	
4007.96 *10*	21.0 *15*	(6071.41)	1/2$^+$	2063.23	(3/2)	Eγ=4008.6 *6* (2007ChZX), 4008.5 (1972Gr34). Iγ(absolute)=0.75 (1972Ha74).
4119.53[‡] *24*	1.90 *9*	(6071.41)	1/2$^+$	1951.66	(3/2$^+$)	
4170.2[‡] *3*	0.54 *10*	(6071.41)	1/2$^+$	1901.07	(1/2,3/2)	
4192.00 *20*	38.5 *12*	(6071.41)	1/2$^+$	1879.25	(1/2$^+$,3/2)	Eγ=4193.3 *4* (2007ChZX), 4193.2 (1972Ha74). Iγ(absolute)=2.5 (1972Ha74).
4236.33 *11*	4.14 *21*	(6071.41)	1/2$^+$	1834.95	(1/2,3/2)	
4295.92 *11*	7.0 *10*	(6071.41)	1/2$^+$	1775.33	1/2$^+$	
4407.53 *11*	2.45 *21*	(6071.41)	1/2$^+$	1663.74	(1/2$^+$,3/2)	
4535.81 *18*	3.9 *9*	(6071.41)	1/2$^+$	1535.32	1/2$^+$	
4824.31 *11*	5.6 *3*	(6071.41)	1/2$^+$	1246.97	1/2$^+$	Eγ=4821.8 (1972Gr34). Iγ(absolute)=0.16 (1972Ha74).
5018.75 *16*	0.53 *4*	(6071.41)	1/2$^+$	1052.67	1/2$^-$,3/2$^-$	
5049.69 *10*	56.0 *23*	(6071.41)	1/2$^+$	1021.55	3/2$^-$	Eγ=5049.1 (1972Gr34). Iγ(absolute)=2.70 (1972Ha74).
[x]5420.1[@]						
5442.06[‡] *18*	0.30 *7*	(6071.41)	1/2$^+$	629.64	3/2$^-$	Eγ=5444.7, Iγ(absolute)=0.25 (1972Ha74).
5649.71 *11*	1.94 *9*	(6071.41)	1/2$^+$	421.40	5/2$^+$	
5911.33 *10*	100.0	(6071.41)	1/2$^+$	159.69	1/2$^-$	Eγ=5912.85, Iγ(absolute)=4.65 (1972Ha74,1972Gr34).

[†] Systematic uncertainty of 0.10 keV is included in the uncertainty quoted by 2012Me04.
[‡] The γ transition placed on the basis of level energies.
[#] Ordering of the 2785.11-2782.91 cascade is not established.
[@] Eγ from 1972Ha74 only. Iγ(absolute)=0.75 (1972Ha74). In 2012Me04, the peak is a multiplet of at least 2 peaks, one from single escape of 5930.7γ in ^{74}Ge(n,γ), the second component could not be unambiguously assigned to neutron capture in ^{76}Ge.
[&] Branching ratios from 1385 level are in severe disagreement with those obtained from ^{76}Ge(^{13}C,^{12}Cγ) (2009Ka22). The values from latter reaction are listed in Adopted Gammas.
[a] For intensity per 100 neutron captures, multiply by 0.255 *30*.
[b] 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.
[x] γ ray not placed in level scheme.

^{76}Ge(n,γ) E=thermal 2012Me04

Level Scheme

Intensities: Intensities per 100 neutron captures

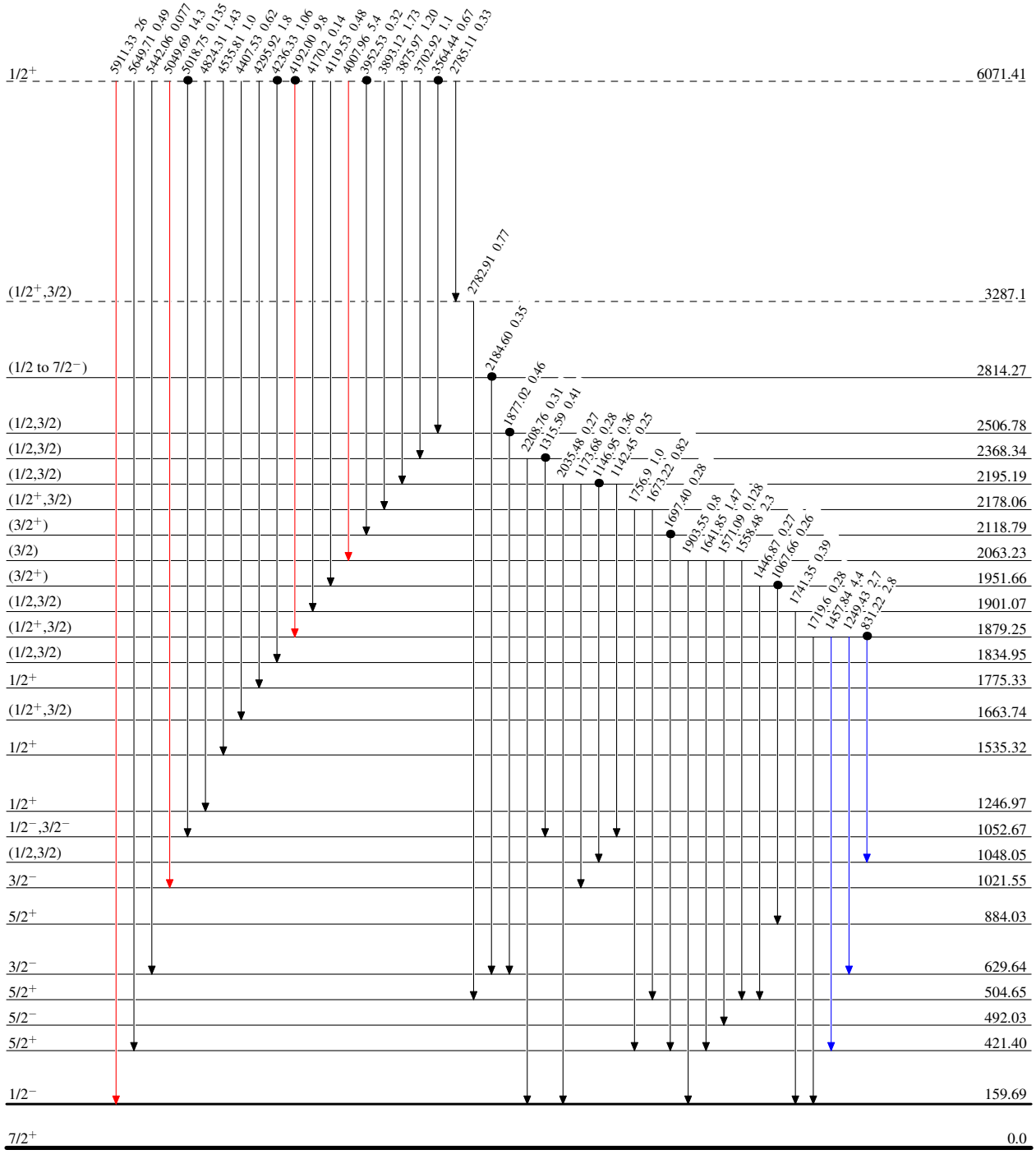
Legend

$I_\gamma < 2\% \times I_\gamma^{max}$

$I_\gamma < 10\% \times I_\gamma^{max}$

$I_\gamma > 10\% \times I_\gamma^{max}$

Coincidence



$^{77}_{32}Ge_{45}$

^{76}Ge(n,γ) E=thermal 2012Me04

Level Scheme (continued)

Intensities: Intensities per 100 neutron captures

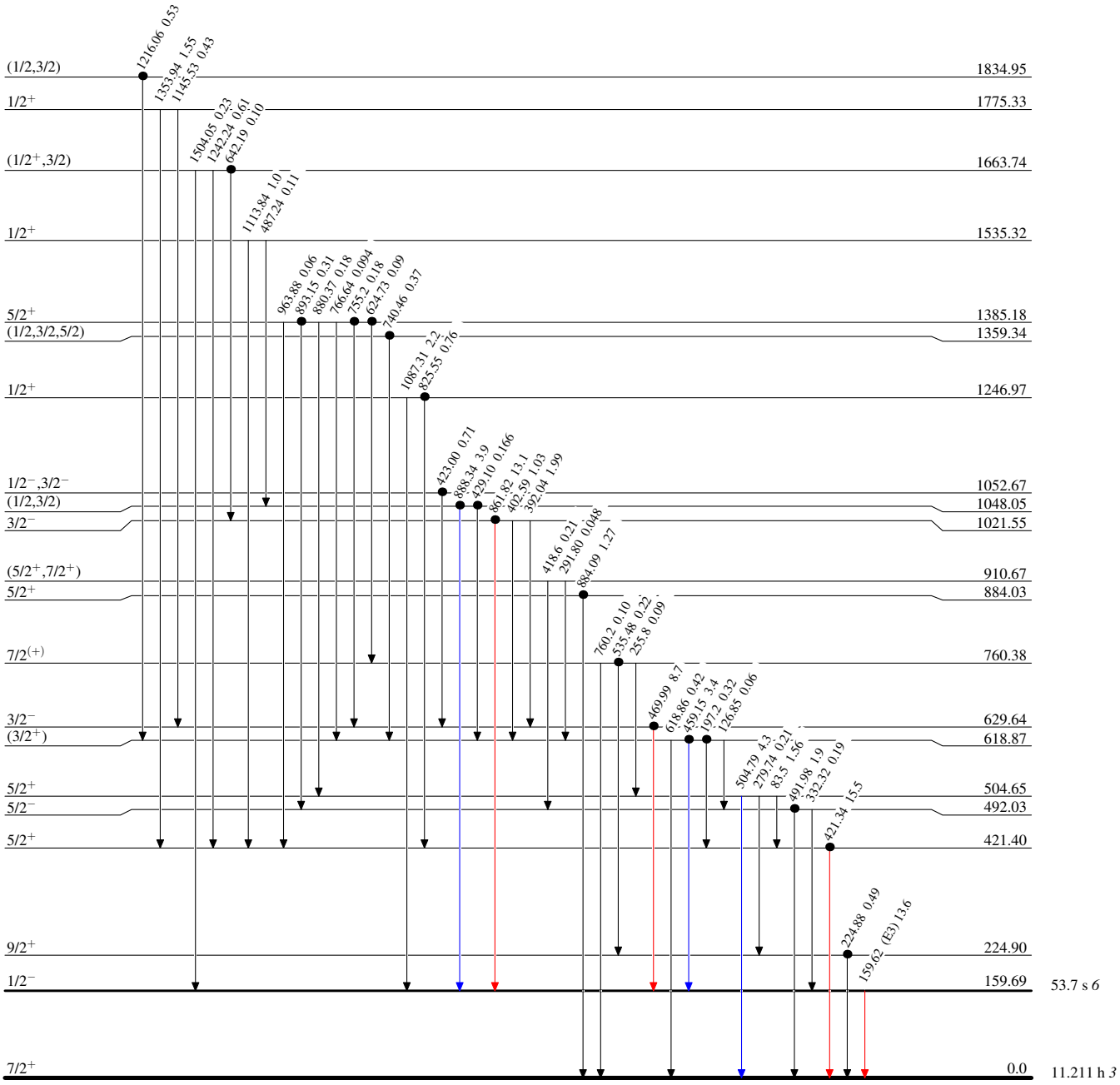
Legend

$I_\gamma < 2\% \times I_\gamma^{max}$

$I_\gamma < 10\% \times I_\gamma^{max}$

$I_\gamma > 10\% \times I_\gamma^{max}$

Coincidence



$^{77}_{32}Ge_{45}$