^{69}Ga(n,γ) E=thermal 1970Li04,1971Ve03

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	G. Gürdal, E. A. Mccutchan	NDS 136, 1 (2016)	1-Jul-2016

Target: $J^\pi=3/2^-$.

1971Ar12: Measured Eγ with Ge(Li) detector.

1971Ve03: Measured Eγ, Iγ with a Ge(Li)-NaI(Tl) pair spectrometer.

1970Li04: Measured Eγ, Iγ with a Ge(Li)-NaI(Tl) pair spectrometer.

1972St06: polarized neutrons. Measured polarization function R proportional to the circular polarization of primary capture γ-rays.

The ^{69}Ga(n,γ) level scheme is mainly that proposed by 1970Li04 and 1971Ve03. Many γ placements are not adopted by the evaluators as 1) they are inconsistent with the results of both (p,nγ) and (α,pnγ) studies and 2) 1970Li04 base some placements on a tentative 188-keV level which subsequent studies found no evidence for. Additional primary and secondary γ rays have been placed by the evaluators on the basis of ^{70}Ga levels known to exist from other reactions.

^{70}Ga Levels

E(level)[†]	J$^\pi$[‡]
0.0	1^+
508.94 *24*	2^+
651.02 *18*	$1^+,2^+$
691.16 *20*	2^-
878.7 *3*	4^-
995.1 *6*	2^+
1009.6 *4*	$1^+,2^+,3^+$
1014.6 *20*	$1^+,2^+,3^+$
1024.9 *3*	$2^+,3^+$
1140.0 *4*	1,2
1200.4 *3*	2^+
1252.6 *20*	$3^-,4^-$
1263.4 *6*	
1307.5 *6*	
1312.3 *14*	$1^+,2^+$
1359.2 *7*	2^+
1414.3 *9*	
1448.9 *5*	$1^+,2^+$
1457.1 *8*	$1^+,2^+$
1518.6 *8*	$1^+,2^+$
1533.3 *4*	2^+
1555.2 *8*	2^+
1622.7 *10*	$1^-,2^-$
1633.7 *10*	1,2,3
1691.7 *9*	
1720.8? *9*	$1^+,2^+,3^+$
1726.3 *9*	
1735.7 *10*	
1794.3? *9*	$1^+,2^+,3^+$
1824.1 *9*	
1846.7 *20*	
1866.2? *17*	
1906.8 *17*	$^+$
1930.5 *17*	$^+$
1937.7 *20*	$^+$
1970.7 *10*	$^+$
1984.7 *10*	
2016.7 *20*	$^-$
2026.7 *20*	

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^{69}Ga(n,γ) E=thermal 1970Li04,1971Ve03 (continued)

^{70}Ga Levels (continued)

E(level)[†]	Jπ[‡]	Comments
2074.7 *10*		
2115.4 *17*		
2127 *3*		
2142.8 *17*	–	
2164.5 *10*		
2189.7 *20*		
2213.7 *20*		
2233.7 *20*		
2254.7 *20*		
2319.7 *10*		
2351.7 *10*		
2388.7 *10*		
2409.8 *10*		
2430.7 *10*		
2464.7 *10*		
2477.7 *10*		
2520.7 *10*	–	
2548.7 *20*		
2571.7 *10*	–	
2624.7 *20*		
2654.7 *10*		
2698.1 *17*		
(7653.9 *3*)	$1^-,2^-$[#]	E(level): 2012Wa38 gives 7653.65 *17*.

[†] From a least-squares fit to Eγ, by evaluators.
[‡] From the Adopted Levels.
[#] s-wave neutron capture on $J^\pi=3/2^-$ target.

γ(^{70}Ga)

E_γ[†]	I_γ[a]	E_i(level)	J_i^π	E_f	J_f^π	Comments
154 *2*	4.8	1359.2	2^+	1200.4	2^+	
187.5[#] *2*	31	878.7	4^-	691.16	2^-	E_γ: placement by evaluators. 1970Li04 tentatively place this γ as depopulating a tentative 188-keV level. E_γ: other: 188 *2* (1970Li04).
318.4[#] *4*	18	1009.6	$1^+,2^+,3^+$	691.16	2^-	E_γ: placement by evaluators. 1970Li04 place this γ as depopulating 508-keV level. E_γ: other: 319 *2* (1970Li04).
362[c] *2*	2.2	1720.8?	$1^+,2^+,3^+$	1359.2	2^+	
374.1[#] *4*	6.6	1024.9	$2^+,3^+$	651.02	$1^+,2^+$	E_γ: other: 374 *2* (1970Li04).
393 *2*	13	1533.3	2^+	1140.0	1,2	
[x]410 *2*	3.2					
427 *2*	2.9	1691.7		1263.4		
508.4[b#] *3*	<75[b]	508.94	2^+	0.0	1^+	E_γ: other: 508.5 *5* (1970Li04).
508.4[b#] *3*	<75[b]	1533.3	2^+	1024.9	$2^+,3^+$	
515.7[#] *4*	0.5	1024.9	$2^+,3^+$	508.94	2^+	E_γ: other: 516 *2* (1970Li04).
553 *2*	1.1	1200.4	2^+	651.02	$1^+,2^+$	
561 *2*	0.6	1555.2	2^+	995.1	2^+	
[x]574[&] *2*	3.2					
[x]596[&] *2*	0.7					

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^{69}Ga(n,γ) E=thermal 1970Li04,1971Ve03 (continued)

γ(^{70}Ga) (continued)

E_γ [†]	I_γ [a]	E_i(level)	J_i^π	E_f	J_f^π	Comments
612.3[#] 6	1.1	1263.4		651.02	$1^+,2^+$	E_γ: other: 613 2 (1970Li04).
632 2	2.5	1140.0	1,2	508.94	2^+	
[x]646 2	3.7					
651.2[#] 2	16	651.02	$1^+,2^+$	0.0	1^+	E_γ: other: 651 2 (1970Li04).
691.2[b#] 2	<48[b]	691.16	2^-	0.0	1^+	E_γ: other: 691 2 (1970Li04).
691.2[b#] 2	<48[b]	1200.4	2^+	508.94	2^+	E_γ: other: 691 2 (1970Li04).
[x]748 2	0.5					
755[c] 2	2	1263.4		508.94	2^+	
798.7[b#c] 6	<1.6[b]	1307.5		508.94	2^+	E_γ: other: 798 2 (1970Li04).
798.7[b#] 6	<1.6[b]	1448.9	$1^+,2^+$	651.02	$1^+,2^+$	E_γ: other: 798 2 (1970Li04).
828 2	0.7	1518.6	$1^+,2^+$	691.16	2^-	
850 2	1.3	1359.2	2^+	508.94	2^+	
904[b] 2	<0.6[b]	1414.3		508.94	2^+	
904[b] 2	<0.6[b]	1555.2	2^+	651.02	$1^+,2^+$	
[x]933 2	0.9					
947 2	0.7	1457.1	$1^+,2^+$	508.94	2^+	
995.2[#] 7	2.2	995.1	2^+	0.0	1^+	E_γ: other: 995 2 (1970Li04).
1038[‡c] 2	1.3	1691.7		651.02	$1^+,2^+$	
1044[‡c] 2	1.9	1555.2	2^+	508.94	2^+	
[x]1058 2	0.4					
[x]1135 2	4.5					
1139.9[#] 4	5.0	1140.0	1,2	0.0	1^+	E_γ: other: 1139 2 (1970Li04).
[x]1171 2						
1203 2	2.6	1200.4	2^+	0.0	1^+	
[x]1244 2	2.6					
1312 2	3	1312.3	$1^+,2^+$	0.0	1^+	
1359 2	1.7	1359.2	2^+	0.0	1^+	
1456 2	1.7	1457.1	$1^+,2^+$	0.0	1^+	
[x]1485[c] 2	0.7					
1518 2	2.2	1518.6	$1^+,2^+$	0.0	1^+	
1532[c] 2	1.3	1533.3	2^+	0.0	1^+	
1725 2	1.5	1726.3		0.0	1^+	
1793 2	0.8	1794.3?	$1^+,2^+,3^+$	0.0	1^+	
1865 3	1.1	1866.2?		0.0	1^+	
1907 3	1.3	1906.8	$^+$	0.0	1^+	
1930 3	0.9	1930.5	$^+$	0.0	1^+	
2117 3	1.4	2115.4		0.0	1^+	
2143 3	1.3	2142.8	$^-$	0.0	1^+	
2163 3	0.6	2164.5		0.0	1^+	
2410 3	0.3	2409.8		0.0	1^+	
2464 3	0.6	2464.7		0.0	1^+	
[x]2581 3	0.8					
[x]2613 3	0.5					
2699 3	0.4	2698.1		0.0	1^+	
[x]2830 3	0.9					
[x]3129 3	0.6					
[x]3361 3	0.5					
[x]3377 3	0.4					
[x]3395 3	0.1					
[x]3424 3	0.3					
[x]3476 3	0.5					
[x]3486 3	0.2					
[x]3498 3	0.1					

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^{69}Ga(n,γ) E=thermal 1970Li04,1971Ve03 (continued)

γ(^{70}Ga) (continued)

E_γ †	I_γ [a]	E_i(level)	J_i^π	E_f	J_f^π
x3560 3	0.1				
x3570 3	0.3				
x3581 3	0.3				
x3659 3	0.3				
x3745 3	0.6				
x3760 3	0.3				
x3774 3	0.3				
x3795 3	0.3				
x3827 3	0.7				
x3865 3	0.5				
x3920 3	0.6				
x3944 3	0.4				
x4033 3	0.5				
x4137 3	0.2				
x4152 3	0.2				
x4180 3	0.5				
x4206 3	0.4				
x4317 3	0.5				
x4323 3	0.4				
x4414 3	0.9				
x4431 3	0.9				
x4467 3	0.7				
x4494 3	0.5				
x4501 2	0.16 3				
x4511 2	0.11 3				
x4525 2	0.15 3				
x4547 2	0.32 5				
x4565 2	0.18 3				
x4571 2	0.29 5				
x4581 2	0.26 5				
x4589 2	0.24 5				
x4596 1	0.63 10				
x4620[c] 2	0.10 2				
x4631 1	0.21 5				
x4660[c] 3	0.03 2				
x4672 1	0.16 3				
x4682 3	0.10 3				
x4696 1	2.40 4				
x4711 1	1.8 3				
x4721 1	0.36 5				
x4753 1	1.36 21				
x4773 3	0.26 6				
x4779 3	0.29 8				
x4796 2	0.21 5				
x4813 2	0.42 8				
x4823 1	1.71 26				
x4842 2	0.45 8				
x4853 2	0.70 13				
x4863 1	1.02 16				
x4872 2	0.27 5				
x4896 2	0.14 3				
x4910 2	0.40 6				
x4922 2	0.23 5				
4956 2	2.2 3	(7653.9)	1⁻,2⁻	2698.1	
x4979 2	0.45 10				
4999 1	1.13 18	(7653.9)	1⁻,2⁻	2654.7	
x5003[c] 2	0.24 6				
5029 2	0.18 3	(7653.9)	1⁻,2⁻	2624.7	
x5038 1	0.61 10				
x5051 1	0.32 6				
x5068 1	0.57 11				
x5072[c] 2	0.47 10				
5082 1	1.29 19	(7653.9)	1⁻,2⁻	2571.7	⁻
x5096 2	0.29 6				
5105 2	0.39 8	(7653.9)	1⁻,2⁻	2548.7	
5133 1	1.26 19	(7653.9)	1⁻,2⁻	2520.7	⁻
x5143 2	0.06 2				
5176 1	0.58 10	(7653.9)	1⁻,2⁻	2477.7	
5189 1	0.82 13	(7653.9)	1⁻,2⁻	2464.7	
x5193[c] 1	0.50 10				
x5215 1	0.37 6				
5223 1	0.55 10	(7653.9)	1⁻,2⁻	2430.7	
5244 1	0.18 3	(7653.9)	1⁻,2⁻	2409.8	
5265[c] 1	0.16 3	(7653.9)	1⁻,2⁻	2388.7	
x5272 1	0.57 8				
5302 1	0.48 8	(7653.9)	1⁻,2⁻	2351.7	
x5312 1	0.60 10				
5334 1	0.79 13	(7653.9)	1⁻,2⁻	2319.7	
x5342 2	0.24 5				
5399 2	0.36 6	(7653.9)	1⁻,2⁻	2254.7	
5420 2	0.10 3	(7653.9)	1⁻,2⁻	2233.7	
5440 2	0.31 5	(7653.9)	1⁻,2⁻	2213.7	
5464 2	0.13 3	(7653.9)	1⁻,2⁻	2189.7	
5489 1	3.0 5	(7653.9)	1⁻,2⁻	2164.5	
5511 2	0.74 11	(7653.9)	1⁻,2⁻	2142.8	⁻
5527[@] 3	0.1	(7653.9)	1⁻,2⁻	2127	
5539 2	1.24 19	(7653.9)	1⁻,2⁻	2115.4	
5579 1	0.70 11	(7653.9)	1⁻,2⁻	2074.7	
5627 2	1.65 26	(7653.9)	1⁻,2⁻	2026.7	
5637 2	0.58 10	(7653.9)	1⁻,2⁻	2016.7	⁻
5669 1	0.57 10	(7653.9)	1⁻,2⁻	1984.7	
5683 1	0.47 8	(7653.9)	1⁻,2⁻	1970.7	⁺
5716 2	0.19 3	(7653.9)	1⁻,2⁻	1937.7	⁺
5723 2	0.78 13	(7653.9)	1⁻,2⁻	1930.5	⁺
5747 2	1.36 21	(7653.9)	1⁻,2⁻	1906.8	⁺
5787 2	0.13 3	(7653.9)	1⁻,2⁻	1866.2?	
5807 2	2.1 3	(7653.9)	1⁻,2⁻	1846.7	
5829 1	0.66 10	(7653.9)	1⁻,2⁻	1824.1	
5859 1	0.47 8	(7653.9)	1⁻,2⁻	1794.3?	1⁺,2⁺,3⁺
5918 1	0.24 5	(7653.9)	1⁻,2⁻	1735.7	
5927 1	0.84 13	(7653.9)	1⁻,2⁻	1726.3	
5933[c] 1	0.31 5	(7653.9)	1⁻,2⁻	1720.8?	1⁺,2⁺,3⁺
5961 1	0.29 5	(7653.9)	1⁻,2⁻	1691.7	
6020 1	0.21 3	(7653.9)	1⁻,2⁻	1633.7	1,2,3
6031 1	0.18 3	(7653.9)	1⁻,2⁻	1622.7	1⁻,2⁻
6098 1	0.99 14	(7653.9)	1⁻,2⁻	1555.2	2⁺
6120 1	0.99 14	(7653.9)	1⁻,2⁻	1533.3	2⁺
6135 1	1.28 19	(7653.9)	1⁻,2⁻	1518.6	1⁺,2⁺
6196 1	0.81 13	(7653.9)	1⁻,2⁻	1457.1	1⁺,2⁺
6207 1	0.68 10	(7653.9)	1⁻,2⁻	1448.9	1⁺,2⁺
6239 1	0.55 8	(7653.9)	1⁻,2⁻	1414.3	
6293 1	0.63 10	(7653.9)	1⁻,2⁻	1359.2	2⁺

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^{69}Ga(n,γ) E=thermal 1970Li04,1971Ve03 (continued)

γ(^{70}Ga) (continued)

E_γ [†]	I_γ [a]	E_i(level)	J_i^π	E_f	J_f^π	Comments
6341 *2*	0.95 *16*	(7653.9)	$1^-,2^-$	1312.3	$1^+,2^+$	
6346.5# *10*	1.9 *3*	(7653.9)	$1^-,2^-$	1307.5		
6391 *2*	4.9	(7653.9)	$1^-,2^-$	1263.4		Polarization function R=−0.44 *14* (1972St06).
6401 *2*	0.55 *8*	(7653.9)	$1^-,2^-$	1252.6	$3^-,4^-$	
6449 *1*	0.36 *5*	(7653.9)	$1^-,2^-$	1200.4	2^+	
6513.6# *10*	4.0 *7*	(7653.9)	$1^-,2^-$	1140.0	1,2	Polarization function R=−0.04 *6* for the unresolved 6514γ and the 6521γ from neutron capture in ^{71}Ga (1972St06).
6629.7# *15*	0.61 *10*	(7653.9)	$1^-,2^-$	1024.9	$2^+,3^+$	
6639 *2*	0.16 *3*	(7653.9)	$1^-,2^-$	1014.6	$1^+,2^+,3^+$	
6658.5# *10*	0.66 *10*	(7653.9)	$1^-,2^-$	995.1	2^+	
6963.3# *10*	0.3 *1*	(7653.9)	$1^-,2^-$	691.16	2^-	
7003.6# *10*	2.6 *4*	(7653.9)	$1^-,2^-$	651.02	$1^+,2^+$	Polarization function R=0.55 *12* (1972St06).
7147.4# *10*	0.20 *4*	(7653.9)	$1^-,2^-$	508.94	2^+	
7655 *1*	0.6 *10*	(7653.9)	$1^-,2^-$	0.0	1^+	

† The γ's below 4501 are based on the data of 1970Li04; those at or above 4501 are based on 1971Ve03, except where noted.
‡ Either of these γ's may be the 1040γ from ^{70}Ga decay to ^{70}Ge.
# From 1971Ar12.
@ From 1970Li04.
& Probably from ^{69}Ga(n,n'γ).
[a] Absolute intensities in photons per 100 n captures, assuming the thermal-capture cross sections of ^{69}Ga and nickel to be 2.1 barn and 4.6 barn, respectively, and Iγ=6.1% for the 7814γ of nickel as reported by 1967Ba79. The uncertainties in intensities estimated by 1970Li04 are about 20% for strong lines and increase up to 100% for weak lines and many lines in the low energy region. Relative intensities given by 1971Ve03 are normalized to 4.9 photons/100 n capture for the 6391γ to obtain absolute intensities.
[b] Multiply placed with undivided intensity.
[c] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

^{69}Ga(n,γ) E=thermal 1970Li04,1971Ve03

Level Scheme

Intensities:

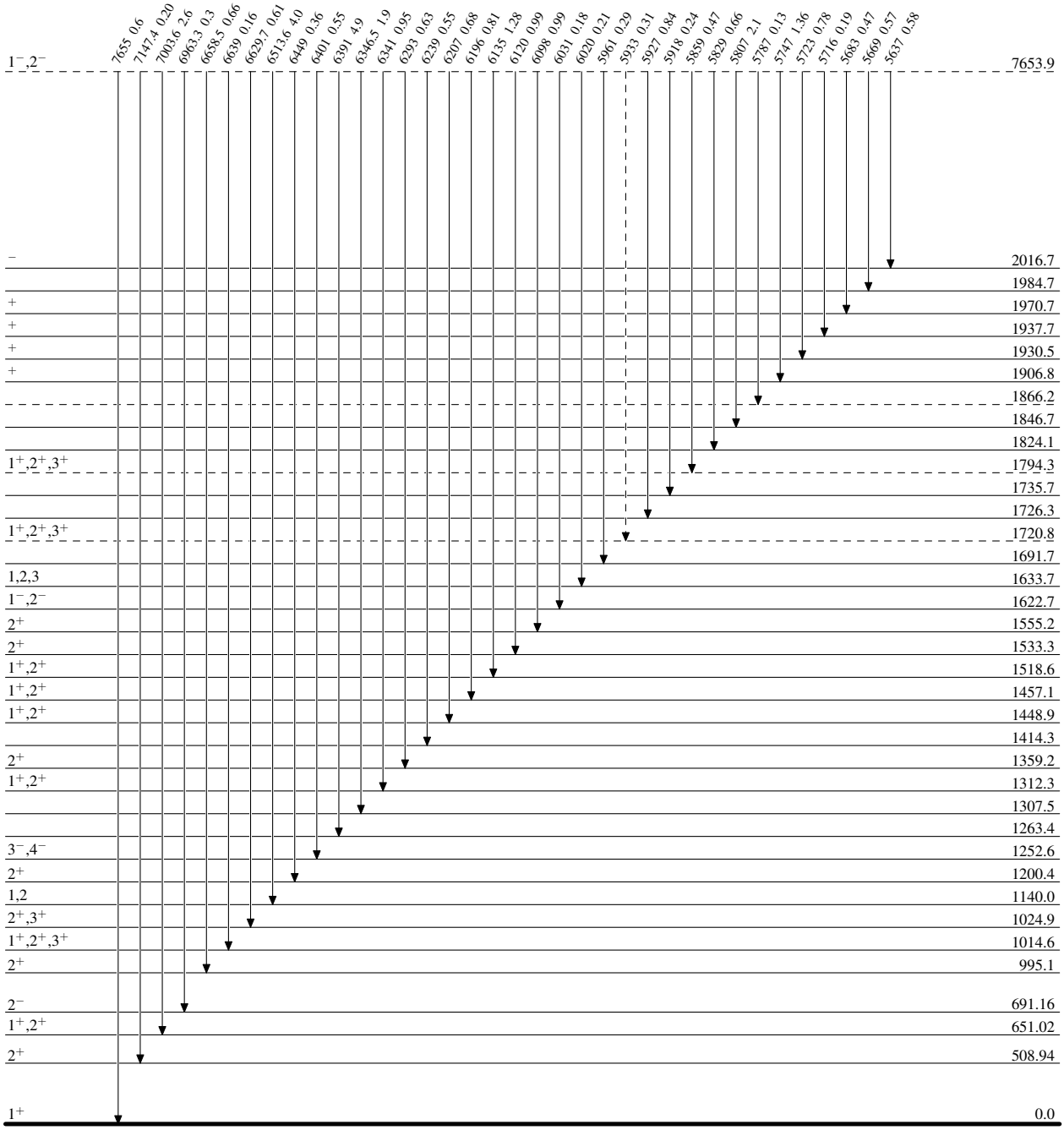
Legend

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

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

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

γ Decay (Uncertain)



$^{70}_{31}Ga_{39}$

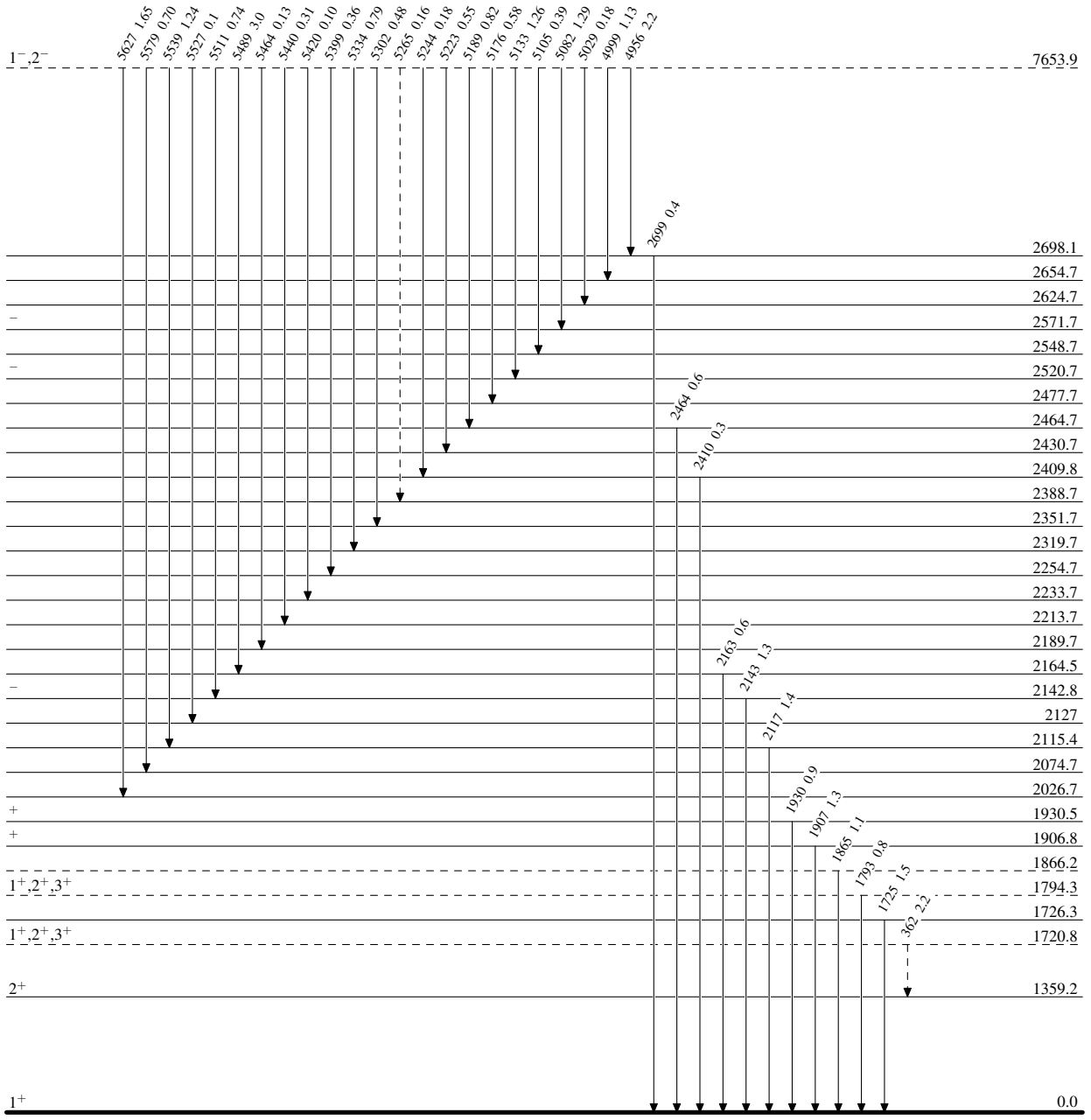
^{69}Ga(n,γ) E=thermal 1970Li04,1971Ve03

Level Scheme (continued)

Intensities:

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)



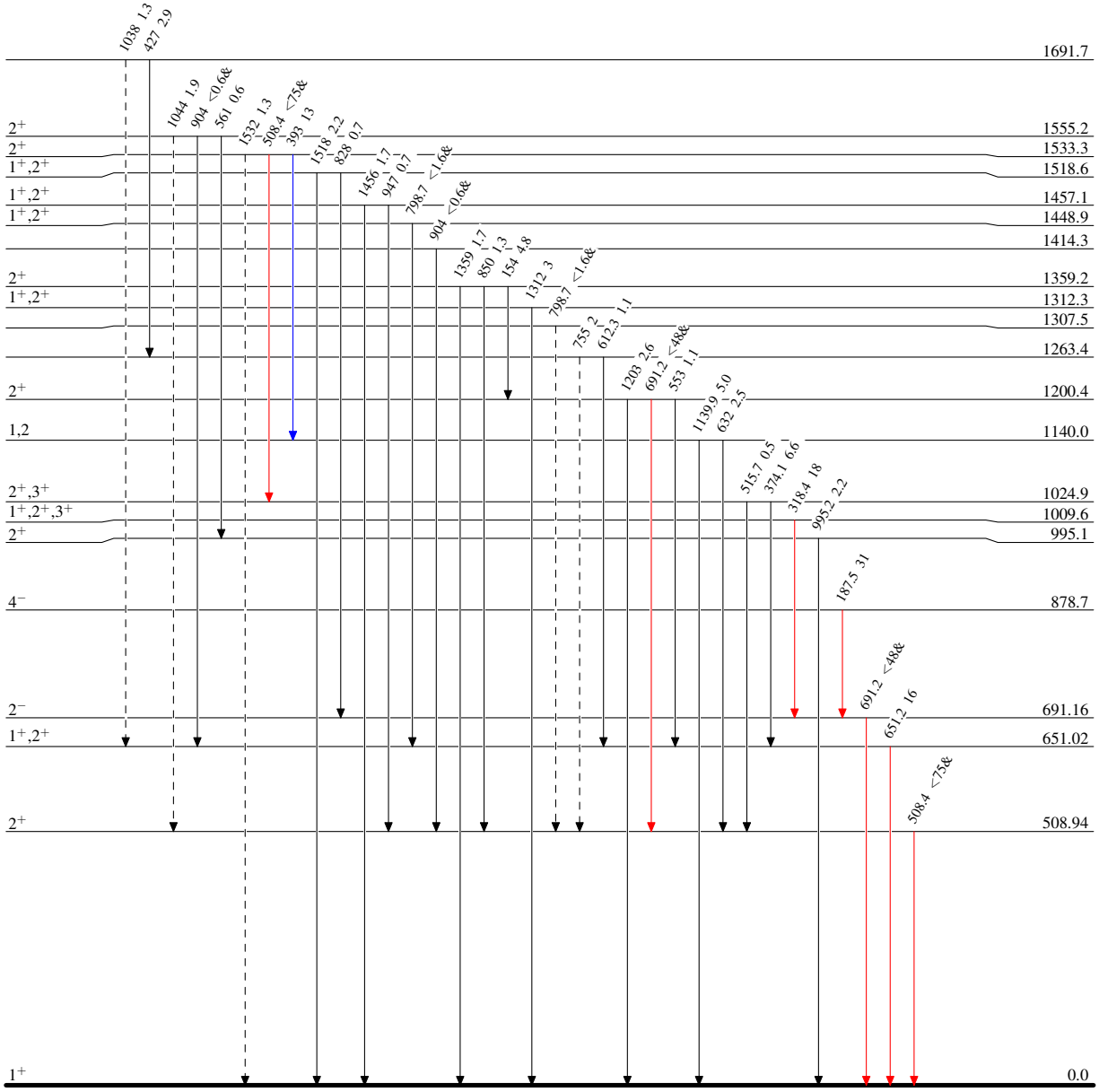
$^{70}_{31}Ga_{39}$

^{69}Ga(n,γ) E=thermal 1970Li04,1971Ve03

Level Scheme (continued)

Intensities:
& 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)



$^{70}_{31}Ga_{39}$