^{138}Ba(n,γ) E=thermal 1991Bo47,1990Is07,1969Mo13

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	P. K. Joshi, B. Singh, S. Singh, A. K. Jain	NDS 138, 1 (2016)	15-Oct-2016

1991Bo47 measured γ's, $\gamma\gamma$-coincidences; HPGe's.
1990Is07 measured γ's; pair spectrometer (HPGe, NaI(Tl)). Natural target. See 1990Is07 for many unplaced transitions observed.
1969Mo13 measured γ's and $\gamma\gamma$-coincidences (Ge(Li),NaI).
2007ChZX: measured Eγ and elemental cross sections for natural targets using Budapest reactor facility. Consult also EGAF database at IAEA-Nuclear Data Sheets webpage and/or LBNL (isotopes project) websites. A total of nine secondary and five primary gamma rays are reported in the measurements at Budapest. Except for the intensity of 1047.7γ, all other Eγ and Iγ data are in reasonable agreement with those from 1991Bo47.
Other: 1969IrZZ.
All data are from 1991Bo47, except as noted. Comparisons made with data in 2007ChZX.

^{139}Ba Levels

E(level)	J$^\pi$ †	Comments
0.0	7/2$^-$	
627.30 *7*	3/2$^-$	
1081.96 *7*	(1/2$^-$)	
1420.66 *10*	(5/2)$^-$	
1679.9 *4*	(7/2)$^-$	
1698.61 *20*	(5/2)$^-$	
1748.14 *23*	3/2$^-$	
1895.45 *8*	1/2,3/2,5/2$^+$	
1946.02 *18*	(3/2$^-$,5/2$^+$)	
1951.54 *15*		
2129.17 *7*	3/2$^-$	
2155.4 *4*	3/2$^-$,5/2$^+$	
2158.82 *8*	3/2$^-$,5/2$^+$	
2185.55 *9*	1/2$^-$,3/2$^-$	
2435.25 *11*	1/2$^-$,3/2$^-$	
2480.74 *7*	(3/2$^-$)	
2485.56 *25*	1/2,3/2,5/2$^+$	
2549.71 *17*	(3/2$^-$)	
2569.86 *13*	(3/2$^-$)	
3024.8 *2*	(1/2$^-$,3/2$^-$)	
3168.17 *21*	(1/2$^-$,3/2$^-$)	
3259.1 *3*	1/2,3/2,5/2$^+$	
3385.07 *21*	(1/2$^-$,3/2$^-$)	
(4723.48 *7*)	1/2$^+$	J$^\pi$: s-wave capture in 0$^+$ g.s. of ^{138}Ba. E(level): S(n)=4723.43 *4* (2012Wa38).

† From Adopted Levels.

γ(^{139}Ba)

Iγ normalization: From ΣIγ(to g.s.)=100 (1991Bo47).
The $\gamma\gamma$ coincidences are primarily taken from 1991Bo47 with some additions from 1969Mo13.

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^{138}Ba(n,γ) E=thermal 1991Bo47,1990Is07,1969Mo13 (continued)

γ(^{139}Ba) (continued)

E_γ	I_γ[k]	E_i(level)	J_i^π	E_f	J_f^π	Comments
295[†‡m] 5	<1.0	2480.74	(3/2⁻)	2185.55	1/2⁻,3/2⁻	
352[†‡m] 5	<1.0	2480.74	(3/2⁻)	2129.17	3/2⁻	
454.67[†] 10	29.0[h] 14	1081.96	(1/2⁻)	627.30	3/2⁻	Eγ=454.78 5, σ=0.0858 22 (2007ChZX).
627.26[†] 10	100 5	627.30	3/2⁻	0.0	7/2⁻	Eγ=627.30 5, σ=0.293 6 (2007ChZX).
666.2[i#] 7	1.44 7	1748.14	3/2⁻	1081.96	(1/2⁻)	Eγ=665.98 7, σ=0.0053 3 (2007ChZX), but placed from a 1293.3 level, not known from any other study.
[x]686.7 5	0.22 2					
687.6 5	0.16 2	2435.25	1/2⁻,3/2⁻	1748.14	3/2⁻	
708.4 1	1.29[@] 12	2129.17	3/2⁻	1420.66	(5/2)⁻	
[x]731.9 5	0.15 2					
738.4 2	0.54 3	2158.82	3/2⁻,5/2⁺	1420.66	(5/2)⁻	
[x]744.7 2	0.23 2					
[x]749.5 2	0.45 3					
[x]755.4 3	0.09 1					
[x]758.7[&] 2	0.12 1					
[x]765.7[&] 2	0.11 1					
793.4 3	0.26 2	1420.66	(5/2)⁻	627.30	3/2⁻	
[x]822.6 4	0.13 1					
[x]866.9[a]						
[x]890.2 3	0.16 1					
[x]1036.5 3						
[x]1037.9[a]						
1047.3 1	2.23 11	2129.17	3/2⁻	1081.96	(1/2⁻)	Eγ=1047.74 5, σ=0.0319 10 (2007ChZX). Note that relative intensity deduced from 2007ChZX is about a factor of 5 higher than that from 1991Bo47.
[x]1054.4 3						
1060.1 3		2480.74	(3/2⁻)	1420.66	(5/2)⁻	
1077.1 2	0.96 6	2158.82	3/2⁻,5/2⁺	1081.96	(1/2⁻)	
[x]1082.7 3	0.22 2					
[x]1090.0 3	0.28 3					
1103.2 2	1.68 11	2185.55	1/2⁻,3/2⁻	1081.96	(1/2⁻)	Eγ=1103.43 10, σ=0.0043 4 (2007ChZX).
1120.8 9	2.28 12	1748.14	3/2⁻	627.30	3/2⁻	
1129.3 3	0.08 2	2549.71	(3/2⁻)	1420.66	(5/2)⁻	
[x]1131.5 3	0.16 2					
1150.1 8	0.06 2	2569.86	(3/2⁻)	1420.66	(5/2)⁻	
[x]1152.2 4	0.42 4					
[x]1186.8 2	0.67 4					
[x]1204.9 3	0.69 4					
[x]1215.8 4	0.14 2					
[x]1220.4 3	0.24 2					
[x]1236.1 3	0.49 5					
[x]1237.1 4	0.38 4					
[x]1250.6 3	0.49 6					
[x]1254.3 4	0.24 4					
1268.2 2	1.81 18	1895.45	1/2,3/2,5/2⁺	627.30	3/2⁻	
[x]1299.2 3	0.41 4					
1318.5 2	0.55 6	1946.02	(3/2⁻,5/2⁺)	627.30	3/2⁻	
[x]1321.7 4	0.32 3					
[x]1328.3 4	0.41 4					
1338.4 2	0.55 6	(4723.48)	1/2⁺	3385.07	(1/2⁻,3/2⁻)	
1353.1 2	1.43 14	2435.25	1/2⁻,3/2⁻	1081.96	(1/2⁻)	
[x]1365.1 4	0.13 2					
[x]1378.8 3	0.44 6					

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^{138}Ba(n,γ) E=thermal 1991Bo47,1990Is07,1969Mo13 (continued)

γ(^{139}Ba) (continued)

E_γ	I_γ[k]	E_i(level)	J_i^π	E_f	J_f^π	Comments
1403.4 *4*	0.35 *8*	2485.56	1/2,3/2,5/2$^+$	1081.96	(1/2$^-$)	
x1406.2 *3*	1.13 *15*					
x1418.4 *3*	0.61 *6*					
1420.57[i] *25*	2.71 *18*	1420.66	(5/2)$^-$	0.0	7/2$^-$	Eγ=1420.41 *7*, σ=0.0089 *5* (2007ChZX).
x1459.2 *8*	0.23 *3*					
1464.3 *3*	0.39 *6*	(4723.48)	1/2$^+$	3259.1	1/2,3/2,5/2$^+$	
(1468)		2549.71	(3/2$^-$)	1081.96	(1/2$^-$)	
x1470.8 *6*	0.44 *5*					
x1484.5 *7*	0.22 *3*					
1488.8 *9*	0.21 *3*	2569.86	(3/2$^-$)	1081.96	(1/2$^-$)	
1501.81[j] *19*	1.92[e] *20*	2129.17	3/2$^-$	627.30	3/2$^-$	
x1505.6[&]						
x1515.5 *3*	0.44 *4*					
1531.4 *3*	0.73 *8*	2158.82	3/2$^-$,5/2$^+$	627.30	3/2$^-$	
x1542.2 *5*	0.18 *2*					
1555.3 *2*	0.56 *6*	(4723.48)	1/2$^+$	3168.17	(1/2$^-$,3/2$^-$)	
1558.3 *2*	1.96 *20*	2185.55	1/2$^-$,3/2$^-$	627.30	3/2$^-$	Eγ=1558.11 *9*, σ=0.0078 *5* (2007ChZX).
x1562.0[&]						
x1569.2 *5*	0.24 *6*					
x1572.3[g] *3*	0.64 *6*					
x1618.6 *3*	0.37 *4*					
1679.9 *4*	0.44[@] *16*	1679.9	(7/2)$^-$	0.0	7/2$^-$	
1698.6[l] *2*	1.28[l] *16*	1698.61	(5/2)$^-$	0.0	7/2$^-$	
1698.6[lm] *2*	1.28[l] *16*	(4723.48)	1/2$^+$	3024.8	(1/2$^-$,3/2$^-$)	
x1720.1 *3*	0.60 *9*					
x1732.2 *3*	0.38 *8*					
1748.3 *3*	0.61 *6*	1748.14	3/2$^-$	0.0	7/2$^-$	
x1785.7 *5*	0.24 *3*					
x1807.1 *3*	0.38 *7*					
x1817.6[b]						
x1841.9 *4*	0.20 *2*					
1853.31[c] *9*	2.20[e] *14*	2480.74	(3/2$^-$)	627.30	3/2$^-$	Eγ=1853.21 *13*, σ=0.0074 *6* (2007ChZX).
1921.8 *4*	0.39 *4*	2549.71	(3/2$^-$)	627.30	3/2$^-$	
1946.9 *4*	0.79 *18*	1946.02	(3/2$^-$,5/2$^+$)	0.0	7/2$^-$	
1951.53[c] *15*	1.3[c] *4*	1951.54		0.0	7/2$^-$	Eγ=1951.7 *5*, σ=0.0016 *5* (2007ChZX).
x2033.8 *6*	0.21 *8*					
x2038.4 *4*	0.43 *10*					
x2074.9 *4*	0.23 *4*					
x2081.4[&] *4*	0.38 *4*					
x2099.5 *4*	0.22 *3*					
x2109.0 *7*	0.44 *6*					
x2126.3 *4*	0.39 *4*					
2129.2 *1*	1.28 *14*	2129.17	3/2$^-$	0.0	7/2$^-$	
x2135.9[&]						
x2140.2 *7*	0.19 *2*					
2152.5 *4*	0.61 *5*	(4723.48)	1/2$^+$	2569.86	(3/2$^-$)	
2155.4 *4*	0.50 *4*	2155.4	3/2$^-$,5/2$^+$	0.0	7/2$^-$	
2173.96[cf] *23*	0.56 *6*	(4723.48)	1/2$^+$	2549.71	(3/2$^-$)	
2176.1		3259.1	1/2,3/2,5/2$^+$	1081.96	(1/2$^-$)	
2237.8 *3*	0.98 *21*	(4723.48)	1/2$^+$	2485.56	1/2,3/2,5/2$^+$	
2242.67[c] *6*	3.81[d] *20*	(4723.48)	1/2$^+$	2480.74	(3/2$^-$)	Eγ=2242.50 *15*, σ=0.0103 *13* (2007ChZX).
x2278.7[cbg] *5*						
2288.19 *9*	2.4[h] *3*	(4723.48)	1/2$^+$	2435.25	1/2$^-$,3/2$^-$	

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^{138}Ba(n,γ) E=thermal 1991Bo47,1990Is07,1969Mo13 (continued)

$\gamma(^{139}Ba)$ (continued)

E_γ	I_γ[k]	E_i(level)	J_i^π	E_f	J_f^π	Comments
2480.68[c] *12*	0.66[h] *12*	2480.74	(3/2$^-$)	0.0	7/2$^-$	
[x]2515.5 *10*	0.46 *7*					
[x]2522.5[†m] *15*	8.5 *15*					
[x]2532.3 *3*	0.55 *5*					
2537.88[c] *6*	3.68[e] *21*	(4723.48)	1/2$^+$	2185.55	1/2$^-$,3/2$^-$	Eγ=2537.64 *13*, σ=0.0103 *7* (2007ChZX).
2550.8 *5*	0.35 *8*	2549.71	(3/2$^-$)	0.0	7/2$^-$	
2564.66[j] *5*	1.9[h] *3*	(4723.48)	1/2$^+$	2158.82	3/2$^-$,5/2$^+$	
2569.68[gj] *13*	0.33 *3*	2569.86	(3/2$^-$)	0.0	7/2$^-$	
2594.29[c] *4*	6.35[e] *26*	(4723.48)	1/2$^+$	2129.17	3/2$^-$	Eγ=2594.00 *10*, σ=0.0185 *8* (2007ChZX).
2632.5		3259.1	1/2,3/2,5/2$^+$	627.30	3/2$^-$	
2777.5 *7*	0.43 *13*	(4723.48)	1/2$^+$	1946.02	(3/2$^-$,5/2$^+$)	
[x]2800.6 *5*	0.31 *8*					
2828.00[cg] *4*	1.62 *13*	(4723.48)	1/2$^+$	1895.45	1/2,3/2,5/2$^+$	
[x]2833.7 *4*	0.51 *15*					
[x]2874.4 *5*	0.36 *10*					
[x]2883.4[&]						
2975.3 *9*	3.01 *5*	(4723.48)	1/2$^+$	1748.14	3/2$^-$	
[x]3432.4[cf] *3*	0.54[c] *12*					
3641.47[c] *5*	20.7[h] *19*	(4723.48)	1/2$^+$	1081.96	(1/2$^-$)	Eγ=3641.22 *13*, σ=0.0560 *16* (2007ChZX).
[x]3685.5[a]						
[x]3856.5[a]						
4096.14[c] *4*	56.0 *28*	(4723.48)	1/2$^+$	627.30	3/2$^-$	Eγ=4095.77 *15*, σ=0.154 *4* (2007ChZX).

[†] From 1969Mo13.
[‡] Observed only in $\gamma\gamma$-coincidences by 1969Mo13.
[#] Placed as deexciting the 1293 state by 1969Mo13.
[@] Background subtracted (1991Bo47).
[&] $\gamma\gamma$-cascade summing to 3641.5 keV (1991Bo47).
[a] $\gamma\gamma$-cascade summing to 4723.4 keV (1991Bo47).
[b] $\gamma\gamma$-cascade summing to 4096.1 keV (1991Bo47).
[c] From 1990Is07. Iγ converted from absolute to relative using Iγ normalization and 10% uncertainty from $\Delta\sigma$(n,γ) added in quadrature by the evaluators.
[d] Weighted av of 3.85 *40* (1991Bo47) and 3.80 *22* (1990Is07).
[e] I_γ(1502γ)=4.0 *13*/100 n captures (1990Is07) and <10 (1969Mo13), I_γ(1854γ)=3.2 *13*/100 n captures (1990Is07), I_γ(2538γ)=4.6 *3*/100 n captures (1990Is07), and I_γ(2594γ)=6.8 *2*/100 n captures (1990Is07).
[f] In 1990Is07, a 3432γ is placed from the capture state to a level at 1291 keV, and the 2147γ as a ground-state transition. Here 3432γ is unplaced and 2147γ placed from the capture state.
[g] Not assigned to a specific Ba isotope by 1990Is07.
[h] Unweighted averages of values given in 1990Is07 (first value) and 1969Mo13 (second value) taken in the following cases. The I_γ values from 1990Is07 converted from absolute to relative using Iγ normalization and 10% uncertainty from $\Delta\sigma$(n,γ) added in quadrature by the evaluators: 455γ: 29.0 *14* and 27.0 *20*. 2288γ: 2.05 *25* and 2.71 *22*. 2481γ: 0.79 *13* and 0.54 *12*. 2565γ: 1.60 *15* and 2.28 *11*. 3641γ: 18.8 *12* and 22.6 *23*.
[i] Weighted averages taken in the following cases: 666γ: 666.1 *8* (1991Bo47) and 666.5 *15* (1969Mo13). 1420γ: 1420.8 *2* (1991Bo47), 1420.01 *33* (1990Is07) and 1420.1 *10* (1969Mo13).
[j] Unweighted averages taken in the following cases: 1502γ: 1502.0 *2* (1991Bo47) and 1501.62 *16* (1990Is07). 2288γ: 2288.1 *1* (1991Bo47) and 2288.26 *6* (1990Is07). 2565γ: 2564.7 *1* (1991Bo47) and 2564.61 *8* (1990Is07). 2570γ: 2569.8 *3* (1991Bo47) and 2569.55 *23* (1990Is07).

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^{138}Ba(n,γ) E=thermal 1991Bo47,1990Is07,1969Mo13 (continued)

$\gamma(^{139}Ba)$ (continued)

[k] For intensity per 100 neutron captures, multiply by 0.921.
[l] Multiply placed with undivided intensity.
[m] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

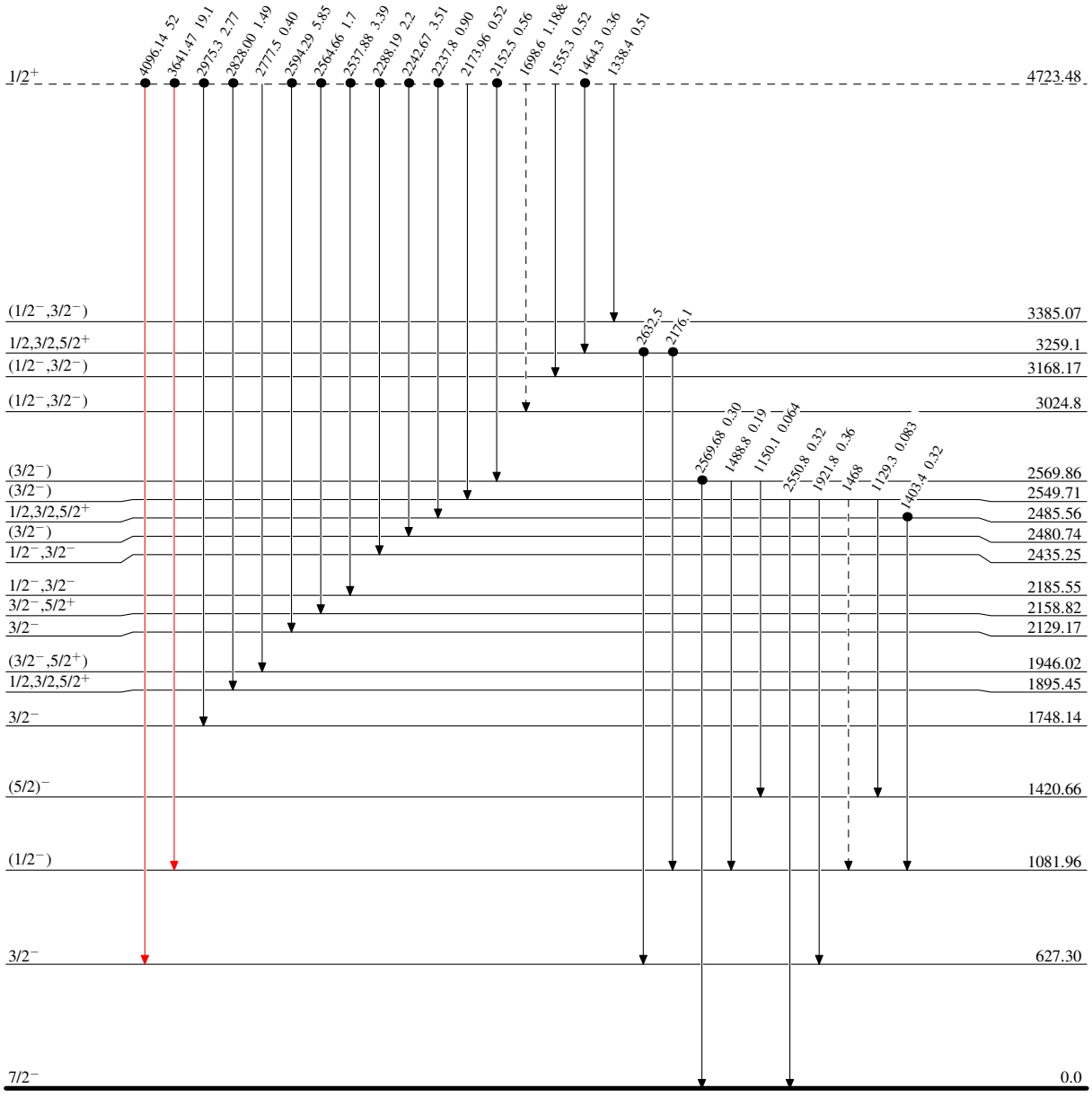
^{138}Ba(n,γ) E=thermal 1991Bo47,1990Is07,1969Mo13

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)
Coincidence

Level Scheme

Intensities: Per 100 neutron captures
& Multiply placed: undivided intensity given



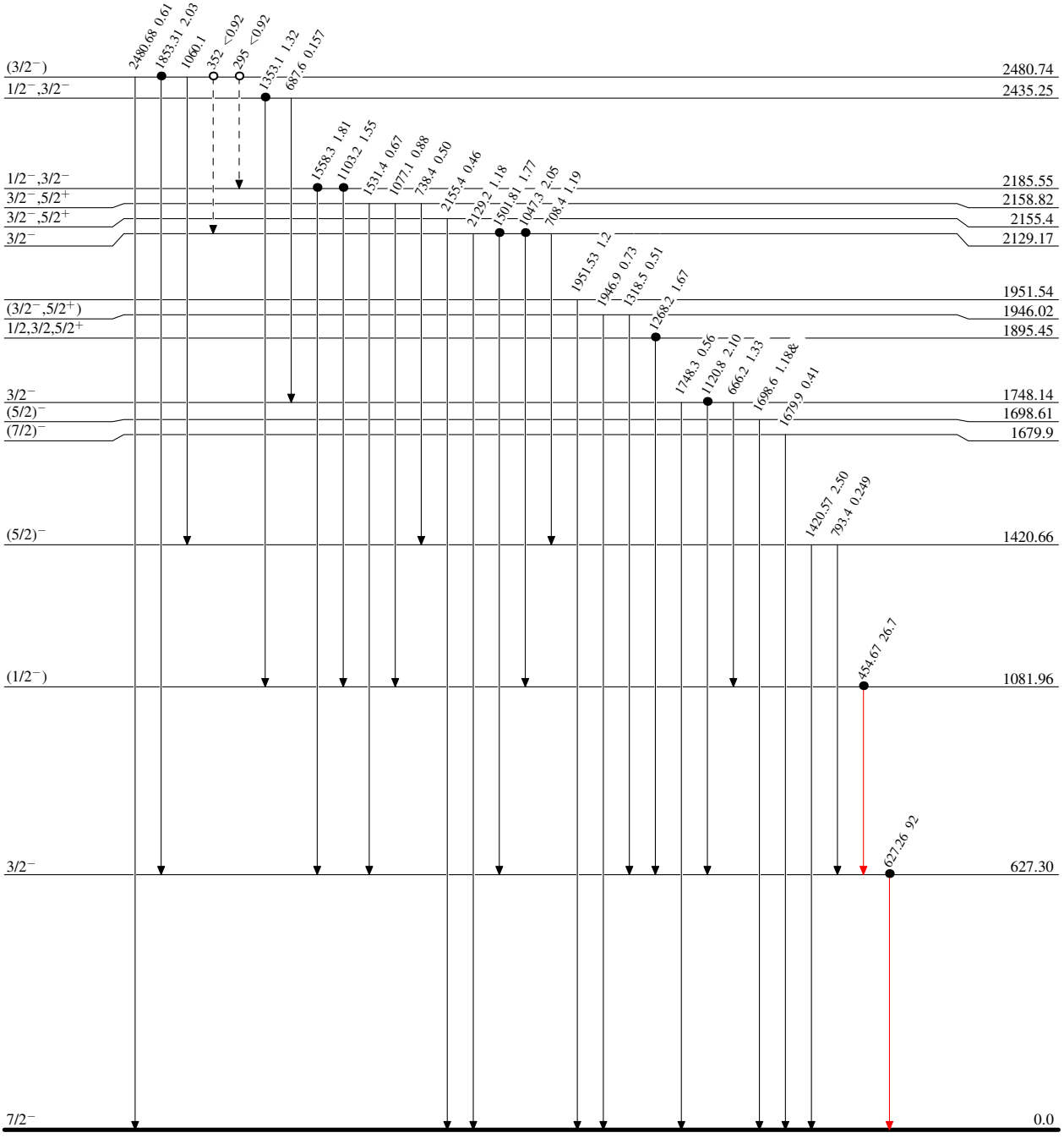
$^{139}_{56}Ba_{83}$

^{138}Ba(n,γ) E=thermal 1991Bo47,1990Is07,1969Mo13

Level Scheme (continued)

Intensities: Per 100 neutron captures
& 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)
- Coincidence
- Coincidence (Uncertain)



$^{139}_{56}Ba_{83}$