^{80}Se(n,γ) E=thermal 1971Ra07

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	M. Shamsuzzoha Basunia	NDS 199,271 (2025)	1-Sep-2024

1971Ra07: natural and 93.65% ^{80}Se targets. Ge(Li)-NaI pair spectrometer, FWHM=2.45 keV for E$\gamma\geq$2.5 MeV. Ge(Li) detectors for Eγ=0-2.5 MeV, FWHM=1.05 keV at 122 keV and FWHM=2.4 keV at 1.33 MeV. Measured Eγ, Iγ, $\gamma\gamma$ (40-ns timing resolution).

Other measurements: 2007ChZX 'Budapest' data: natural target; Eγ and elemental cross sections measured for 13 known secondary and 1 known primary γ, Eγ alone for several additional secondary transitions; same as 2003ChZS. 1981En07: natural target, reported three primary γ-rays. 1970Ba54: 95.7% ^{80}Se target, four primary and three secondary γ-rays reported.

σ_γ=0.593 b *46* ^{81}Se^{m+g} (2018MuZY, 2008Na01).

S(n)=6101.1 *6* measured by 1981En07 cf. 6700.8 *3* from 2021Wa16.

^{81}Se Levels

E(level)[†]	J$^\pi$[‡]	Comments
0	1/2$^-$	
102.87 *10*	7/2$^+$	
293.96 *21*	9/2$^+$	
467.86 *13*	3/2$^-$	
491.24 *25*	(5/2$^-$)	
616.7? *6*		
624.5 *3*	5/2$^-$	
889.3 *3*	(3/2$^+$,5/2,7/2$^+$)	
1051.8 *4*	5/2$^+$	
1232.89 *23*	1/2$^+$	
1303.61 *23*	5/2$^+$	
1406.6 *4*	3/2$^-$	
1702.0 *4*	3/2$^+$	
1711.3 *3*	(5/2$^-$,1/2$^-$,3/2)	
1725.11 *19*	(3/2)$^+$	
1828.2 *4*	3/2$^+$	
2174.2 *6*		
2253.0 *4*	(5/2$^+$)	
2333.3 *3*	5/2$^+$	
2383.3 *9*	(5/2$^-$,7/2,9/2$^-$)	
2568.5 *8*	(1/2,3/2)	
2773.6 *5*	5/2$^+$	
2952.9 *10*	1/2,3/2,5/2$^+$	
3525.7[#] *11*	1/2,3/2,5/2$^+$	
(6701.1 *4*)	1/2$^+$[@]	E(level): from a least-squares fit. S(n)=6700.8 *3* (2021Wa16).

† From a least-squares fit to Eγ, excluding Eγ for all multiply-placed lines.
‡ From Adopted Levels.
# 1971Ra07 show no γ deexciting this level; however, the unplaced 3056.5γ has plausible Eγ and Iγ for a 3526 to 468 level transition.
@ J^π based on s-wave thermal neutron capture by J^π=0$^+$ target.

^{80}Se(n,γ) E=thermal 1971Ra07 (continued)

γ(^{81}Se)

Iγ normalization: Absolute intensity (intensity/100 neutron captures by ^{80}Se) measured by 1971Ra07. Intensities calibrated relative to I(479γ) in boron(n,γ) (for low Eγ) and I(7367.7γ) in Pb(n,γ) (for high Eγ); uncertainty ≈10% for Eγ≤2000, 15% for Eγ>2000. Absolute intensity data from 'Budapest data' in 2007ChZX are in satisfactory agreement for the 468γ and 4976γ, but are typically high by factors of 2 to 16 for the other lines common to both studies.

No capture state to g.s. transition was found (Iγ<0.2%).

The relatively strong 521γ branch deexciting the 624 level in ^{81}As β^- decay is not reported in (n,γ); however, it would probably have been masked in (n,γ) by a ^{77}Se impurity γ (see 1974Ch11).

E_γ[†]	I_γ[@b]	E_i(level)	J^π_i	E_f	J^π_f	Comments
102.89 *10*	1.11 *8*	102.87	7/2+	0	1/2−	
126[‡] *1*	<0.1	616.7?		491.24	(5/2−)	
148[‡] *1*	<0.1	616.7?		467.86	3/2−	
156.4 *3*	0.24 *4*	624.5	5/2−	467.86	3/2−	Other: Eγ=156.9 *3*, Iγ=1.4 *4* (2007ChZX, 'Budapest' data).
191.05 *20*	0.66 *6*	293.96	9/2+	102.87	7/2+	
264.8 *3*	0.16 *4*	889.3	(3/2+,5/2,7/2+)	624.5	5/2−	
388.4 *3*	0.67 *5*	491.24	(5/2−)	102.87	7/2+	
399.8[c] *6*	0.14[c] *4*	889.3	(3/2+,5/2,7/2+)	491.24	(5/2−)	
399.8[c] *6*	0.14[c] *4*	1702.0	3/2+	1303.61	5/2+	
467.74 *15*	44 *5*	467.86	3/2−	0	1/2−	Other: Eγ=467.77 *4*, Iγ=44 *3* (2007ChZX, 'Budapest' data).
491.33[d] *15*	6.2[d&] *5*	491.24	(5/2−)	0	1/2−	
491.33[de]	<0.6[d&]	1725.11	(3/2)+	1232.89	1/2+	E_γ: 491.33 *15* for doublet. Other: Eγ=491.16 *9*, Iγ=7.6 *12* (2007ChZX, 'Budapest' data).
649.5 *5*	0.17 *4*	1702.0	3/2+	1051.8	5/2+	
672.19[c]	0.51[c] *5*	1725.11	(3/2)+	1051.8	5/2+	E_γ: 672.19 *25* for doublet.
672.19[c] *25*	0.51[c] *5*	2383.3	(5/2−,7/2,9/2−)	1711.3	(5/2−,1/2−,3/2)	
[x]721.3[‡] *6*	0.8 *3*					
757.6 *3*	0.47 *10*	1051.8	5/2+	293.96	9/2+	Other: Eγ=757.3 *3*, Iγ=3.0 *8* (2007ChZX, 'Budapest' data).
765.04 *20*	1.54 *13*	1232.89	1/2+	467.86	3/2−	Other: Eγ=765.48 *9*, Iγ=3.1 *4* (2007ChZX, 'Budapest' data).
786.4 *4*	0.56 *15*	889.3	(3/2+,5/2,7/2+)	102.87	7/2+	Other: Eγ=785.98 *17*, Iγ=1.8 *5* (2007ChZX, 'Budapest' data).
[x]788.5 *5*	<0.6					
[x]799.6[‡] *7*	0.06 *3*					
[x]805.1[‡] *7*	0.08 *4*					
812.5[c] *6*	0.28[c] *4*	1303.61	5/2+	491.24	(5/2−)	
812.5[c] *6*	0.28[c] *4*	1702.0	3/2+	889.3	(3/2+,5/2,7/2+)	
835.74 *20*	1.10 *12*	1303.61	5/2+	467.86	3/2−	
889[‡] *1*	0.7	889.3	(3/2+,5/2,7/2+)	0	1/2−	
915.4 *6*	0.10 *4*	1406.6	3/2−	491.24	(5/2−)	
[x]918.8 *5*	0.15 *5*					
938.7[d] *3*	0.36[da] *4*	1406.6	3/2−	467.86	3/2−	
938.7[d] *3*	≤0.04[da]	1828.2	3/2+	889.3	(3/2+,5/2,7/2+)	
949.65[c] *25*	1.25[c] *15*	1051.8	5/2+	102.87	7/2+	
949.65[c] *25*	1.25[c] *15*	2253.0	(5/2+)	1303.61	5/2+	
[x]987.7[‡] *8*	0.09 *4*					
[x]993.0[‡] *8*	0.29 *11*					

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^{80}Se(n,γ) E=thermal 1971Ra07 (continued)

γ(^{81}Se) (continued)

E_γ[†]	I_γ[@b]	E_i(level)	J^π_i	E_f	J^π_f	Comments
[x]997.3 *7*	0.20 *9*					
[x]1012.7[‡] *5*	0.25 *5*					
1087.2[c] *4*	0.24[c] *6*	1702.0	3/2$^+$	616.7?		
1087.2[c] *4*	0.24[c] *6*	1711.3	(5/2$^-$,1/2$^-$,3/2)	624.5	5/2$^-$	
1162.0 *10*	0.7 *3*	2568.5	(1/2,3/2)	1406.6	3/2$^-$	
[x]1164.5 *4*	<0.8					
1201.0 *10*	0.4 *3*	1303.61	5/2$^+$	102.87	7/2$^+$	Other: Eγ=1202.35 *9*, Iγ=12.9 *14* (2007ChZX, 'Budapest' data).
1210.8 *10*	0.7 *4*	1702.0	3/2$^+$	491.24	(5/2$^-$)	
1232.7[c]	0.33[c] *6*	1232.89	1/2$^+$	0	1/2$^-$	Eγ: 1232.7 *4* for doublet.
1232.7[c]	0.33[c] *6*	1725.11	(3/2)$^+$	491.24	(5/2$^-$)	Eγ: 1232.7 *4* for doublet.
1243.54 *25*	0.66 *6*	1711.3	(5/2$^-$,1/2$^-$,3/2)	467.86	3/2$^-$	
1257.14 *20*	1.11 *9*	1725.11	(3/2)$^+$	467.86	3/2$^-$	Other: Eγ=1257.8 *6*, Iγ=1.4 *11* (2007ChZX, 'Budapest' data).
[x]1327.7 *8*	0.15 *5*					
1360.7 *10*	0.24 *5*	1828.2	3/2$^+$	467.86	3/2$^-$	
1367.2 *10*	0.33 *5*	2773.6	5/2$^+$	1406.6	3/2$^-$	
1406.7 *4*	1.3 *2*	1406.6	3/2$^-$	0	1/2$^-$	Other: Eγ=1406.8 *3*, Iγ=4.9 *11* (2007ChZX, 'Budapest' data).
[x]1438.2[‡] *7*	0.22 *6*					
[x]1462.3[‡] *3*	0.21 *6*					
1549.4 *7*	0.30 *5*	2174.2		624.5	5/2$^-$	
[x]1562.5 *5*	0.24 *4*					
1599.5 *5*	0.35 *4*	1702.0	3/2$^+$	102.87	7/2$^+$	
1627.1 *10*	0.28 *5*	2253.0	(5/2$^+$)	624.5	5/2$^-$	
1636.2[‡] *8*	0.38 *7*	2253.0	(5/2$^+$)	616.7?		
[x]1670.0[‡] *6*	0.33 *5*					
1702.2 *10*	0.33 *11*	1702.0	3/2$^+$	0	1/2$^-$	
1706.6 *7*	0.52 *6*	2174.2		467.86	3/2$^-$	
1711.0 *6*	0.55 *8*	1711.3	(5/2$^-$,1/2$^-$,3/2)	0	1/2$^-$	
1725.4 *3*	5.9 *5*	1725.11	(3/2)$^+$	0	1/2$^-$	Other: Eγ=1725.36 *15*, Iγ=15.2 *20* (2007ChZX, 'Budapest' data).
[x]1769.3 *6*	0.33 *5*					
1784.8 *8*	0.90 *24*	2253.0	(5/2$^+$)	467.86	3/2$^-$	Other: Eγ=1784.7 *6*, Iγ=3.1 *10* (2007ChZX, 'Budapest' data).
[x]1799.5[‡] *6*	0.24 *6*					
1828.1 *4*	0.39 *5*	1828.2	3/2$^+$	0	1/2$^-$	
1841.9 *5*	0.26 *5*	2333.3	5/2$^+$	491.24	(5/2$^-$)	
[x]1858.5[‡] *10*	0.13 *4*					
1865.3 *3*	0.57 *7*	2333.3	5/2$^+$	467.86	3/2$^-$	Other: Eγ=1863.9 *4*, Iγ=3.8 *14* (2007ChZX, 'Budapest' data).
1884.2 *5*	0.50 *6*	2773.6	5/2$^+$	889.3	(3/2$^+$,5/2,7/2$^+$)	
1892.0 *8*	0.24 *5*	2383.3	(5/2$^-$,7/2,9/2$^-$)	491.24	(5/2$^-$)	
[x]1896.3 *8*	0.38 *6*					
[x]1951.3 *4*	0.60 *7*					
1959.5 *5*	0.42 *7*	2253.0	(5/2$^+$)	293.96	9/2$^+$	
[x]2032.2 *6*	0.40 *2*					
[x]2041.1 *5*	0.40 *1*					
[x]2051.0[‡] *8*	0.21 *8*					
2149.6[c] *8*	0.32[c] *8*	2253.0	(5/2$^+$)	102.87	7/2$^+$	
2149.6[c] *8*	0.32[c] *8*	2773.6	5/2$^+$	624.5	5/2$^-$	
[x]2151.3 *6*	0.8 *2*					
[x]2162.3 *7*	1.10 *3*					

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^{80}Se(n,γ) E=thermal 1971Ra07 (continued)

γ(^{81}Se) (continued)

E_γ[†]	I_γ[@b]	E_i(level)	J_i^π	E_f	J_f^π	Comments
[x]2207.1 *6*	0.38 *11*					
[x]2218.6[‡] *10*	0.7 *3*					
[x]2273.2 *6*	0.48 *20*					
2485.6 *20*	0.65 *20*	2952.9	1/2,3/2,5/2$^+$	467.86	3/2$^-$	Other: Eγ=2483.4 *4*, Iγ=5.2 *14* (2007ChZX, 'Budapest' data).
2570.0 *15*	1.37 *20*	2568.5	(1/2,3/2)	0	1/2$^-$	Other: Eγ=2569.8 *3*, Iγ=2.8 *11* (2007ChZX, 'Budapest' data).
[x]2694.0 *10*	1.32 *20*					
[x]2731.3 *13*	1.07 *20*					
[x]2792.1 *20*	0.68 *22*					
[x]2910.1 *12*	1.35 *20*					
[x]2966.0 *13*	1.08 *20*					
[x]3056.5[#] *15*	1.00 *15*					
3175.4 *10*	1.16 *20*	(6701.1)	1/2$^+$	3525.7	1/2,3/2,5/2$^+$	
3748.3 *10*	1.7 *4*	(6701.1)	1/2$^+$	2952.9	1/2,3/2,5/2$^+$	
[x]3820.4[‡] *18*	0.55 *15*					
4133.7 *12*	0.83 *15*	(6701.1)	1/2$^+$	2568.5	(1/2,3/2)	
[x]4310.6[‡] *14*	0.50 *20*					
[x]4336.6 *20*	0.7 *3*					
4366.2 *10*	2.0 *4*	(6701.1)	1/2$^+$	2333.3	5/2$^+$	
4447.5 *10*	1.86 *25*	(6701.1)	1/2$^+$	2253.0	(5/2$^+$)	
[x]4540.4[‡] *24*	0.50 *20*					
4975.9 *5*	8.7 *23*	(6701.1)	1/2$^+$	1725.11	(3/2)$^+$	E_γ: from 1981En07. Other: 4976.1 *10* (1971Ra07), 4975.5 *5* (2007ChZX). Other Iγ: 5.2 *18* (2007ChZX, 'Budapest' data), 8.8 *20* (1981En07), 8.4 (1970Ba54).
4997.5 *17*	0.43 *14*	(6701.1)	1/2$^+$	1702.0	3/2$^+$	
5295.3 *17*	0.22 *10*	(6701.1)	1/2$^+$	1406.6	3/2$^-$	
5469.7 *12*	0.45 *15*	(6701.1)	1/2$^+$	1232.89	1/2$^+$	Other data: Eγ=5467.6 *8*, Iγ=2.0 *6* (1981En07).
6232.9 *11*	33 *6*	(6701.1)	1/2$^+$	467.86	3/2$^-$	E_γ: from 1981En07. Other: 6233.0 *15* (1971Ra07). Other Iγ: 29 *7* (1981En07), 21 (1970Ba54). However, γ is absent in 2007ChZX.

[†] From 1971Ra07, except as noted. Several otherwise unknown transitions listed in 2007ChZX, 'Budapest' data are not included here because it is unclear whether these were actually observed or merely expected (no Iγ reported).

[‡] Uncertain γ-transition.

[#] See comment on 3526 level concerning possible placement of this γ.

[@] Photons per 100 captures in ^{80}Se from 1971Ra07, except as noted. Authors′ uncertainties in relative Iγ are shown; the additional uncertainty in absolute Iγ is ≈10% for Eγ≤2 MeV, 15% for Eγ>2 MeV noted in 1971Ra07 − the evaluator assigns 15% for all. Except for the 468γ and 4976γ, 'Budapest' data from 2007ChZX (which supersedes 2003ChZS) is in poor agreement.

[&] Iγ=6.2 *5* for doublet. Assuming I(388γ)/I(491γ)=0.101 *12* for 491 level branching (from β^- decay), Iγ=6.6 *9* for the 491 to g.s. component of 491γ in (n,γ), leaving Iγ=−0.4 *10* for the 1725 to 1233 component. The evaluator, therefore, assigns the entire doublet Iγ to the former transition and an upper limit of 0.6 to the latter. Placement of latter component is, consequently, shown as tentative.

[a] Iγ=0.36 *4* for doublet. Assuming I(938γ)/I(1406γ)=0.33 *6* for 1407-level branching (from β^- decay), Iγ=0.43 *10* for 1407 to 468 transition in (n,γ), leaving Iγ=−0.07 *11* for 1828 to 889 component. Evaluator, therefore assigns the entire doublet Iγ to the former transition and an upper limit of 0.04 to the latter.

[b] For intensity per 100 neutron captures, multiply by 1.00 *15*.

[c] Multiply placed with undivided intensity.

[d] Multiply placed with intensity suitably divided.

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^{80}Se(n,γ) E=thermal 1971Ra07 (continued)

$\gamma(^{81}$Se) (continued)

[e] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

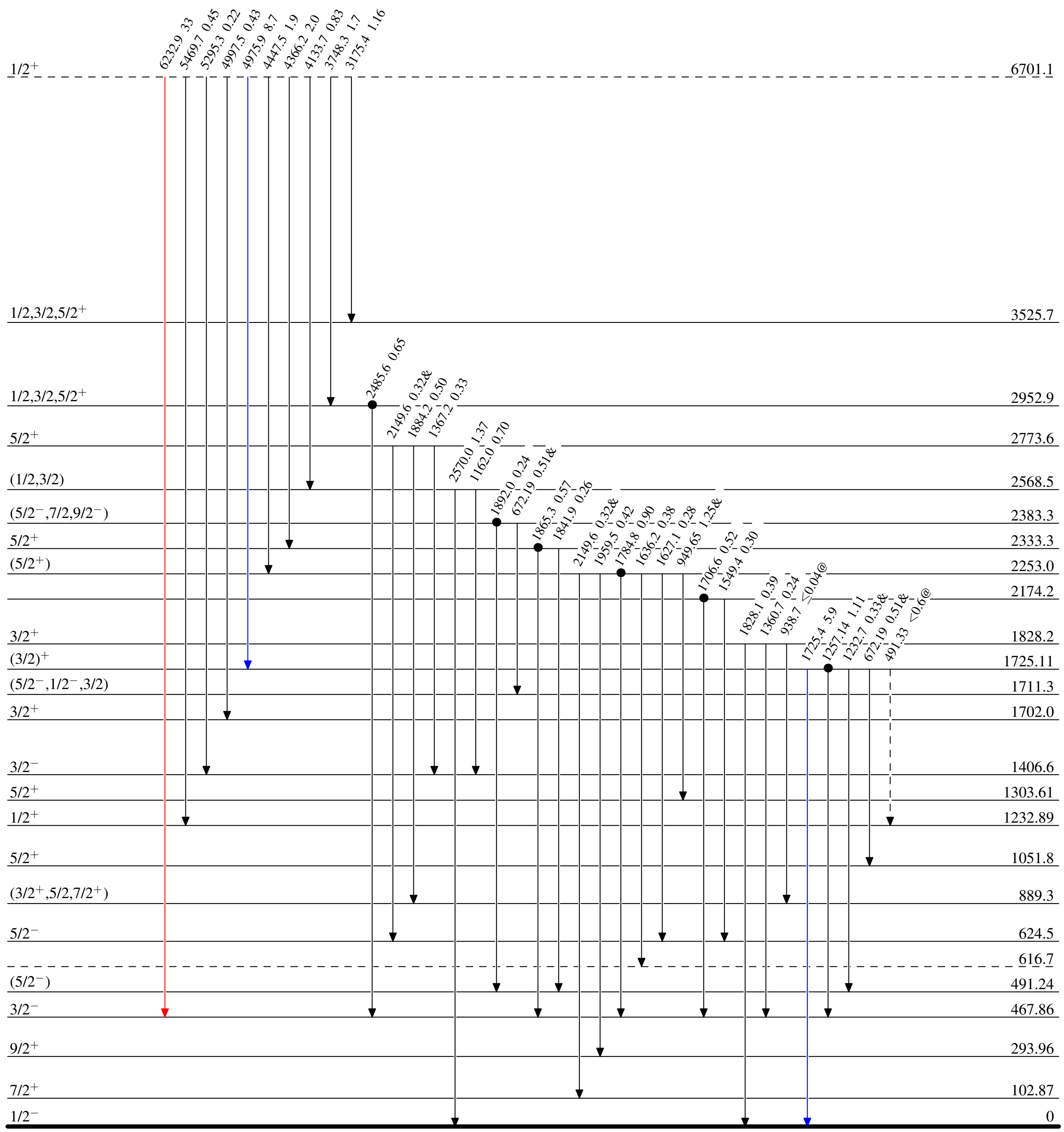
^{80}Se(n,γ) E=thermal 1971Ra07

Level Scheme

Intensities: Iγ per 100 neutron captures.
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided

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

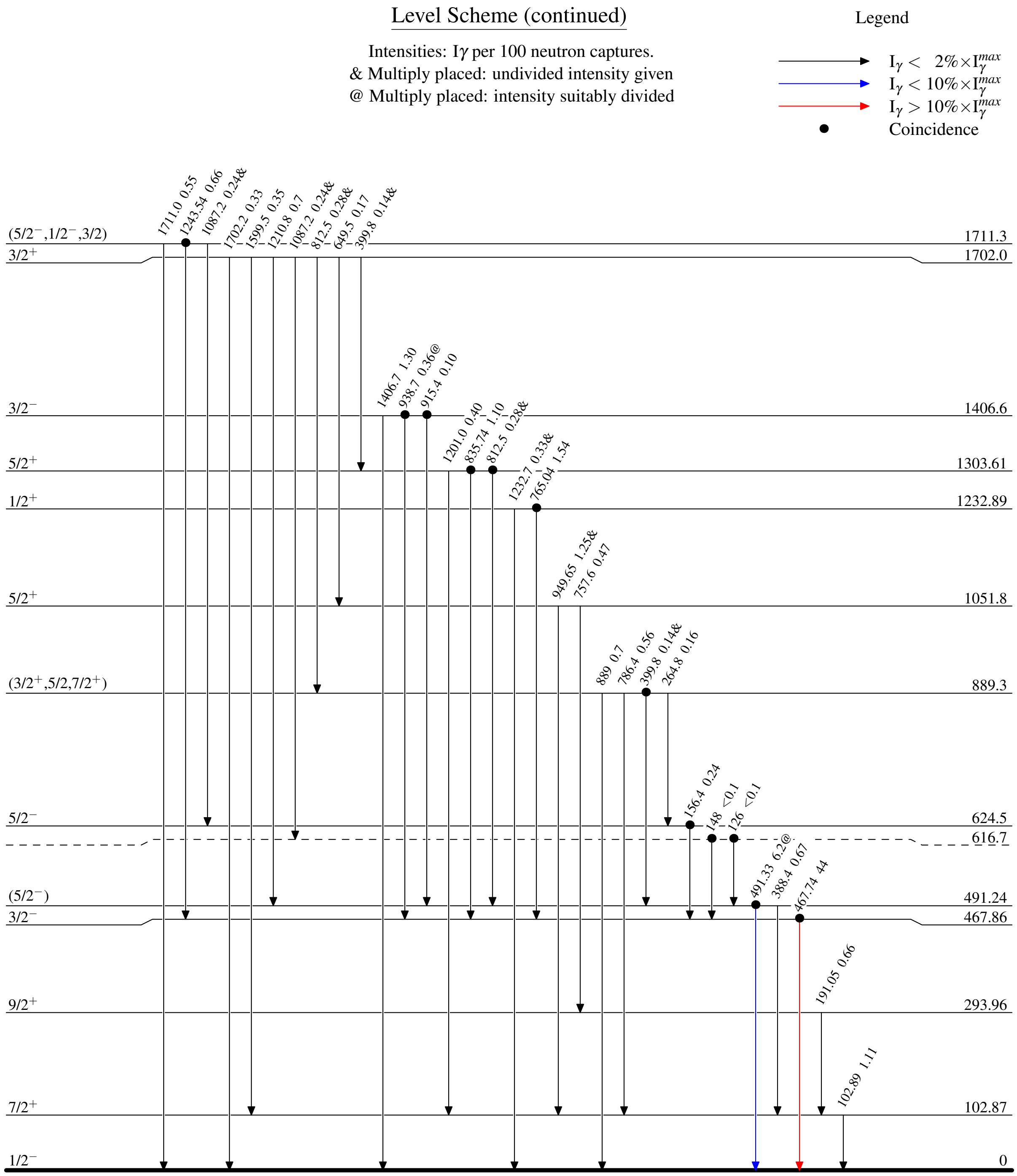


$^{81}_{34}Se_{47}$

^{80}Se(n,γ) E=thermal 1971Ra07

Level Scheme (continued)

Intensities: Iγ per 100 neutron captures.
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided



$^{81}_{34}Se_{47}$