

$^{138}\text{Ba}(\text{n},\text{n}'\gamma)$ **2003Go02,1984Di03**

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 146, 1 (2017)	30-Sep-2017

2003Go02: E=fast neutrons were produced the IR-8 reactor at the Russian Research Centre Kurchatov Institute. Target was 1.7 g/cm² thick BaCO₃ (99.8% in ^{138}Ba). γ rays were detected by Ge detectors and γ -ray polarization was measured by a two-crystal Compton polarimeter. Measured $E\gamma$, $I\gamma$, $\gamma(\theta)$, $\gamma(\text{pol})$, Doppler-shift attenuation. Deduced levels, J, π , $T_{1/2}$, γ -ray multipolarities and mixing ratios. Comparisons with neighboring nuclei and shell-model calculations.

1984Di03: E=fast neutrons were produced from the 5 MW light-water moderated research reactor of the Central Research Institute for Physics in Budapest. Target was BaCO₃ (99.8% in ^{138}Ba). γ rays were detected with a coaxial Ge(Li) detector (FWHM=1.9 keV at 1.33 MeV). Measured $E\gamma$, $I\gamma$, $\gamma(\theta)$. Deduced levels, J, π , γ -ray multipolarities and mixing ratios. Comparisons with shell-model calculations.

2013SeZZ: E=fast neutrons were produced from the IR-8 reactor at I.V. Kurchatov Institute of Atomic Energy, in Moscow. Target was 99.8% enriched ^{138}Ba . γ rays were detected with HPGe detectors. Measured $E\gamma$, $I\gamma$, $\gamma(\theta, \text{pol})$. Deduced levels, J, π , mixing ratios.

1993Be03,1993BeZL: measured Doppler-shift attenuation. Deduced $T_{1/2}$.

Other: **1986DiZY** report J^π for 2415 (5⁺), 2815 (4⁺), 2991 (3), 3050 (2⁺).

 ^{138}Ba Levels

E(level) [†]	J^π [‡]	$T_{1/2}$ [#]	Comments
0.0	0 ⁺		
1435.858 18	2 ⁺	0.19 ps +13-6	$T_{1/2}$: from 1993Be03 using DSAM.
1898.641 22	4 ⁺		
2090.58 3	6 ⁺		
2189.91 3	0 ⁺	≥0.8 ps	J^π : assigned by 1995Bo05 based on 754.05 γ isotropic, inconsistent with $J^\pi=(1,2^+)$ in Adopted Levels based on observation of 2090 γ to 0 ⁺ and strong primary feeding from 2 ⁺ in (n, γ) E=thermal.
2203.10 4	6 ⁺		
2217.891 18	2 ⁺	0.137 ps 10	$T_{1/2}$: weighted average of 0.140 ps 10 from 2003Go02 and 0.11 ps 3 from 1993BeZL , using DSAM.
2307.566 23	4 ⁺		
2415.395 25	5 ⁺		
2445.576 23	3 ⁺	≥0.7 ps	
2583.02 4	1 ⁺	0.13 ps +4-3	
2639.40 3	2 ⁺	0.42 ps +12-8	
2779.36 3	4 ⁺		
2851.50 3	4 ⁺	≥1.5 ps	
2880.73 3	3 ⁻	0.055 ps 6	
2931.45 4	2 ⁺	0.19 ps +5-4	
2991.10 3	3 ⁺		
3049.94 4	2 ⁺	0.33 ps +14-8	
3154.80 7	4 ⁺		
3163.03 6	(2) ⁺	0.28 ps +55-12	
3183.74 22	8 ⁺		
3242.40 8	3		
3257.27 7	3		
3286.14? 7			
3309.0			E(level): from 2013SeZZ .
3338.85 8	2 ⁺	0.031 ps +9-8	
3360.1 3	7 ⁺		
3366.77 7	2 ⁺	0.031 ps +10-8	
3376.70 9	3		
3379.92? 11	(5 ⁺)		J^π : proposed by 2003Go02 .
3442.02? 16	2 ⁽⁺⁾		
3486.00 5			

Continued on next page (footnotes at end of table)

$^{138}\text{Ba}(\text{n},\text{n}'\gamma)$ [2003Go02,1984Di03](#) (continued) ^{138}Ba Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2} [#]	Comments
3504.09 <i>14</i>	2 ⁻	≥0.2 ps	J ^π : 2 ⁺ proposed by 2003Go02 .
3562.28 <i>9</i>	(4) ⁻		
3600.71 <i>22</i>	1	≥0.09 ps	
3610.2 <i>4</i>			
3617.9 <i>4</i>	0 ⁺		
3622.0 <i>4</i>	10 ⁺		
3632.9 <i>4</i>	9 ⁻		
3642.60? <i>19</i>			
3642.85 <i>20</i>	2 ⁺	0.019 ps + <i>16-11</i>	
3646.66 <i>13</i>	(3) ⁻		
3684.7 <i>3</i>	1		
3694.2 <i>3</i>			
3734.4 <i>3</i>	2 ⁺	0.08 ps + <i>13-4</i>	
3800.06 <i>24</i>	2 ⁺	0.09 ps + <i>21-6</i>	
3859.6? <i>3</i>	(5) ⁻		
3922.1 <i>3</i>	(3) ⁻		
3931.24 <i>24</i>			
3935.06 <i>16</i>	2 ⁺		
4001.3 <i>4</i>	2 ⁽⁺⁾		
4025.9 <i>4</i>	1 ⁻	≤35 fs	
4165.1? <i>3</i>	(4) ⁻		
4242.2 <i>11</i>	(1,2 ⁺)		
4323.3 <i>4</i>	1 ⁻		
4615.52 <i>16</i>			
4630.5 <i>8</i>			

[†] From a least-squares fit to γ -ray energies.[‡] From Adopted Levels, unless otherwise noted.[#] From [2003Go02](#) using DSAM, unless otherwise noted.

E _γ [†]	I _γ [†]	E _i (level)	J _i ^π	E _f	J _f ^π	Mult.#	δ [#]	α [@]	Comments
107.7 1	2.0 3	2415.395	5 ⁺	2307.566	4 ⁺				E _γ : 107.7 1 (1984Di03), 107.8 2 (2003Go02). I _γ : 2 1 (1984Di03), 2.0 3 (2003Go02). A ₂ =-0.17 2I, A ₄ =+0.02 33 (2003Go02).
112.51 3	28.7 20	2203.10	6 ⁺	2090.58	6 ⁺	D+Q	-0.27 +12-10	0.746 6	E _γ : 112.6 1 (1984Di03), 112.51 3 (2003Go02). I _γ : from 2003Go02. Other: 18 1 (1984Di03). δ: from 1984Di03. Other: δ=+0.03 7 from 2003Go02. A ₂ =+0.26 6, A ₄ =+0.03 8 (1984Di03), A ₂ =+0.31 2, A ₄ =-0.01 3 (2003Go02).
138.13 7	3.3 3	2445.576	3 ⁺	2307.566	4 ⁺				E _γ : 138.2 1 (1984Di03), 138.10 7 (2003Go02). I _γ : 4 1 (1984Di03), 3.2 3 (2003Go02).
^x 162.4 [‡] 1	10 [‡] 1								
^x 165.8 [‡] 1	2 [‡] 1								
^x 177.4 [‡] 1	2 [‡] 1								
191.95 2	76 4	2090.58	6 ⁺	1898.641	4 ⁺			0.199	E _γ : 191.9 1 (1984Di03), 191.95 2 (2003Go02). I _γ : 75 2 (1984Di03), 88 6 (2003Go02). A ₂ =+0.074 8, A ₄ =-0.001 12 (2003Go02), see text in 2003Go02. Isotropic transition (1984Di03).
193.9 2	1.15 10	2639.40	2 ⁺	2445.576	3 ⁺				
212.28 3	8.9 7	2415.395	5 ⁺	2203.10	6 ⁺	D+Q	-0.07 2	0.123	E _γ : 212.3 1 (1984Di03), 212.28 3 (2003Go02). I _γ : 8 1 (1984Di03), 9.3 7 (2003Go02). A ₂ =-0.30 1I, A ₄ =-0.14 10 (1984Di03), A ₂ =-0.03 2, A ₄ =+0.03 3 (2003Go02).
227.71 6	2.11 17	2445.576	3 ⁺	2217.891	2 ⁺	D(+Q)	+0.01 8		E _γ : 227.7 1 (1984Di03), 227.71 6 (2003Go02). I _γ : 1 1 (1984Di03), 2.14 17 (2003Go02). δ: or -5.6 +18-46 (2003Go02). A ₂ =-0.12 7, A ₄ =+0.10 10 (2003Go02).
^x 273.1 [‡] 1	5 [‡] 1								
304.0 2	0.57 9	2203.10	6 ⁺	1898.641	4 ⁺				
324.83 2	16.4 10	2415.395	5 ⁺	2090.58	6 ⁺	M1+E2	-0.10 2	0.0353 1	E _γ : 324.9 1 (1984Di03), 324.83 2 (2003Go02). I _γ : 16 1 (1984Di03), 16.9 12 (2003Go02). δ: other: δ=-7.8 +16-18 from 1984Di03. A ₂ =-0.07 3, A ₄ =+0.08 4 (1984Di03), A ₂ =+0.00 9, A ₄ =+0.00 8 (2003Go02). POL=+0.9 2 (2003Go02).
333.68 8	1.99 16	2779.36	4 ⁺	2445.576	3 ⁺				
363.90 4	5.4 7	2779.36	4 ⁺	2415.395	5 ⁺	D+Q	-0.11 3		E _γ : 364.0 1 (1984Di03), 363.88 4 (2003Go02). I _γ : 7 1 (1984Di03), 5.1 4 (2003Go02). δ: or -4.7 +6-9 (2003Go02). A ₂ =+0.02 4, A ₄ =+0.03 6 (2003Go02).
365.10 11	2.27 19	2583.02	1 ⁺	2217.891	2 ⁺	D(+Q)	-0.1 6		E _γ , I _γ , Mult.: from 2003Go02 only. A ₂ =+0.00 8, A ₄ =+0.00 12 (2003Go02). δ: or -2.6 +18-∞ (2003Go02).

¹³⁸Ba(n,n'γ) **2003Go02,1984Di03** (continued)

γ(¹³⁸Ba) (continued)

E _γ [†]	I _γ [†]	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. [#]	δ [#]	α [@]	Comments
375.6 2	0.51 7	3154.80	4 ⁺	2779.36	4 ⁺				
^x 385.1 2	0.66 9								
408.96 2	32.6 14	2307.566	4 ⁺	1898.641	4 ⁺	M1+E2	-0.23 +5-7	0.0218 2	E _γ : 408.9 1 (1984Di03), 408.96 2 (2003Go02). I _γ : 32 1 (1984Di03), 36.0 25 (2003Go02). δ: from 1984Di03. Other: δ=+0.03 2 from 2003Go02. A ₂ =+0.19 3, A ₄ =-0.01 4 (1984Di03), A ₂ =+0.322 11, A ₄ =+0.002 15 (2003Go02). POL=+3.1 +12-4 (2003Go02). A ₂ =+0.15 7, A ₄ =+0.01 11 (2003Go02). δ: or +2.9 +18-9 (2003Go02).
421.41 11	2.06 16	2639.40	2 ⁺	2217.891	2 ⁺	D(+Q)	-0.08 12		
436.07 2	0.49 6	2851.50	4 ⁺	2415.395	5 ⁺				
438.3 3	0.40 7	3622.0	10 ⁺	3183.74	8 ⁺				
449.2 3	0.33 6	3632.9	9 ⁻	3183.74	8 ⁺				
^x 454.6 [‡] 1	2 [‡] 1								
462.79 2	311 7	1898.641	4 ⁺	1435.858	2 ⁺	E2		0.0122	E _γ : 462.8 1 (1984Di03), 462.79 2 (2003Go02). I _γ : 309 7 (1984Di03), 332 23 (2003Go02). A ₂ =+0.10 1, A ₄ =-0.08 1 (1984Di03) A ₂ =+0.233 9, A ₄ =-0.047 12 (2003Go02). POL=+2.1 +6-2 (2003Go02). E _γ : 516.6 1 (1984Di03), 516.70 2 (2003Go02). I _γ : from 2003Go02. Other: 43 3 (1984Di03). A ₂ =-0.121 10, A ₄ =+0.029 15 (2003Go02). POL=+0.68 10 (2003Go02).
516.70 2	25.5 18	2415.395	5 ⁺	1898.641	4 ⁺	M1+E2	+0.059 7		
^x 524.5 2	0.57 7								
546.93 3	13.0 10	2445.576	3 ⁺	1898.641	4 ⁺	M1+E2	-0.13 2		E _γ : 546.9 1 (1984Di03), 546.93 3 (2003Go02). I _γ : 12 1 (1984Di03), 13.9 10 (2003Go02). A ₂ =+0.10 3, A ₄ =+0.01 3 (1984Di03), A ₂ =+0.021 13, A ₄ =-0.012 19 (2003Go02). POL=+0.75 16 (2003Go02).
^x 608.5 [‡] 1	7 [‡] 1								
^x 627.3 [‡] 1	7 [‡] 1								
^x 648.1 2	0.35 7								
^x 663.9 [‡] 1	3 [‡] 1								
^x 669.3 3	0.40 9								
683.78 13	3.1 2	2991.10	3 ⁺	2307.566	4 ⁺	D+Q	-2.5 5		E _γ : unweighted average of 683.9 1 (1984Di03), 683.65 7 (2003Go02). Placed by 2003Go02, unplaced in 1984Di03. I _γ : 3 1 (1984Di03), 3.1 2 (2003Go02). δ: or -0.27 6 (2003Go02). A ₂ =+0.14 5, A ₄ =+0.04 7 (2003Go02).
717.67 17	1.03 11	3163.03	(2) ⁺	2445.576	3 ⁺				
^x 735.78 9	2.42 19								E _γ : 735.7 1 (1984Di03), 735.85 9 (2003Go02). I _γ : 3 1 (1984Di03), 2.40 19 (2003Go02).
739.44 19	1.30 13	3154.80	4 ⁺	2415.395	5 ⁺				

$\gamma(^{138}\text{Ba})$ (continued)

E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. #	$\delta^\#$	Comments
754.05 2	17 2	2189.91	0 ⁺	1435.858	2 ⁺			E_γ : 754.0 1 (1984Di03), 754.05 2 (2003Go02). Placed by by 2003Go02, unplaced in 1984Di03. I_γ : unweighted of 15 1 (1984Di03), 19.0 13 (2003Go02). $A_2=+0.001$ 13, $A_4=-0.009$ 20, isotropic transition (2003Go02).
^x 760.8 2	0.76 9							
765.90 14	1.82 16	3646.66	(3) ⁻	2880.73	3 ⁻	D(+Q)	-0.07 10	E_γ : 765.8 1 (1984Di03), 766.09 14 (2003Go02). It is unplaced in 1984Di03. I_γ : 2 1 (1984Di03), 1.82 16 (2003Go02). δ : or +1.5 6 (2003Go02). $A_2=+0.23$ 8, $A_4=+0.01$ 11 (2003Go02).
773.15 5	3.8 3	2991.10	3 ⁺	2217.891	2 ⁺	M1+E2	-2.5 3	E_γ : 773.1 1 (1984Di03), 773.16 5 (2003Go02). I_γ : 3 1 (1984Di03), 3.9 3 (2003Go02). δ : or -0.18 4 (2003Go02). Other: -2.0 +4-6 (1984Di03). $A_2=-0.42$ 6, $A_4=+0.15$ 7 (1984Di03), $A_2=-0.40$ 4, $A_4=+0.03$ 6 (2003Go02). POL=+1.2 +7-4 (2003Go02).
^x 775.0 5	0.53 11							
782.06 10	2.7 2	2217.891	2 ⁺	1435.858	2 ⁺	M1(+E2)	-0.02 8	E_γ : 782.0 1 (1984Di03), 782.12 10 (2003Go02). I_γ : 2 1 (1984Di03), 2.7 2 (2003Go02). $A_2=+0.17$ 5, $A_4=-0.02$ 7 (2003Go02). δ : or +2.5 +7-4 (2003Go02). POL=+1.1 +10-6 (2003Go02).
^x 792.8 3	0.43 8							
796.7 3	0.51 8	3242.40	3	2445.576	3 ⁺			
^x 807.9 ‡ 3	1 ‡ 1							
813.0 4	0.80 10	3694.2		2880.73	3 ⁻			E_γ : from table 2 of 2003Go02; in unplaced gammas in table 1.
855.7 3	0.72 9	3163.03	(2) ⁺	2307.566	4 ⁺			
871.68 2	38 3	2307.566	4 ⁺	1435.858	2 ⁺	E2		E_γ : 871.7 1 (1984Di03), 871.68 2 (2003Go02). I_γ : 37 3 (1984Di03), 39 3 (2003Go02). $A_2=+0.12$ 9, $A_4=-0.09$ 9 (1984Di03), $A_2=+0.311$ 11, $A_4=-0.067$ 15 (2003Go02). POL=+3.5 +15-7 (2003Go02).
880.77 10	2.3 3	2779.36	4 ⁺	1898.641	4 ⁺			E_γ : 880.8 1 (1984Di03), 880.70 15 (2003Go02). I_γ : from 2003Go02. Other: 5 1 (1984Di03).
^x 921.1 6	0.63 13							
^x 930.3 3	0.61 8							
934.78 9	2.56 20	3242.40	3	2307.566	4 ⁺	D+Q	+0.25 7	E_γ : 934.8 1 (1984Di03), 934.77 9 (2003Go02). I_γ : 2 1 (1984Di03), 2.58 20 (2003Go02). δ : or +8 +6-3 (2003Go02). $A_2=-0.31$ 6, $A_4=-0.01$ 8 (2003Go02).
944.7 3	2.10 17	3360.1	7 ⁺	2415.395	5 ⁺	(Q)		I_γ : uncertainty of 0.17 in table 1 seems a misprint. $A_2=+0.25$ 8, $A_4=-0.06$ 11 (2003Go02).
952.85 11	2.69 22	2851.50	4 ⁺	1898.641	4 ⁺	M1+E2	-1.5 5	E_γ : 952.7 2 (1984Di03), 952.90 11 (2003Go02). I_γ : 3 1 (1984Di03), 2.67 22 (2003Go02). δ : or -5 +2-9 (2003Go02). $A_2=-0.28$ 6, $A_4=-0.10$ 9 (2003Go02). POL=+1.2 +10-6 (2003Go02).

$\gamma(^{138}\text{Ba})$ (continued)

E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.#	$\delta^\#$	Comments
980.7 3	0.70 12	3183.74	8 ⁺	2203.10	6 ⁺			
1009.70 2	33 1	2445.576	3 ⁺	1435.858	2 ⁺	M1+E2	+0.018 7	E_γ : 1009.7 1 (1984Di03), 1009.7 2 (2003Go02). I_γ : 33 1 (1984Di03), 37 3 (2003Go02). δ : other: -2.9 1 from 1984Di03. $A_2=-0.31$ 1, $A_4=+0.08$ 1 (1984Di03) $A_2=-0.181$ 9, $A_4=-0.002$ 14 (2003Go02). POL=+0.60 11 (2003Go02).
^x 1028.7 2	0.96 12							
^x 1033.1 2	0.86 11							
1040.42 4	5.2 4	3486.00		2445.576	3 ⁺			
1054.2 2	0.91 11	3935.06	2 ⁺	2880.73	3 ⁻			
1064.11 10	2.1 3	3154.80	4 ⁺	2090.58	6 ⁺			E_γ : 1064.0 1 (1984Di03), 1064.20 9 (2003Go02). I_γ : 3 1 (1984Di03), 2.0 3 (2003Go02).
1068.24 8	2.96 25	3286.14?		2217.891	2 ⁺			E_γ : 1068.2 1 (1984Di03), 1068.27 8 (2003Go02). It is unplaced in 1984Di03. I_γ : 3 1 (1984Di03), 2.96 25 (2003Go02). $A_2=-0.01$ 6, $A_4=-0.15$ 9 (2003Go02).
^x 1082.8 3	1.08 13							
1093.1 3	1.66 16	3183.74	8 ⁺	2090.58	6 ⁺			
^x 1097.3‡ 1	15‡ 1							
1105.98	0.68	3309.0		2203.10	6 ⁺			E_γ, I_γ : from 2013SeZZ.
1116.71 8	3.4 3	3562.28	(4) ⁻	2445.576	3 ⁺	D+Q	+0.07 4	E_γ : 1116.8 1 (1984Di03), 1116.66 8 (2003Go02). It is unplaced in 1984Di03. I_γ : 4 1 (1984Di03), 3.3 3 (2003Go02). $A_2=-0.14$ 7, $A_4=+0.01$ 11 (2003Go02).
1147.16 3	16.2 15	2583.02	1 ⁺	1435.858	2 ⁺	M1+E2	-0.19 11	E_γ : 1147.1 1 (1984Di03), 1147.16 3 (2003Go02). I_γ : 15 1 (1984Di03), 18.1 13 (2003Go02). $A_2=-0.08$ 4, $A_4=+0.10$ 5 (1984Di03), $A_2=+0.014$ 14, $A_4=-0.001$ 21 (2003Go02). POL=+1.0 2 (2003Go02).
1151.26 18	2.50 21	3049.94	2 ⁺	1898.641	4 ⁺			E_γ : 1151.0 2 (1984Di03), 1151.38 14 (2003Go02). I_γ : 2 1 (1984Di03), 2.52 21 (2003Go02). $A_2=+0.12$ 14, $A_4=-0.01$ 19 (2003Go02).
^x 1158.1 2	2.93 24							
^x 1177.0 2	1.06 14							
^x 1186.9 3	1.79 18							
^x 1201.3‡ 1	4‡ 1							
1204.0 4	1.2 4	2639.40	2 ⁺	1435.858	2 ⁺			E_γ : unweighted average of 1204.4 1 (1984Di03), 1203.6 2 (2003Go02). I_γ : 3 1 (1984Di03), 1.1 2 (2003Go02).
^x 1218.4‡ 4	3‡ 1							
1251.7 3	0.92 15	3442.02?	2 ⁽⁺⁾	2189.91	0 ⁺			
1256.22 10	2.42 22	3154.80	4 ⁺	1898.641	4 ⁺	D+Q	-1.0 +2-3	E_γ : 1256.2 1 (1984Di03), 1256.25 11 (2003Go02). I_γ : 1 1 (1984Di03), 2.49 22 (2003Go02). δ : or $1/\delta=0.00$ 1 (2003Go02). $A_2=-0.18$ 7, $A_4=-0.07$ 10 (2003Go02).
1264.67 10	3.3 4	3163.03	(2) ⁺	1898.641	4 ⁺	(Q)		E_γ : 1264.7 1 (1984Di03), 1264.63 12 (2003Go02).

$\gamma(^{138}\text{Ba})$ (continued)

E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. #	$\delta^\#$	Comments
								I_γ : 2 1 (1984Di03), 3.4 3 (2003Go02). $A_2=+0.09$ 7, $A_4=+0.04$ 10 (2003Go02).
$^{x1279.2}$ 7	0.61 10							
1284.4 3	2.29 19	4165.1?	(4) ⁻	2880.73	3 ⁻			
$^{x1307.9}$ 3	1.07 11							
$^{x1337.0}$ 2	1.14 11							
1343.54 & 3	20.4 & 10	2779.36	4 ⁺	1435.858	2 ⁺	(E2)		E_γ : 1343.4 1 (1984Di03), 1343.54 2 (2003Go02). I_γ : 20 1 (1984Di03), 21.2 15 for the doublet in 2003Go02. $A_2=+0.09$ 2, $A_4=-0.07$ 2 (1984Di03), $A_2=+0.234$ 12, $A_4=-0.074$ 17 (2003Go02). POL=+3.3 +18-8 (2003Go02).
1343.54 & a 3	21.2 & 15	3242.40	3	1898.641	4 ⁺			E_γ : 1343.4 1 (1984Di03), 1343.54 2 (2003Go02). I_γ : for the doublet in 2003Go02.
1358.75 9	3.2 2	3257.27	3	1898.641	4 ⁺	D+Q	+0.11 6	E_γ : 1358.6 1 (1984Di03), 1358.80 6 (2003Go02). I_γ : 3 1 (1984Di03), 3.2 2 (2003Go02). δ : or -50 +40-600 (2003Go02). $A_2=-0.17$ 5, $A_4=+0.02$ 7 (2003Go02).
1387.0 & 4	0.96 & 10	3286.14?		1898.641	4 ⁺			
1387.0 & 4	0.96 & 10	3694.2		2307.566	4 ⁺			
$^{x1392.9}$ 2	1.13 11							
1407.1 4	0.38 8	3610.2		2203.10	6 ⁺			
1415.71 3	18.9 13	2851.50	4 ⁺	1435.858	2 ⁺	E2		E_γ : 1415.7 1 (1984Di03), 1415.71 3 (2003Go02). I_γ : 19 1 (1984Di03), 18.8 13 (2003Go02). $A_2=+0.22$ 3, $A_4=-0.10$ 4 (1984Di03), $A_2=+0.349$ 14, $A_4=-0.083$ 19 (2003Go02). POL=+2.7 +14-7 (2003Go02).
$^{x1426.3}$ 3	0.55 8							
1435.86 2	1000 11	1435.858	2 ⁺	0.0	0 ⁺	E2		E_γ : 1435.8 1 (1984Di03), 1435.86 2 (2003Go02). I_γ : 1000 11 (1984Di03), 1000 70 (2003Go02). $A_2=+0.11$ 1, $A_4=-0.11$ 2 (1984Di03), $A_2=+0.261$ 9, $A_4=-0.095$ 12 (2003Go02). POL=+2.4 +7-4 (2003Go02).
1444.86 2	27.2 10	2880.73	3 ⁻	1435.858	2 ⁺	E1(+M2)	+0.04 2	E_γ : 1444.8 1 (1984Di03), 1444.86 2 (2003Go02). I_γ : 27 1 (1984Di03), 28 2 (2003Go02). δ : others: -0.14 6 or -3.0 4 (1984Di03). $A_2=-0.33$ 3, $A_4=+0.08$ 4 (1984Di03), $A_2=-0.164$ 10, $A_4=+0.001$ 15 (2003Go02). POL=+1.6 +5-3 (2003Go02).
$^{x1464.0}$ ‡ 1	4 ‡ 1							
1478.28 17	1.68 15	3376.70	3	1898.641	4 ⁺	D+Q	-0.13 12	δ : or -4 +1-6 (2003Go02). $A_2=-0.02$ 10, $A_4=-0.09$ 14 (2003Go02).
1481.27 10	3.3 3	3379.92?	(5 ⁺)	1898.641	4 ⁺	D+Q	+3.0 4	E_γ : 1481.3 1 (1984Di03), 1481.24 10 (2003Go02). It is unplaced in 1984Di03.

$\gamma(^{138}\text{Ba})$ (continued)

E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. #	$\delta^\#$	Comments
								I_γ : 3 1 (1984Di03), 3.3 3 (2003Go02). $A_2=+0.37$ 5, $A_4=+0.12$ 7 (2003Go02).
$x1490.8$ 3 1495.58 3	0.75 8 13.9 10	2931.45	2 ⁺	1435.858	2 ⁺	M1+E2	-0.75 4	E_γ : 1495.5 1 (1984Di03), 1495.59 3 (2003Go02). I_γ : 13 1 (1984Di03), 14.8 10 (2003Go02). δ : or -4.2 +4-5 (2003Go02). $A_2=-0.183$ 11, $A_4=-0.048$ 17, $\text{pol}=+1.4$ +5-3 (2003Go02).
$x1500.6$ 3 $x1507.9$ 5 $x1512.9$ 2 1515.8 4 $x1536.2$ 5 $x1541.0$ 2 1555.24 3	0.43 7 0.37 8 0.80 10 0.42 9 0.31 9 0.76 10 6.5 5	3931.24		2415.395	5 ⁺			
		2991.10	3 ⁺	1435.858	2 ⁺	M1+E2	+9.8 +21-14	E_γ : 1555.2 1 (1984Di03), 1555.25 4 (2003Go02). I_γ : 6 1 (1984Di03), 6.6 5 (2003Go02). δ : other: 0.21 +4-3 from 1984Di03. $A_2=+0.05$ 4, $A_4=+0.03$ 5 (1984Di03), $A_2=+0.19$ 2, $A_4=+0.10$ 3 (2003Go02). POL=+4 +7-2 (2003Go02).
$x1566.2$ 2 $x1572.2$ 2 1582.0 4 1587.6 4 $x1596.8$ 4 1605.4 2 1614.07 3	0.70 10 0.72 9 0.41 7 0.39 7 0.37 7 1.10 10 18.9 13	3800.06 3486.00	2 ⁺	2217.891 1898.641	2 ⁺ 4 ⁺			
		3504.09 3049.94	2 ⁻ 2 ⁺	1898.641 1435.858	4 ⁺ 2 ⁺	M1+E2	+0.16 2	E_γ : 1614.0 1 (1984Di03), 1614.08 3 (2003Go02). I_γ : 19 2 (1984Di03), 18.9 13 (2003Go02). δ : others: -0.08 5 or 3.1 +6-5 (1984Di03). $A_2=+0.13$ 3, $A_4=+0.00$ 4 (1984Di03), $A_2=+0.255$ 14, $A_4=-0.063$ 19 (2003Go02). POL=+1.4 +6-4 (2003Go02).
$x1620.5$ 4 1627.8 4 $x1649.0$ 4 $x1655.9$ 2	0.71 11 0.71 9 0.89 12 1.34 23	3935.06	2 ⁺	2307.566	4 ⁺			E_γ : 1655.7 4 (1984Di03), 1655.9 2 (2003Go02). I_γ : 3 1 (1984Di03), 1.31 14 (2003Go02).
1663.2 5 $x1674.8$ 3 $x1684.3$ 2 1727.02 6	0.55 10 0.95 10 1.19 11 6.5 6	3562.28	(4) ⁻	1898.641	4 ⁺			
		3163.03	(2) ⁺	1435.858	2 ⁺	M1(+E2)	+0.05 5	E_γ : 1727.0 1 (1984Di03), 1727.03 6 (2003Go02). I_γ : 8 1 (1984Di03), 6.2 4 (2003Go02). δ : or +2.0 +5-3 (2003Go02). $A_2=+0.22$ 3, $A_4=-0.02$ 4 (2003Go02). POL=+1.5 +22-9 (2003Go02).
1743.95 18	2.12 18	3642.60?		1898.641	4 ⁺			$A_2=+0.22$ 7, $A_4=+0.09$ 10 (2003Go02).

¹³⁸Ba(n,n'γ) 2003Go02,1984Di03 (continued)

γ(¹³⁸Ba) (continued)

E _γ [†]	I _γ [†]	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. [#]	δ [#]	Comments
^x 1746.9 3	0.97 12							
^x 1750.5 6	0.31 9							
1806.77 18	2.02 16	3242.40	3	1435.858	2 ⁺	D+Q	+0.17 5	E _γ : 1806.7 3 (1984Di03), 1806.80 18 (2003Go02). I _γ : 2 1 (1984Di03), 2.02 16 (2003Go02). δ: or -28 +6-∞ (2003Go02). A ₂ =+0.01 6, A ₄ =+0.05 9 (2003Go02).
1821.30 8	4.9 4	3257.27	3	1435.858	2 ⁺	D+Q	+0.46 4	E _γ : 1821.2 3 (1984Di03), 1821.31 8 (2003Go02). I _γ : 5 1 (1984Di03), 4.9 4 (2003Go02). δ: or +4.2 +7-6 (2003Go02). A ₂ =+0.28 4, A ₄ =+0.00 5 (2003Go02).
^x 1832.2 4	1.26 12							
1850.3 1	3.2 2	3286.14?		1435.858	2 ⁺	D+Q	+0.7 5	E _γ : 1850.2 1 (1984Di03), 1850.30 10 (2003Go02). It is unplaced in 1984Di03. I _γ : 3 1 (1984Di03), 3.2 2 (2003Go02). δ: assuming J=2 for 3286 level (2003Go02). A ₂ =+0.34 5, A ₄ =-0.12 7 (2003Go02).
1903.0 4	0.67 9	3338.85	2 ⁺	1435.858	2 ⁺			
^x 1909.3 6	0.59 11							
^x 1914.3 3	1.25 15							
1940.76 9	4.5 5	3376.70	3	1435.858	2 ⁺	D+Q	+0.9 +4-3	E _γ : 1940.7 1 (1984Di03), 1940.80 9 (2003Go02). It is unplaced in 1984Di03. I _γ : 6 1 (1984Di03), 4.4 3 (2003Go02). A ₂ =+0.47 4, A ₄ =+0.01 6 (2003Go02). A ₂ =-0.19 11, A ₄ =+0.01 17 (2003Go02).
1960.9 3	1.58 14	3859.6?	(5) ⁻	1898.641	4 ⁺	(D)		
^x 1993.0 4	0.54 8							
^x 1999.5 4	0.51 8							
2023.5 3	1.80 16	3922.1	(3) ⁻	1898.641	4 ⁺	(D)		A ₂ =-0.14 9, A ₄ =-0.03 12 (2003Go02).
2032.6 3	1.39 14	3931.24		1898.641	4 ⁺			A ₂ =+0.04 11, A ₄ =+0.01 16 (2003Go02).
2068.1 4	1.07 12	3504.09	2 ⁻	1435.858	2 ⁺			A ₂ =+0.27 12, A ₄ =+0.00 18 (2003Go02).
^x 2071.8 5	0.64 11							
^x 2092.1 5	0.64 8							
^x 2112.3 [‡] 2	3 [‡] 1							
^x 2136.4 5	0.62 9							
2164.8 3	1.21 12	3600.71	1	1435.858	2 ⁺			A ₂ =+0.10 15, A ₄ =+0.00 20 (2003Go02).
2182.0 4	1.11 10	3617.9	0 ⁺	1435.858	2 ⁺			A ₂ =+0.00 8, A ₄ =-0.03 12 (2003Go02).
^x 2197.8 3	0.73 8							
2210.9 3	0.97 9	3646.66	(3) ⁻	1435.858	2 ⁺			
2217.86 2	88 3	2217.891	2 ⁺	0.0	0 ⁺	E2		E _γ : 2217.8 1 (1984Di03), 2217.86 2 (2003Go02). I _γ : 87 3 (1984Di03), 92 6 (2003Go02). Mult.: Q from γ(θ), M2 ruled out by RUL. A ₂ =+0.11 1, A ₄ =-0.11 1 (1984Di03) A ₂ =+0.270 9, A ₄ =-0.092 12 (2003Go02).
^x 2232.0 4	0.55 7							
^x 2240.6 4	0.58 9							
^x 2373.3 2	0.48 9							
^x 2391.4 5	0.46 9							
^x 2402.8 7	0.64 10							

$^{138}\text{Ba}(\text{n},\text{n}'\gamma)$ **2003Go02,1984Di03** (continued)

$\gamma(^{138}\text{Ba})$ (continued)							Comments
E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. #	
$^{x2437.1\ 5}$	0.67 8						
$^{x2447.7\ 5}$	0.50 7						
2486.1 8	0.28 8	3922.1	(3) ⁻	1435.858	2 ⁺		
2499.3 3	0.70 8	3935.06	2 ⁺	1435.858	2 ⁺		
$^{x2511.3\ 5}$	0.41 7						
2582.96 10	3.6 3	2583.02	1 ⁺	0.0	0 ⁺	D	E_γ : 2583.0 1 (1984Di03), 2582.92 10 (2003Go02). I_γ : 3 1 (1984Di03), 3.6 3 (2003Go02). $A_2=-0.10\ 4$, $A_4=+0.00\ 6$ (2003Go02).
2639.38 3	23.7 14	2639.40	2 ⁺	0.0	0 ⁺	E2	E_γ : 2639.3 1 (1984Di03), 2639.39 3 (2003Go02). I_γ : 23 1 (1984Di03), 26.4 19 (2003Go02). Mult.: Q from $\gamma(\theta)$, M2 ruled out by RUL. $A_2=+0.12\ 8$, $A_4=-0.09\ 9$ (1984Di03), $A_2=+0.276\ 11$, $A_4=-0.082\ 15$ (2003Go02).
2731.8 8	0.45 10	4630.5		1898.641	4 ⁺		
$^{x2753.1\ 6}$	0.62 10						
2806.3 11	0.69 8	4242.2	(1,2 ⁺)	1435.858	2 ⁺		
$^{x2831.2\ 6}$	0.97 12						
2931.3 3	1.00 15	2931.45	2 ⁺	0.0	0 ⁺	E2	Mult.: Q from $\gamma(\theta)$, M2 ruled out by RUL. $A_2=+0.21\ 9$, $A_4=-0.08\ 12$ (2003Go02).
$^{x3027.8\ 6}$	0.45 7						
$^{x3061.2\ 6}$	0.59 8						
$^{x3150.4\ 5}$	0.50 10						
$^{x3157.0\ 8}$	0.52 10						
3179.62 15	2.58 20	4615.52		1435.858	2 ⁺		$A_2=-0.02\ 7$, $A_4=-0.02\ 9$ (2003Go02).
3338.81 8	6.1 4	3338.85	2 ⁺	0.0	0 ⁺	E2	Mult.: Q from $\gamma(\theta)$, M2 ruled out by RUL. $A_2=+0.27\ 3$, $A_4=-0.09\ 4$ (2003Go02).
3366.73 7	5.7 4	3366.77	2 ⁺	0.0	0 ⁺	E2	Mult.: Q from $\gamma(\theta)$, M2 ruled out by RUL. $A_2=+0.27\ 3$, $A_4=-0.06\ 4$ (2003Go02).
$^{x3437.0\ 7}$	0.55 10						
3442.12 18	2.01 18	3442.02?	2 ⁽⁺⁾	0.0	0 ⁺	Q	$A_2=+0.24\ 7$, $A_4=-0.06\ 9$ (2003Go02).
3504.1 2	2.04 17	3504.09	2 ⁻	0.0	0 ⁺	Q	$A_2=+0.25\ 7$, $A_4=-0.09\ 9$ (2003Go02).
$^{x3539.9\ 6}$	0.63 10						
3600.7 3	1.04 11	3600.71	1	0.0	0 ⁺	D	$A_2=-0.07\ 12$, $A_4=+0.00\ 18$ (2003Go02).
3642.8 2	2.90 20	3642.85	2 ⁺	0.0	0 ⁺	E2	Mult.: Q from $\gamma(\theta)$, M2 ruled out by RUL. $A_2=+0.30\ 5$, $A_4=-0.06\ 7$ (2003Go02).
3684.6 3	1.39 13	3684.7	1	0.0	0 ⁺	D	$A_2=+0.01\ 9$, $A_4=0$ (2003Go02).
3734.3 3	1.55 14	3734.4	2 ⁺	0.0	0 ⁺	E2	Mult.: Q from $\gamma(\theta)$, M2 ruled out by RUL. $A_2=+0.29\ 11$, $A_4=-0.24\ 16$ (2003Go02).
3800.1 3	1.59 14	3800.06	2 ⁺	0.0	0 ⁺	E2	Mult.: Q from $\gamma(\theta)$, M2 ruled out by RUL. $A_2=+0.27\ 11$, $A_4=-0.08\ 15$ (2003Go02).
4001.2 4	1.26 13	4001.3	2 ⁽⁺⁾	0.0	0 ⁺	Q	$A_2=+0.26\ 15$, $A_4=-0.16\ 19$ (2003Go02).
$^{x4012.9\ 9}$	0.41 9						
4025.8 4	1.37 14	4025.9	1 ⁻	0.0	0 ⁺	D	$A_2=-0.17\ 9$, $A_4=+0.00\ 13$ (2003Go02).
$^{x4051.3\ 9}$	0.70 10						
4323.2 4	1.10 12	4323.3	1 ⁻	0.0	0 ⁺	D	$A_2=-0.14\ 13$, $A_4=+0.01\ 18$ (2003Go02).

$\gamma(^{138}\text{Ba})$ (continued)

[†] From [2003Go02](#), unless value is also available in [1984Di03](#), in which case weighted average is taken, or otherwise noted. Note that intensities in [2003Go02](#) are normalized to $I\gamma(1435.82\gamma)=100$ and the evaluator has re-normalized them to $I\gamma(1435.82\gamma)=1000$ as in [1984Di03](#). Values without uncertainties are also available in [2013SeZZ](#) and are in good agreement with data in [2003Go02](#).

[‡] From [1984Di03](#) only.

[#] From [2003Go02](#) based on $\gamma(\theta)$, $\gamma(\text{pol})$ or RUL, unless otherwise noted. Where assignments of multipolarities in [2003Go02](#) and [1984Di03](#) are only based on $\gamma(\theta)$, the evaluator has replaced E1 or M1 with D and E2 with Q if applicable.

[@] 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.

[&] Multiply placed with undivided intensity.

^a Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

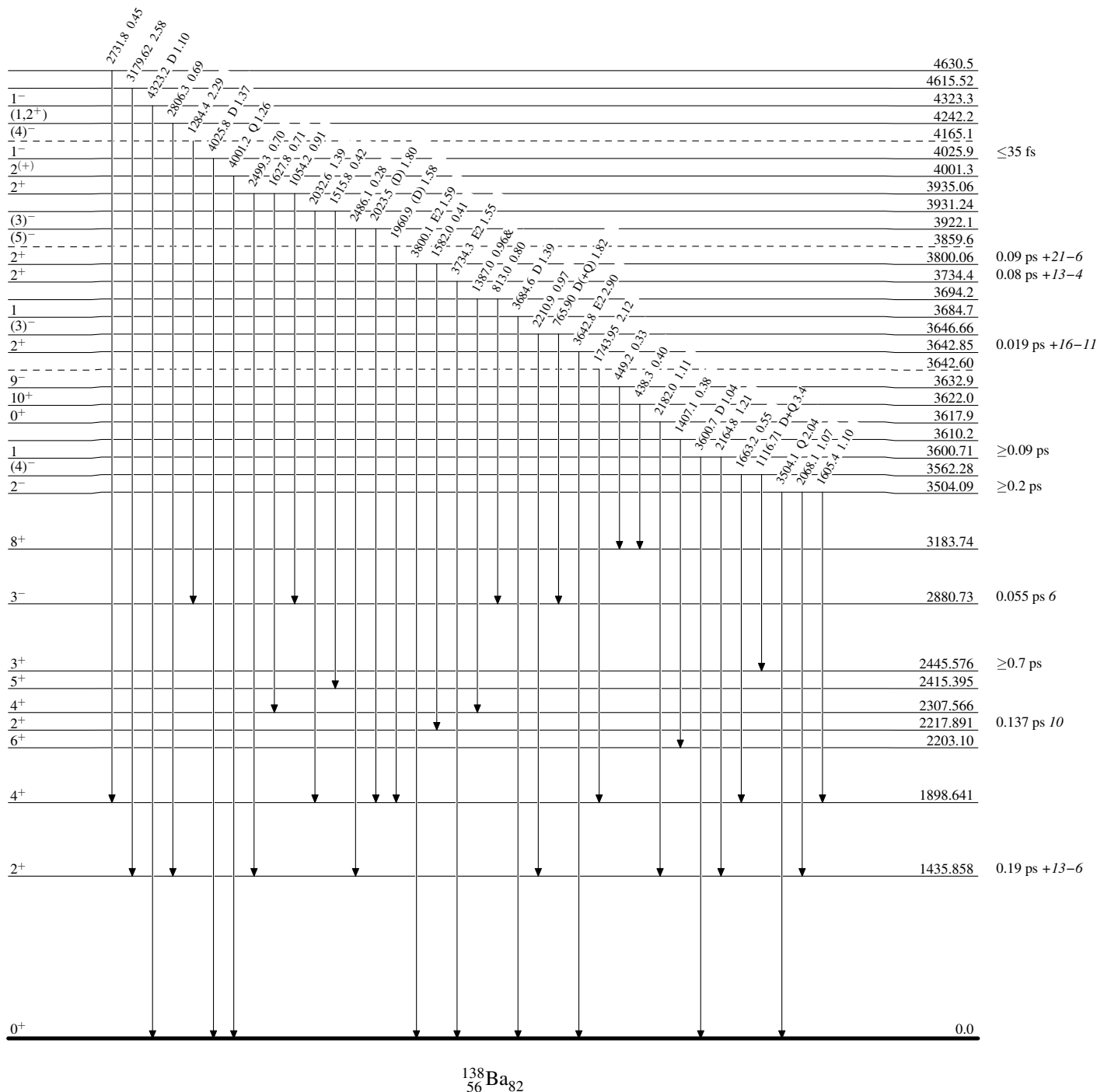
$^{138}\text{Ba}(n,n'\gamma)$ 2003Go02,1984Di03

Level Scheme

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

Legend

—→ $I_\gamma < 2\% \times I_\gamma^{\max}$
—→ $I_\gamma < 10\% \times I_\gamma^{\max}$
—→ $I_\gamma > 10\% \times I_\gamma^{\max}$



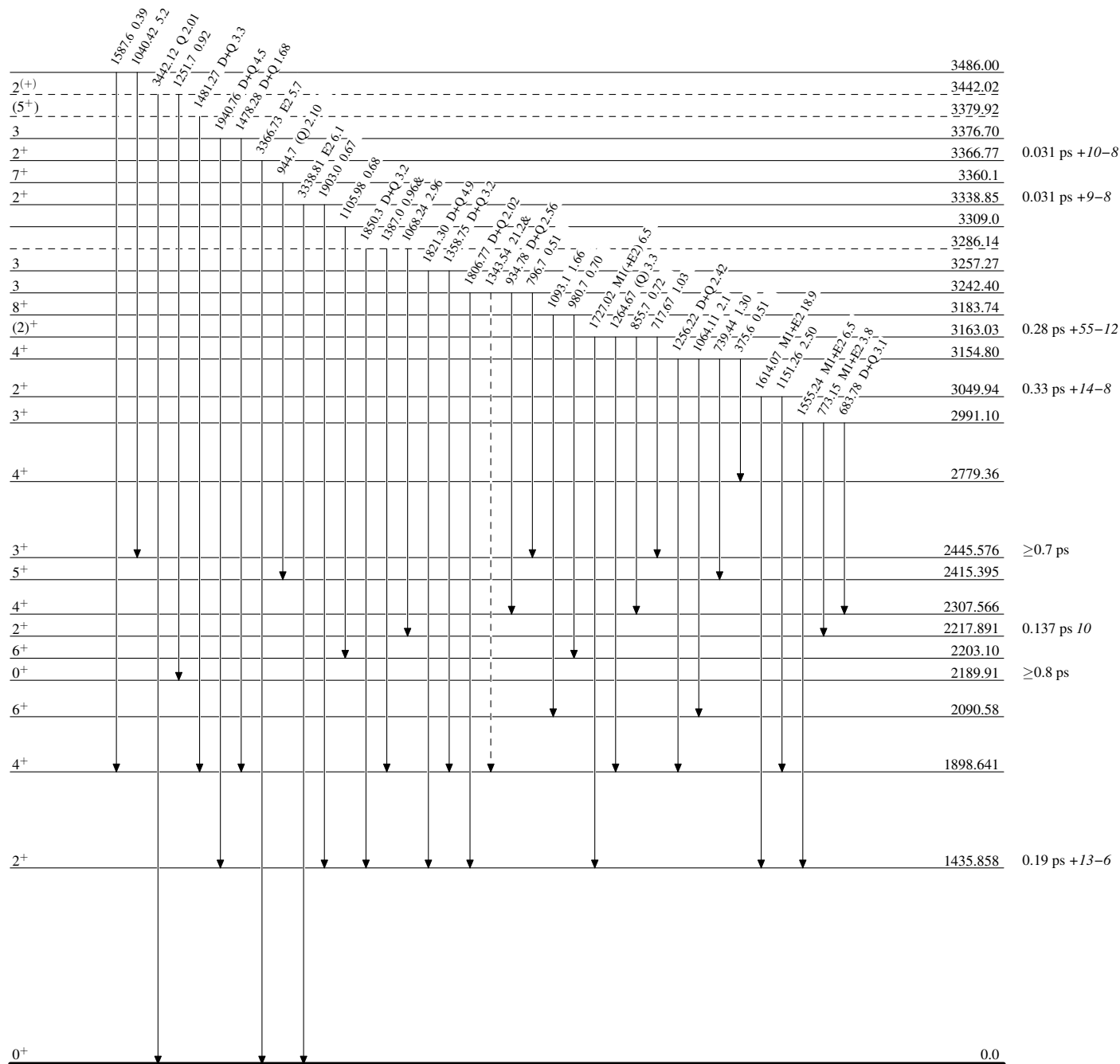
$^{138}\text{Ba}(n,n'\gamma)$ 2003Go02,1984Di03

Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $---$ γ Decay (Uncertain)



¹³⁸Ba(n,γ) 2003G-002,1984D03

Level Scheme (continued)

Intensities: Relative I_γ

& Multiply placed: undivided intensity given

