

$^{135}\text{Ba}(\gamma, \gamma')$ 2004Sc39

Type	Author	History	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, Alexander A. Rodionov And Yuri L. Khazov		NDS 109, 517 (2008)	22-Jan-2008

2004Sc39: E(end-point)=2.5, 3.1, 4.1 MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ with three high-resolution HPGe γ -ray spectrometers. One of the detectors was surrounded by a BGO anti-Compton shield to improve its response function. Nuclear resonance fluorescence (NRF) technique.

 ^{135}Ba Levels

Additional information 1.

E(level)	$J^{\pi\ddagger}$	$g\Gamma_0$ @	$I_{S,0}$ (eV b) #	Comments
0	$3/2^+$			
221	$1/2^+$			
480	$5/2^+$			
588	$3/2^+$			
714	$(7/2^-)$			
874	$7/2^+$	0.00092 eV 12	4.5 5	B(E2)=0.22 3. Additional information 2.
910	$1/2^+$			
980	$3/2^+, 5/2^+$	0.0028 eV 5	9.0 6	B(M1)=0.26 5. Additional information 3.
1214		0.00092 eV 21	1.9 3	B(E1)= 4.9×10^{-6} 11; B(M1)=0.044 10. Additional information 4.
1872		0.0059 eV 16	3.5 3	B(E1)= 8.5×10^{-6} 24; B(M1)=0.077 21. Additional information 5.
1942	$3/2^+, 5/2^+$	0.0024 eV 6	0.56 15	B(M1)=0.028 7. E(level): From low-energy end point measurement only in 2004Sc39. Additional information 6.
1965	$(1/2^+, 3/2^+)$	0.0025 eV 17	0.70 17	B(M1)=0.028 20. Additional information 7.
1991		0.0041 eV 7	1.10 18	B(E1)= 5.0×10^{-6} 8; B(M1)=0.045 8. E(level): From low-energy end point measurement only in 2004Sc39. Additional information 8.
2077		0.0045 eV 13	1.57 18	B(E1)= 4.8×10^{-6} 14. Additional information 9.
2283		0.0013 eV 3	0.98 22	B(E1)= 1.1×10^{-6} 2; B(M1)=0.010 2. Additional information 10.
2334		0.0018 eV 3	1.25 22	B(E1)= 1.3×10^{-6} 2; B(M1)=0.012 2. Additional information 11.
2420		0.0018 eV 3	1.19 21	B(E1)= 1.2×10^{-6} 2; B(M1)=0.011 2. Additional information 12.
2440		0.0022 eV 3	1.43 22	B(E1)= 1.5×10^{-6} 2; B(M1)=0.013 2. Additional information 13.
2447		0.0039 eV 8	1.79 24	B(E1)= 2.5×10^{-6} 6; B(M1)=0.023 5. Additional information 14.
2478		0.0021 eV 3	1.28 21	B(E1)= 1.3×10^{-6} 2; B(M1)=0.012 2. Additional information 15.
2485		0.0027 eV 4	1.67 23	B(E1)= 1.7×10^{-6} 2; B(M1)=0.015 2. Additional information 16.
2496		0.0019 eV 3	1.17 21	B(E1)= 1.2×10^{-6} 2; B(M1)=0.011 2. Additional information 17.

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$^{135}\text{Ba}(\gamma, \gamma')$ 2004Sc39 (continued) ^{135}Ba Levels (continued)

E(level)	$g\Gamma_0$ @	$I_{s,0}$ (eV b) #	Comments
2602	0.0017 eV 3	0.95 18	B(E1)= 9×10^{-7} 2; B(M1)=0.008 2. Additional information 18.
2621	0.0036 eV 4	1.99 23	B(E1)= 1.9×10^{-6} 2; B(M1)=0.017 2. Additional information 19.
2638	0.0023 eV 4	1.29 21	B(E1)= 1.2×10^{-6} 2; B(M1)=0.011 2. Additional information 20.
2651 †	0.0018 eV 4	0.99 20	B(E1)= 9×10^{-7} 2; B(M1)=0.008 2. Additional information 21.
2658	0.0025 eV 9	1.08 20	B(E1)= 1.3×10^{-6} 5; B(M1)=0.011 4. Additional information 22.
2667 †	0.0056 eV 7	0.87 19	B(E1)= 2.8×10^{-6} 3; B(M1)=0.026 3. Additional information 23.
2708 †	0.0023 eV 5	1.18 24	B(E1)= 1.1×10^{-6} 2; B(M1)=0.010 2 or B(E1)= 1.9×10^{-6} 2; B(M1)=0.017 2 depending upon placements of γ transitions. Additional information 24. $g\Gamma_0$: alternate value: 0.0040 eV 5. $I_{s,0}$ (eV b): alternate value: 2.09 25.
2710	0.0105 eV 9	0.88 22	B(E1)= 4.7×10^{-6} 5; B(M1)=0.043 4. Additional information 25.
2730	0.0061 eV 14	1.98 24	B(E1)= 2.9×10^{-6} 7; B(M1)=0.026 6. Additional information 26.
2781	0.0029 eV 4	1.43 21	B(E1)= 1.3×10^{-6} 2; B(M1)=0.012 2. Additional information 27.
2872	0.0056 eV 7	1.38 20	B(E1)= 2.2×10^{-6} 3; B(M1)=0.020 3. Additional information 28.
2947	0.0237 eV 18	10.5 8	B(E1)= 8.9×10^{-6} 7; B(M1)=0.080 6. Additional information 29.
3092 †	0.0225 eV 17	4.6 5	B(E1)= 5.9×10^{-6} 5; B(M1)=0.053 5 or B(E1)= 7.3×10^{-6} 6; B(M1)=0.066 5 depending upon placements of γ transitions. Additional information 30. $g\Gamma_0$: for 51% branch to g.s. Alternate value: 0.0183 eV 16 for 63% branch to g.s.
3111	0.0026 eV 6	1.03 22	B(E1)= 8×10^{-7} 2; B(M1)=0.008 2. Additional information 31.
3122	0.0027 eV 6	1.05 24	B(E1)= 8×10^{-7} 2; B(M1)=0.008 2. Additional information 32.
3126	0.0082 eV 10	0.98 22	B(E1)= 2.6×10^{-6} 3; B(M1)=0.023 3. Additional information 33.
3148 †	0.0074 eV 10	1.51 23	B(E1)= 2.3×10^{-6} 3; B(M1)=0.021 3 or B(E1)= 1.2×10^{-6} 2; B(M1)=0.011 2 depending upon placements of γ transitions. Additional information 34. $g\Gamma_0$: for 52% branch to g.s. Alternate value: 0.0039 eV 6 for 100% branch to g.s.
3163 †	0.0064 eV 10	0.60 19	B(E1)= 5×10^{-7} 2; B(M1)=0.004 1 or 1.9×10^{-6} 3; 0.017 3 depending upon placements of γ transitions. Additional information 35. $g\Gamma_0$: for 25% branch to g.s. Alternate value: 0.0016 eV 5 for 100% branch to g.s.
3182	0.0036 eV 5	1.37 21	B(E1)= 1.1×10^{-6} 2; B(M1)=0.010 2. Additional information 36.
3190 †	0.0165 eV 14	1.24 21	B(E1)= 4.8×10^{-6} 4; B(M1)=0.044 4. Additional information 37.
3196	0.0028 eV 6	1.04 21	B(E1)= 8×10^{-7} 2; B(M1)=0.007 2. Additional information 38.
3272	0.0116 eV 12	2.1 3	B(E1)= 3.2×10^{-6} 3; B(M1)=0.029 3. Additional information 39.

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$^{135}\text{Ba}(\gamma, \gamma')$ 2004Sc39 (continued) ^{135}Ba Levels (continued)

E(level)	$g\Gamma_0$ @	$I_{s,0}$ (eV b) #	Comments
3324	0.0023 eV 6	0.81 19	B(E1)= 6×10^{-7} 2; B(M1)=0.005 1. Additional information 40.
3410 †	0.0285 eV 23	9.4 8	B(E1)= 8.1×10^{-6} 6; B(M1)=0.073 5 or B(E1)= 6.9×10^{-6} 6; B(M1)=0.062 5 depending upon placements of γ transitions. Additional information 41. $g\Gamma_0$: for 85% branch to g.s. Alternate value: 0.0334 eV 24 for 100% branch to g.s.
3415	0.0028 eV 7	0.91 24	B(E1)= 7×10^{-7} 2; B(M1)=0.006 2. Additional information 42.
3422	0.0028 eV 6	0.92 21	B(E1)= 7×10^{-7} 2; B(M1)=0.006 1. Additional information 43.
3454	0.0183 eV 17	1.8 3	B(E1)= 4.2×10^{-6} 4; B(M1)=0.038 3. Additional information 44.
3587	0.0032 eV 10	1.0 3	B(E1)= 7×10^{-7} 2; B(M1)=0.006 2. Additional information 45.
3632	0.0037 eV 9	1.1 3	B(E1)= 7×10^{-7} 2; B(M1)=0.007 2. Additional information 46.
3656	0.0108 eV 17	1.4 3	B(E1)= 2.1×10^{-6} 3; B(M1)=0.019 3. Additional information 47.
3696	0.0045 eV 10	1.3 3	B(E1)= 8×10^{-7} 2; B(M1)=0.008 2. Additional information 48.
3708 †	0.0161 eV 18	4.5 5	B(E1)= 5.5×10^{-6} 6; B(M1)=0.050 6 or B(E1)= 3.0×10^{-6} 3; B(M1)=0.027 3 depending upon placements of γ transitions. Additional information 49. $g\Gamma_0$: for 54% branch to g.s. Alternate value: 0.030 eV 3 for 100% branch to g.s.
3720	0.0128 eV 15	3.6 4	B(E1)= 2.4×10^{-6} 3; B(M1)=0.022 3. Additional information 50.
3753 †	0.026 eV 3	2.4 4	B(E1)= 1.6×10^{-6} 3; B(M1)=0.014 3 or B(E1)= 4.7×10^{-6} 5; B(M1)=0.043 4 depending upon alternative placements of γ rays. Additional information 51. $g\Gamma_0$: for 33% branch to g.s. Alternate value: 0.0087 eV 16 for 100% branch to g.s.
3779 †	0.043 eV 5	3.0 5	B(E1)= 2.0×10^{-6} 3; B(M1)=0.018 3 or B(E1)= 7.6×10^{-6} 9; B(M1)=0.069 8 depending upon placements of γ transitions. Additional information 52. $g\Gamma_0$: for 26% branch to g.s. Alternate value: 0.0112 eV 19 for 100% branch to g.s.
3813	0.0071 eV 20	1.9 5	B(E1)= 1.2×10^{-6} 3; B(M1)=0.011 3. Additional information 53.
3881	0.0090 eV 18	2.3 5	B(E1)= 1.5×10^{-6} 3; B(M1)=0.013 3. Additional information 54.

† Alternative assignments possible for γ transition(s) connected with this level.

‡ From 'Adopted Levels'. 2004Sc39 state that J^{π} 's could not be deduced from their $\gamma(\theta)$ data due to isotropic nature of these distributions. When no J^{π} is quoted this is expected to be 1/2,3/2,5/2 from primarily dipole excitation in ^{135}Ba (g.s. $J^{\pi}=3/2^+$), but in rare cases E2 excitation is possible which can give also allow 7/2⁺ choice.

Total elastic cross section.

@ g =statistical factor= $(2J_f+1)/(2J_i+1)$; J_i =g.s. spin=3/2, J_f =spin of final state, expected as primarily 1/2,3/2,5/2 from dipole excitation, but 7/2⁺ is also permitted in some cases from less likely L=2 excitation.

¹³⁵ Ba(γ, γ') 2004Sc39 (continued)						
$\gamma(^{135}\text{Ba})$						
$E_i(\text{level})$	J_i^π	E_γ	I_γ	E_f	J_f^π	Comments
874	7/2 ⁺	874	98 [†] 1	0	3/2 ⁺	
980	3/2 ⁺ , 5/2 ⁺	980	81 [†] 9	0	3/2 ⁺	
1214		1214	81 6	0	3/2 ⁺	
1872		1872	55 [†] 11	0	3/2 ⁺	
1942	3/2 ⁺ , 5/2 ⁺	1942	23 [†] 10	0	3/2 ⁺	
1965	(1/2 ⁺ , 3/2 ⁺)	1965	28 [†] 13	0	3/2 ⁺	
1991		1991	28 [†] 14	0	3/2 ⁺	
2077		2077	39 [†] 7	0	3/2 ⁺	
2283		2283	100	0	3/2 ⁺	
2334		2334	100	0	3/2 ⁺	
2420		2420	100	0	3/2 ⁺	
2440		2440	100	0	3/2 ⁺	
2447		2447 ^{#‡}	72 [†] 6	0	3/2 ⁺	
2478		2478	100	0	3/2 ⁺	
2485		2485	100	0	3/2 ⁺	
2496		2496	100	0	3/2 ⁺	
2602		2602 ^{#‡}	100	0	3/2 ⁺	
2621		2621	100	0	3/2 ⁺	
2638		2638	100	0	3/2 ⁺	
2651		2651 ^{#‡}	100	0	3/2 ⁺	
2658		2658	80 [†] 15	0	3/2 ⁺	
2667		2447 [#]	71 26	221	1/2 ⁺	I _γ : from $\Gamma_i/\Gamma_0=2.5$ 9 and $\Gamma_0/\Gamma=0.29$ 3 (2004Sc39).
		2667 [#]	29 3	0	3/2 ⁺	
2708		2708 ^{#‡}	100	0	3/2 ⁺	
2710		2489	84 11	221	1/2 ⁺	
		2710	16 2	0	3/2 ⁺	
2730		2730	63 [†] 7	0	3/2 ⁺	
2781		2781	100	0	3/2 ⁺	
2872		2651 [#]	46 16	221	1/2 ⁺	
		2872 ^{#‡}	54 7	0	3/2 ⁺	
2947		2947	100	0	3/2 ⁺	
3092		2378	31 8	714	(7/2 ⁻)	
		2872 [#]	18 5	221	1/2 ⁺	
		3092 [‡]	51 4	0	3/2 ⁺	I _γ : alternate value: 63 6 for alternative placements of γ 's from 3092 level.
3111		3111	100	0	3/2 ⁺	
3122		3122	100	0	3/2 ⁺	
3126		2645	69 26	480	5/2 ⁺	
		3126	31 4	0	3/2 ⁺	
3148		2667 [#]	48 17	480	5/2 ⁺	
		3148 [‡]	52 7	0	3/2 ⁺	I _γ : alternate value: 100 if 2667 γ has alternative placement.
3163		2683 [#]	75 36	480	5/2 ⁺	
		3163 [‡]	25 4	0	3/2 ⁺	I _γ : alternate value: 100 for alternative placements of γ 's from 3163 level.
3182		3182	100	0	3/2 ⁺	
3190		2602 [#]	27 10	588	3/2 ⁺	
		2708 [#]	53 15	480	5/2 ⁺	
		3190	20 2	0	3/2 ⁺	
3196		3196	100	0	3/2 ⁺	

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$^{135}\text{Ba}(\gamma, \gamma')$ **2004Sc39** (continued) $\gamma(^{135}\text{Ba})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ	I_γ	E_f	J_f^π	Comments
3272		2683 [#]	50 15	588	3/2 ⁺	
		3272 ^{#‡}	50 5	0	3/2 ⁺	
3324		3324	100	0	3/2 ⁺	
3410		3190 [#]	15 4	221	1/2 ⁺	
		3410 [‡]	85 6	0	3/2 ⁺	I_γ : alternate value: 100 for alternative placements of γ 's from 3410 level.
3415		3415	100	0	3/2 ⁺	
3422		3422	100	0	3/2 ⁺	
3454		2973.5	69 18	480	5/2 ⁺	
		3454	31 3	0	3/2 ⁺	
3587		3587	100	0	3/2 ⁺	
3632		3632	100	0	3/2 ⁺	
3656		3068	56 25	588	3/2 ⁺	
		3656	44 7	0	3/2 ⁺	
3696		3696	100	0	3/2 ⁺	
3708		2799 [#]	46 15	910	1/2 ⁺	
		3708 [‡]	54 6	0	3/2 ⁺	I_γ : alternate value: 100 for alternative placements of γ 's from 3708 level.
3720		3720	100	0	3/2 ⁺	
3753		3272 [#]	67 21	480	5/2 ⁺	
		3753 [‡]	33 3	0	3/2 ⁺	I_γ : alternate value: 100 for alternative placements of γ 's from 3753 level.
3779		2799 [#]	45 17	980	3/2 ⁺ , 5/2 ⁺	
		3190 [#]	29 11	588	3/2 ⁺	
		3779 [‡]	26 3	0	3/2 ⁺	I_γ : alternate value: 100 for alternative placements of γ 's from 3779 level.
3813		3813	100	0	3/2 ⁺	
3881		3881	100	0	3/2 ⁺	

[†] 2004Sc39 adopt value from 1998-NDS (1998Se07), the same value is given in 'adopted gammas'.

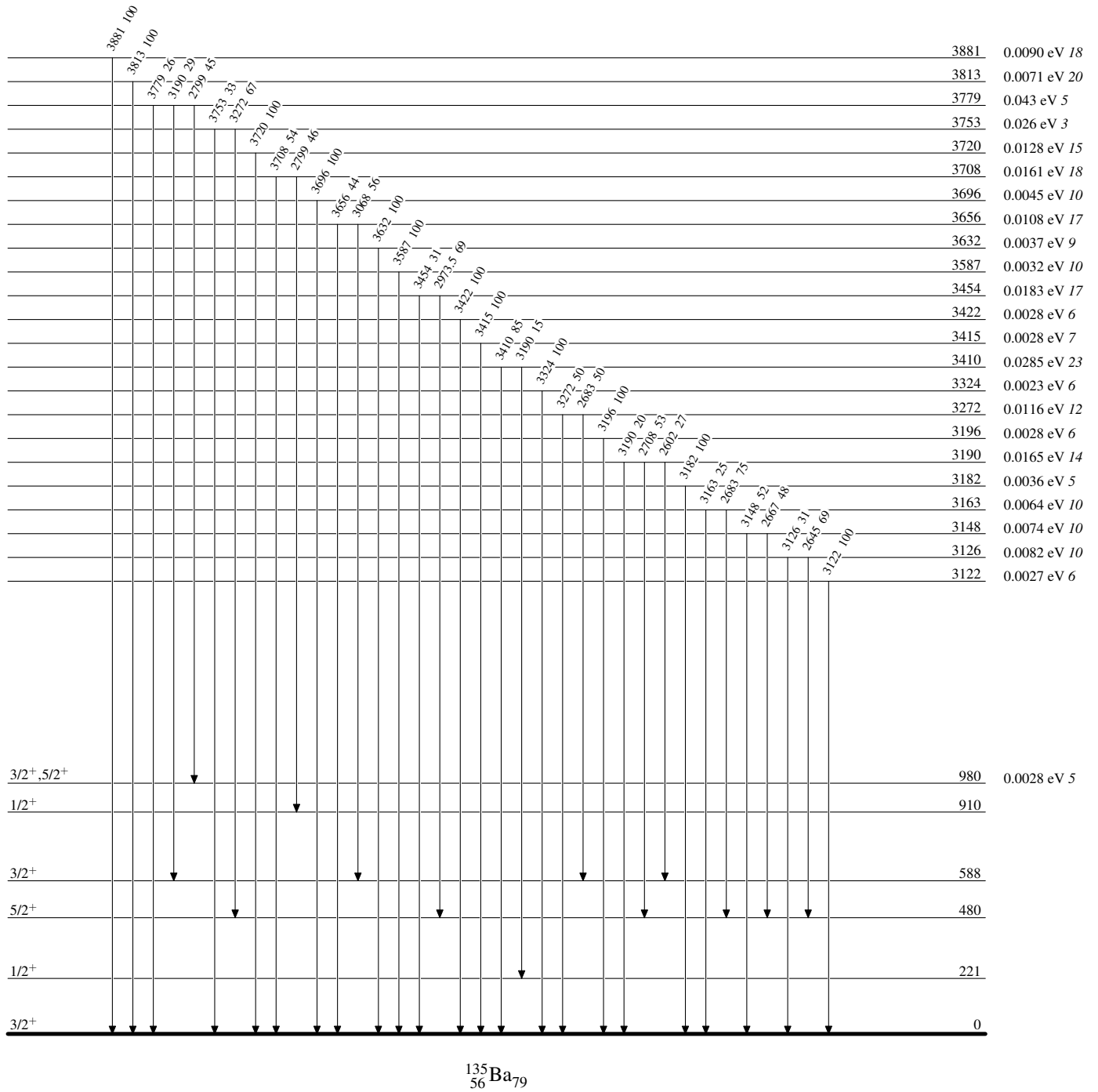
[‡] Alternative assignments possible.

[#] Multiply placed.

$^{135}\text{Ba}(\gamma,\gamma')$ 2004Sc39

Level Scheme

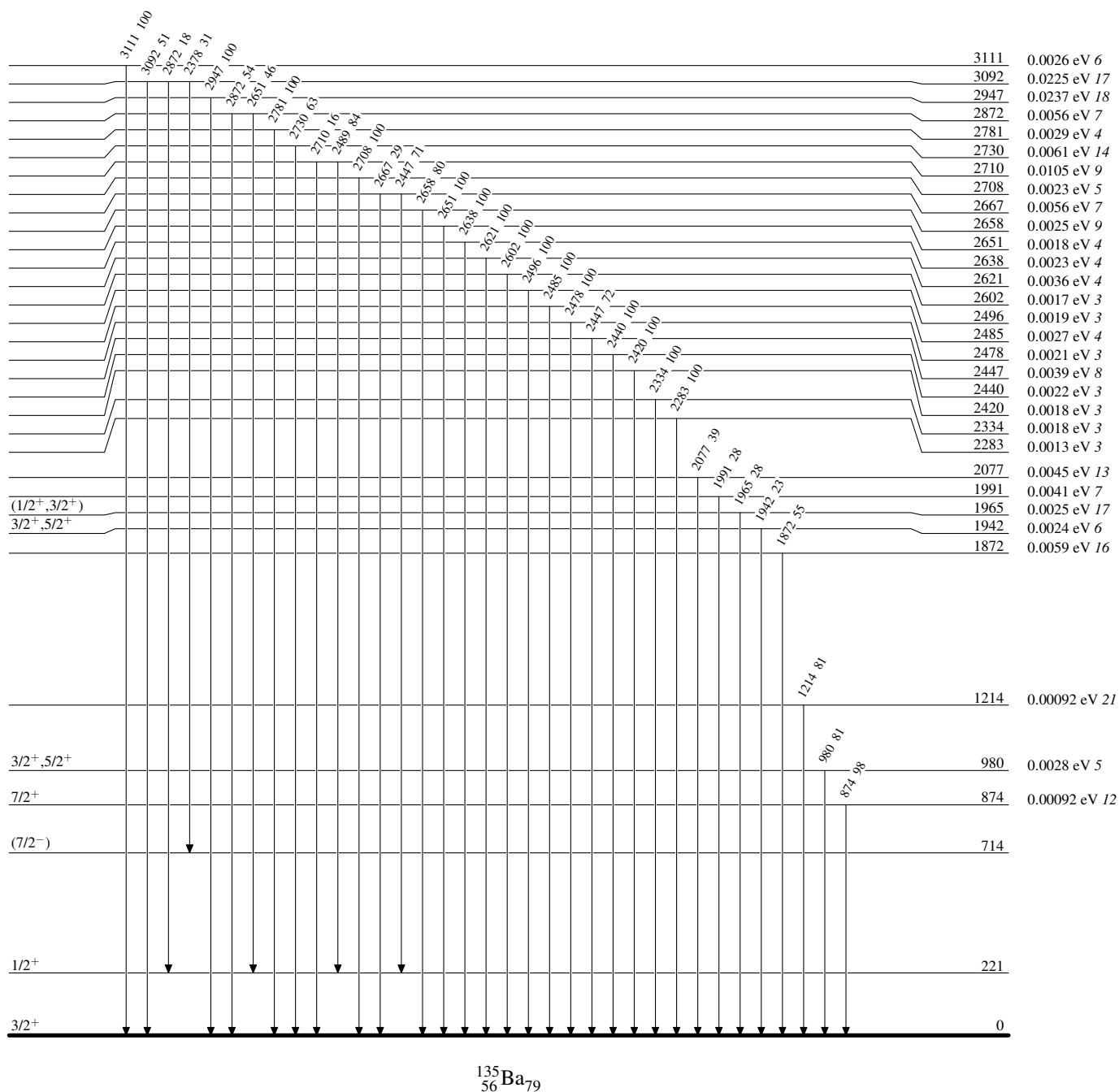
Intensities: % photon branching from each level



$^{135}\text{Ba}(\gamma,\gamma')$ 2004Sc39

Level Scheme (continued)

Intensities: % photon branching from each level



$^{135}_{56}\text{Ba}_{79}$