Coulomb excitation 2007WaZV,1974Mc15,1973Be44

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, E. Browne	NDS 109, 2439 (2008)	31-Jul-2008

2007WaZV: Beam=^{208}Pb at 1300 MeV. Target=^{240}Pu. Experiment performed at ATLAS-Argonne facility using Gammasphere array with 99 Compton-suppressed Ge detectors. Measured Eγ, Iγ, $\gamma\gamma$, $\gamma(\theta)$. The beam energy is 10-15% above the Coulomb barrier, thus the method is called 'unsafe' Coulomb excitation. The results from this experiment were also reported at NS-2008 conference at NSCL, Michigan in June 2008.

1998Ha08 (also 1999Wi11,1999Cl07): (^{208}Pb,^{208}Pb′) E=1300 MeV. Measured Eγ, Iγ, $\gamma\gamma$ using the Argonne-Notre Dame array of 12 Compton-suppressed Ge detectors and 46 BGO scintillators. Enriched (98%) target. 1999Wi11 report measurements with GAMMASPHERE array containing 101 Ge detectors. The experiments reported by 1998Ha08, 1999Wi11 and 1999Cl07 are by the same experimental group as 2007WaZV, where most data details are given.

1974Mc15, 1973Be44, 1971Fo17: (α,α') E=17 MeV. Measured B(E2)′s. The α spectrum is shown in 1973Be44.

1965Fr11: (d,d′).

All data given here are from 2007WaZV, unless otherwise stated.

^{240}Pu Levels

A level at 938,(2$^+$) with BE2=0.079 *18* (1974Mc15,1973Be44) is omitted here. First the 938 level in other reactions (see 'Adopted Levels levels′) is assigned 1$^-$; second from the spectrum figure in 1973Be44, the peak corresponding to 938 is very weak and, assuming a linear calibration, seems to be at about 1040 keV, rather than at 938.

E(level)[†]	J$^\pi$[‡]	T$_{1/2}$	Comments
0[@]	0$^+$		
42.824[@] *8*	2$^+$	167 ps *6*	B(E2)=13.33 *18* (1973Be44), 12.57 *35* (1971Fo17), 12.9 *3* (1965Fr11). T$_{1/2}$: from 'Adopted Levels', includes values deduced from the measured B(E2) values given above.
141.8[@] *3*	4$^+$		B(E4)↑=1.3 *6* (1973Be44)
294.0[@] *5*	6$^+$		
496.8[@] *5*	8$^+$		
649[#]	3$^-$		B(E3)↑=0.41 *6* (1974Mc15)
746.7[@] *6*	10$^+$		
877.7?[&] *6*	(7$^-$)		
992.1[a] *8*	4$^+$		
1040.2[@] *6*	12$^+$		
1056.1[&] *6*	9$^-$		
1137.9?[a] *7*	(6$^+$)		
1276.8[&] *6*	11$^-$		
1322.9[a] *6*	8$^+$		
1373.9[@] *6*	14$^+$		
1538.9[&] *6*	13$^-$		
1556.4[a] *6*	10$^+$		
1744.9[@] *7*	16$^+$		
1829.5[a] *6*	12$^+$		
1841.0[&] *6*	15$^-$		
2136.0[a] *6*	14$^+$		
2150.8[@] *7*	18$^+$		
2181.7[&] *7*	17$^-$		
2474.3[a] *7*	16$^+$		

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Coulomb excitation 2007WaZV,1974Mc15,1973Be44 (continued)

^{240}Pu Levels (continued)

E(level)†	Jπ‡	E(level)†	Jπ‡	E(level)†	Jπ‡	E(level)†	Jπ‡
2559.6& 7	19⁻	3420.3& 8	23⁻	4410.0& 8	27⁻	5511.4& 9	31⁻
2589.4@ 7	20⁺	3558.2@ 8	24⁺	4530.1[a] 10	26⁺	5558.4[a] 13	30⁺
2836.3[a] 7	18⁺	3625.8[a] 8	22⁺	4638.6@ 8	28⁺	5818.5@ 9	32⁺
2973.0& 7	21⁻	3899.8& 8	25⁻	4949.2& 8	29⁻	6095.5?& 10	(33⁻)
3059.0@ 8	22⁺	4062.7[a] 9	24⁺	5029.2[a] 12	28⁺		
3217.5[a] 7	20⁺	4085.5@ 8	26⁺	5219.5@ 9	30⁺		

† From least-squares fit to Eγ′s.
‡ As proposed by 2007WaZV for all levels above 142, except for 649 level, which is from 1974Mc15. The assignments are the same in 'Adopted Levels', except that above 900 KEV, most are placed in parentheses due to lack of strong supporting arguments.
# From 1974Mc15 only.
@ Band(A): g.s., K^π=0⁺ band.
& Band(B): Octupole, K^π=0⁻ band.
[a] Band(C): K^π=0⁺ band. This band starts out as β vibrational band, at $\hbar\omega\approx$0.2 MeV, it is crossed by a 2 quasiparticle (possibly neutrons) excitation.

γ(^{240}Pu)

A γ-ray cascade: 303.5-340.3-370.7-405.8-437.5-466.8 possibly belongs to ^{240}Pu (2007WaZV).

Eγ	Iγ	E_i(level)	J^π_i	E_f	J^π_f	Mult.†	Comments
42.824 8		42.824	2⁺	0	0⁺		Eγ: from 'adopted gammas'.
99.0 3		141.8	4⁺	42.824	2⁺		
145.8‡ 4		1137.9?	(6⁺)	992.1	4⁺		
152.2 3	37.0 10	294.0	6⁺	141.8	4⁺	(Q)	A_2=+0.29 5; A_4=−0.04 5
165.0 3	0.2 2	1538.9	13⁻	1373.9	14⁺		
178.4‡ 4		1056.1	9⁻	877.7?	(7⁻)		
185.0‡ 3	0.12 8	1322.9	8⁺	1137.9?	(6⁺)		
185.7 3	0.6 3	4085.5	26⁺	3899.8	25⁻		
202.8 3	84.4 21	496.8	8⁺	294.0	6⁺	(Q)	A_2=+0.29 4; A_4=−0.04 4
220.7 3	0.4 2	1276.8	11⁻	1056.1	9⁻	(Q)	A_2=+0.22 4; A_4=−0.06 6
228.6 4	0.7 4	4638.6	28⁺	4410.0	27⁻		
233.5 3	0.18 12	1556.4	10⁺	1322.9	8⁺		
236.6 3	0.7 4	1276.8	11⁻	1040.2	12⁺		
249.9 3	100.0 14	746.7	10⁺	496.8	8⁺	(Q)	A_2=+0.19 4; A_4=−0.03 5
262.1 3	2.1 10	1538.9	13⁻	1276.8	11⁻	(Q)	A_2=+0.18 4; A_4=−0.03 5
270.3 4		5219.5	30⁺	4949.2	29⁻		
273.2 3	0.31 17	1829.5	12⁺	1556.4	10⁺	Q	A_2=+0.18 2; A_4=−0.12 4
279.6‡ 4		1556.4	10⁺	1276.8	11⁻		
290.6‡ 4		1829.5	12⁺	1538.9	13⁻		
292.6‡ 4		2474.3	16⁺	2181.7	17⁻		
293.5 3	96.6 23	1040.2	12⁺	746.7	10⁺	(Q)	A_2=+0.21 3; A_4=−0.02 5
295.0‡ 3	0.29 17	2136.0	14⁺	1841.0	15⁻		
302.1 3	5.7 25	1841.0	15⁻	1538.9	13⁻	Q	A_2=+0.23 3; A_4=−0.05 4
306.5 3	0.9 5	2136.0	14⁺	1829.5	12⁺	Q	A_2=+0.26 2; A_4=−0.10 4
309.4 3	0.5 5	1056.1	9⁻	746.7	10⁺	D	A_2=−0.20 5; A_4=+0.04 8

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Coulomb excitation 2007WaZV,1974Mc15,1973Be44 (continued)

$\gamma(^{240}Pu)$ (continued)

E_γ	I_γ	E_i(level)	J^π_i	E_f	J^π_f	Mult.[†]	Comments
310.6[‡] *4*		4949.2	29⁻	4638.6	28⁺		
324.5 *3*		4410.0	27⁻	4085.5	26⁺		
333.7 *3*	84.1 *23*	1373.9	14⁺	1040.2	12⁺	Q	A_2=+0.21 *1*; A_4=−0.04 *3*
338.2 *3*	1.3 *12*	2474.3	16⁺	2136.0	14⁺	Q	A_2=+0.30 *5*; A_4=−0.13 *6*
340.7 *3*	9 *8*	2181.7	17⁻	1841.0	15⁻	(Q)	A_2=+0.17 *4*; A_4=−0.03 *4*
341.6 *3*	0.7 *3*	3899.8	25⁻	3558.2	24⁺		
361.3 *3*	0.6 *2*	3420.3	23⁻	3059.0	22⁺		
362.0 *3*	0.7 *5*	2836.3	18⁺	2474.3	16⁺	Q	A_2=+0.22 *5*; A_4=−0.14 *6*
371.0 *3*	70.5 *20*	1744.9	16⁺	1373.9	14⁺	(Q)	A_2=+0.19 *3*; A_4=−0.01 *5*
377.9 *3*	7 *5*	2559.6	19⁻	2181.7	17⁻	(Q)	A_2=+0.21 *3*; A_4=−0.04 *4*
381.2 *3*	0.5 *4*	3217.5	20⁺	2836.3	18⁺	Q	A_2=+0.18 *5*; A_4=−0.11 *7*
383.6 *3*	0.9 *2*	2973.0	21⁻	2589.4	20⁺		
405.9 *3*	52.9 *25*	2150.8	18⁺	1744.9	16⁺	(Q)	A_2=+0.19 *4*; A_4=−0.05 *5*
408.3 *4*		3625.8	22⁺	3217.5	20⁺		
408.9 *3*	1.4 *3*	2559.6	19⁻	2150.8	18⁺		
413.3 *3*	4.2 *26*	2973.0	21⁻	2559.6	19⁻	(Q)	A_2=+0.16 *5*; A_4=−0.04 *5*
436.8 *3*	3.1 *38*	2181.7	17⁻	1744.9	16⁺		
436.9 *5*		4062.7	24⁺	3625.8	22⁺		
438.6 *3*	35 *3*	2589.4	20⁺	2150.8	18⁺	(Q)	A_2=+0.21 *4*; A_4=−0.02 *6*
445.2[‡] *4*		1322.9	8⁺	877.7?	(7⁻)		
447.3 *3*	2.9 *11*	3420.3	23⁻	2973.0	21⁻	(Q)	A_2=+0.19 *3*; A_4=−0.04 *5*
467.1 *3*	3.7 *21*	1841.0	15⁻	1373.9	14⁺		
467.4 *5*		4530.1	26⁺	4062.7	24⁺		
469.6 *3*	21.0 *14*	3059.0	22⁺	2589.4	20⁺	(Q)	A_2=+0.19 *5*; A_4=−0.02 *6*
479.5 *3*	2.2 *15*	3899.8	25⁻	3420.3	23⁻	Q	A_2=+0.19 *4*; A_4=−0.07 *3*
498.7 *3*	2.8 *18*	1538.9	13⁻	1040.2	12⁺	D	A_2=−0.15 *3*; A_4=−0.01 *5*
499.1 *5*		5029.2	28⁺	4530.1	26⁺		
499.2 *3*	12.5 *13*	3558.2	24⁺	3059.0	22⁺	Q	A_2=+0.27 *3*; A_4=−0.08 *3*
500.3 *3*	0.26 *17*	1556.4	10⁺	1056.1	9⁻	D	A_2=−0.18 *3*; A_4=+0.07 *4*
510.2 *3*	1.9 *14*	4410.0	27⁻	3899.8	25⁻	Q	A_2=+0.24 *5*; A_4=−0.12 *4*
527.3 *3*	5.4 *9*	4085.5	26⁺	3558.2	24⁺	(Q)	A_2=+0.33 *5*; A_4=−0.05 *5*
529.2 *5*		5558.4	30⁺	5029.2	28⁺		
530.1 *3*	1.8 *9*	1276.8	11⁻	746.7	10⁺	D	A_2=−0.14 *5*; A_4=+0.04 *4*
539.2 *3*	1.3 *9*	4949.2	29⁻	4410.0	27⁻		
552.7 *4*	0.28 *15*	1829.5	12⁺	1276.8	11⁻	D	A_2=−0.23 *4*; A_4=+0.03 *3*
553.1 *3*	2.6 *9*	4638.6	28⁺	4085.5	26⁺		
559.2 *3*	1.4 *10*	1056.1	9⁻	496.8	8⁺	D	A_2=−0.16 *5*; A_4=−0.02 *7*
562.2 *3*	1.0 *7*	5511.4	31⁻	4949.2	29⁻		
580.9 *3*	1.9 *7*	5219.5	30⁺	4638.6	28⁺		
583.7[‡] *4*		877.7?	(7⁻)	294.0	6⁺		
584.1[‡] *4*		6095.5?	(33⁻)	5511.4	31⁻		
597.1 *3*	0.7 *4*	2136.0	14⁺	1538.9	13⁻	D	A_2=−0.20 *2*; A_4=+0.04 *4*
599.0 *3*	1.9 *9*	5818.5	32⁺	5219.5	30⁺		
633.3 *4*	0.4 *4*	2474.3	16⁺	1841.0	15⁻	D	A_2=−0.22 *3*; A_4=+0.02 *5*
652.8 *4*	0.08 *4*	3625.8	22⁺	2973.0	21⁻		
654.6 *3*	0.23 *18*	2836.3	18⁺	2181.7	17⁻		
657.8 *3*	0.09 *6*	3217.5	20⁺	2559.6	19⁻		

[†] Assigned on the basis of A_2 and A_4 coefficients from 2007WaZV. The mult=Q most likely corresponds to E2 and mult=D to E1.
[‡] Placement of transition in the level scheme is uncertain.

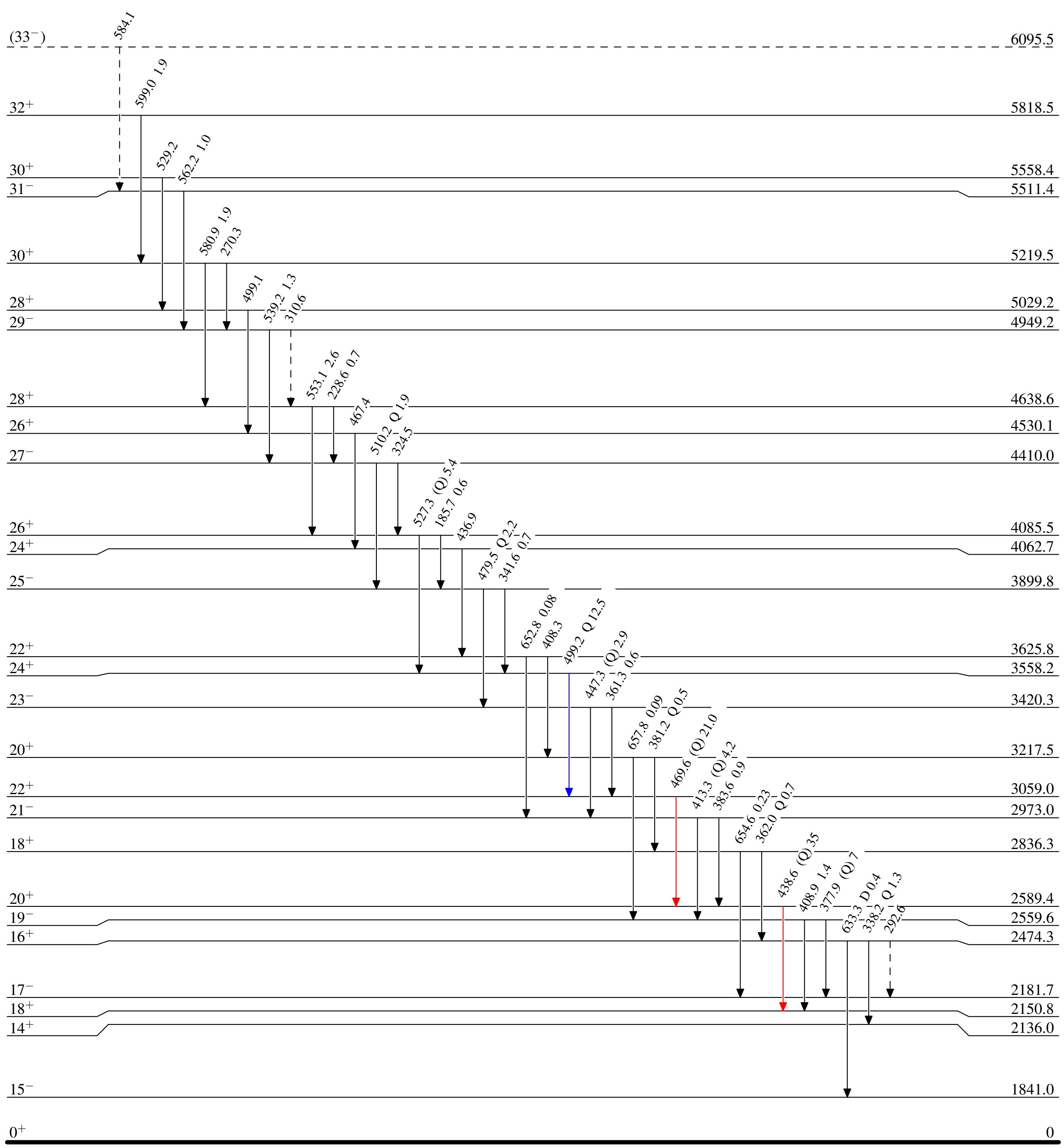
Coulomb excitation 2007WaZV,1974Mc15,1973Be44

Level Scheme

Intensities: Relative I_γ

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)

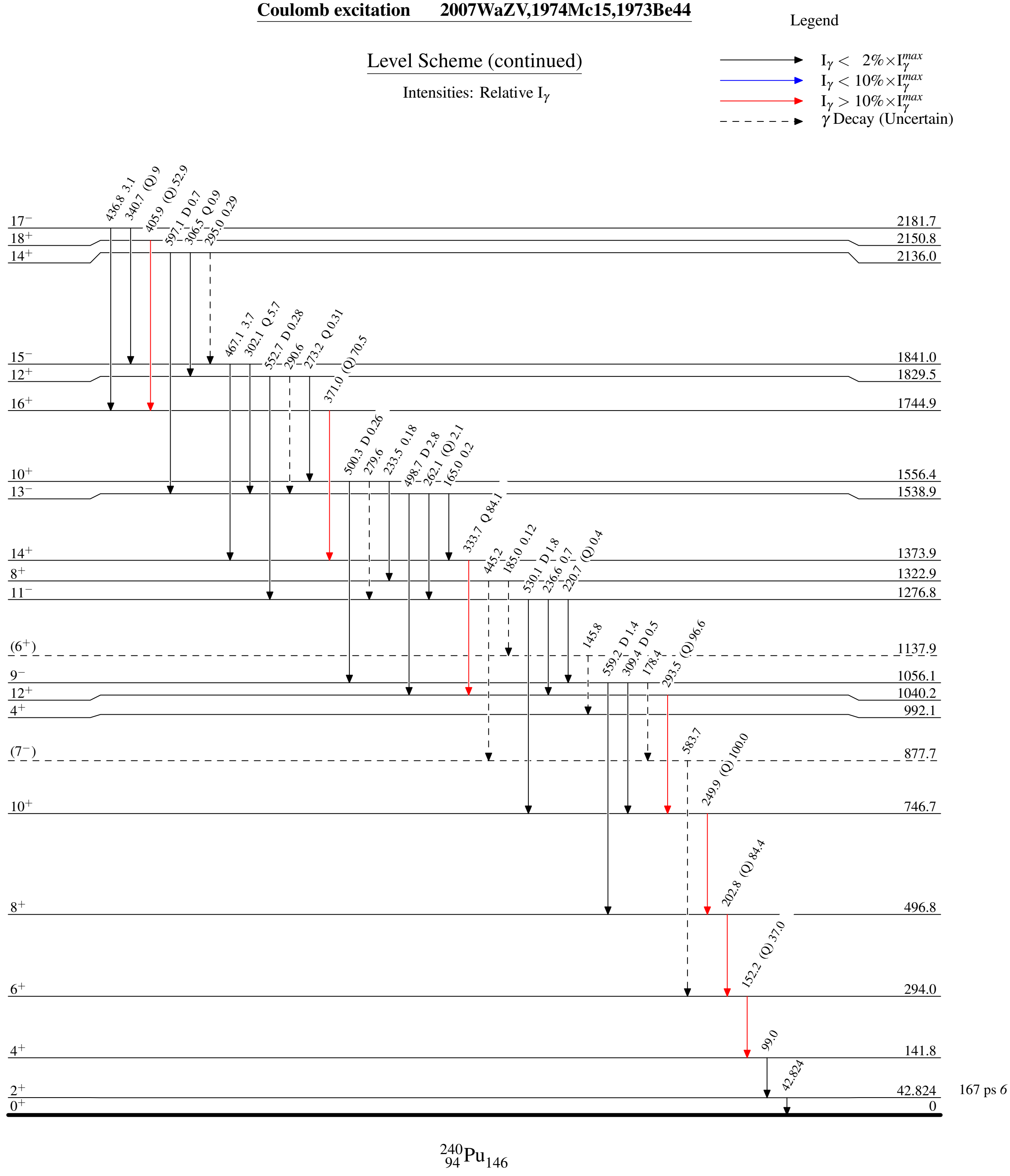


$^{240}_{94}Pu_{146}$

Coulomb excitation 2007WaZV,1974Mc15,1973Be44

Level Scheme (continued)

Intensities: Relative I_γ



Coulomb excitation 2007WaZV,1974Mc15,1973Be44