Coulomb excitation 1977Dr04

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	NDS 110, 1 (2009)	20-Nov-2008

Reactions: (^{16}O, ^{16}O′γ) at E=25-42 MeV and (α,α′) at 10 MeV. Measured γ, $\gamma\gamma$, (^{16}O)(γ), $\gamma(\theta)$, (^{16}O)$\gamma(\theta)$, Doppler-shift attenuation.

Other main references: 1972Th09, 1971Le04, 1970Za04.

1972Th09: (^{35}Cl, ^{35}Cl′γ) E=30-90 MeV and (α,α′) E=5-12 MeV. Measured γ, $\gamma\gamma$, $\gamma(\theta)$, $T_{1/2}$. B(E2)′s deduced.

1971Le04: (α,α′γ) E=5-11 MeV and (p,p′) E=4.5 MeV. Measured γ, excitation functions. B(E2)′s deduced.

1970Za04: (α,α′) E=12 MeV. B(E2)′s deduced from α-particle spectra.

Others: 1972La39, 1969BeYY, 1960Na13, 1960Ol02, 1959De29, 1959Be68, 1957Cl44, 1956He78.

(^{16}O,^{16}O′): 1969BeYY.

(α,α′): 1972La39, 1960Na13, 1957Cl44, 1956He78.

(d,d′): 1960Ol02.

(p,p′): 1960Ol02, 1959De29, 1959Be68, 1957Cl44.

^{151}Eu Levels

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$	Comments
0.0	$5/2^+$		
21.50 *6*	$7/2^+$		B(E2)↑=0.06 *2* (from $T_{1/2}$). Other: 0.09 *1* (1960Ol02).
196.35 *11*	$11/2^-$		B(E3)↑=0.0160 *15* (1977Dr04)
196.55 *6*	$(3/2)^+$	0.24 ns *4*	B(E2)↑=0.095 *6* (1977Dr04) B(E2)↑: Others: 1972Th09, 1970Za04, 1960Ol02, 1957Cl44, 1956He78. $T_{1/2}$: from centroid-shift method (1972Th09).
243.28 *6*	$7/2^-$	0.40 ns *7*	B(E1)↑<0.0006 $T_{1/2}$: centroid-shift method (1972Th09).
260.42 *9*	$5/2^+$		B(E2)↑=0.00028 *10* (1977Dr04)
307.17 *7*	$(5/2)^+$		B(E2)↑=0.072 *10* (1977Dr04) B(E2)↑: Other: 1972Th09.
307.50 *6*	$(7/2)^+$	3.3 ps *8*	B(E2)↑=0.39 *1* (1977Dr04) B(E2)↑: Other: 1972Th09. Values from 1971Le04, 1970Za04, 1960Ol02, 1957Cl44 and 1956He78 refer to multiplet of 3 levels near 307. $T_{1/2}$: DSA method (1977Dr04).
307.80 *7*	$(9/2)^+$		B(E2)↑=0.039 *4* (1977Dr04)
349.83 *12*	$9/2^-$		B(E1)↑=0.0012 *6* (1977Dr04)
353.54 *9*	$5/2^-$,$7/2^-$		B(E2)↑=0.0021 *7* (1977Dr04)
499.79 *7*	$(7/2^+)$		B(E2)↑=0.060 *4* (1977Dr04) J$^\pi$: 192$\gamma(\theta)$ and 500$\gamma(\theta)$ support J=7/2, not 5/2 or 9/2. B(E2)↑: Others: 1972Th09, 1971Le04.
503.40 *7*	$9/2^+$		B(E2)↑=0.22 *2* (1977Dr04) B(E2)↑: Others: 1972Th09, 1971Le04, 1970Za04, 1960Na13.
579.8 *2*			B(E2)↑=0.015 *1* (1977Dr04) B(E2)↑: Others: 1971Le04, 1970Za04.
587.06 *12*			B(E2)↑=0.0038 *7* (1977Dr04)
600.73 *9*			B(E2)↑=0.0210 *15* (1977Dr04) B(E2)↑: Others: 1971Le04, 1970Za04.
697.21 *10*	$5/2^+$		B(E2)↑=0.032 *3* (1977Dr04)
719.14 *11*	$(7/2^+,9/2^+)$		B(E2)↑=0.028 *4* (1977Dr04) B(E2)↑: Others: 1971Le04, 1970Za04.
757.6 *2*	$(3/2^+,5/2^+)$		B(E2)↑=0.0160 *15* (1977Dr04) B(E2)↑: Other: 1970Za04.
810?[#] *10*			B(E2)↑=0.0084 (1970Za04)
859.4? *3*			B(E2)↑=0.0013 *4* (1977Dr04)
900?[#] *10*			B(E2)↑=0.0038 (1970Za04)

Continued on next page (footnotes at end of table)

Coulomb excitation 1977Dr04 (continued)

^{151}Eu Levels (continued)

E(level)[†]	Comments
963?[#] *10*	B(E2)↑=0.014 (1970Za04)
1106?[#] *10*	B(E2)↑=0.040 (1970Za04)

[†] From least-squares fit to Eγ's.
[‡] See 'Adopted Levels'.
[#] Seen by 1970Za04 only. Treated as uncertain.

Coulomb excitation 1977Dr04 (continued)

$\gamma(^{151}Eu)$

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	α[‡]	Comments
21.5		21.50	$7/2^+$	0.0	$5/2^+$				From 'adopted gammas'.
63.9 *1*	0.65 *11*	307.17	$(5/2)^+$	243.28	$7/2^-$	(E1)		0.940	α(K)=0.780 *12*; α(L)=0.1255 *19*; α(M)=0.0271 *4*; α(N+..)=0.00700 *11* α(N)=0.00605 *9*; α(O)=0.000885 *13*; α(P)=6.12×10^{-5} *9* Mult.: from intensity balance 63.9γ consistent with E1, not with M1 or E2.
110.15 *15*	0.020[†] *6*	353.54	$5/2^-,7/2^-$	243.28	$7/2^-$				
110.66 *12*	6.3 *4*	307.17	$(5/2)^+$	196.55	$(3/2)^+$				A_2=+0.04 *7*, A_4=0.00 *7*. Deduced δ=+0.14 *5*. Other: 1972Th09. K/L=4.5 (1959Be68).
146.3 *2*	0.11 *4*	499.79	$(7/2^+)$	353.54	$5/2^-,7/2^-$				
149.9 *2*	0.34 *8*	499.79	$(7/2^+)$	349.83	$9/2^-$				
153.3 *2*	0.69 *8*	349.83	$9/2^-$	196.55	$(3/2)^+$				
174.8 *1*	1.41 *5*	196.35	$11/2^-$	21.50	$7/2^+$				K/L=4.5 (1959Be68).
175.00 *15*	0.42[†] *3*	196.55	$(3/2)^+$	21.50	$7/2^+$				
192.34 *8*	2.7 *4*	499.79	$(7/2^+)$	307.50	$(7/2)^+$				A_2=−0.004 *15*, A_4=+0.02 *3*.
195.84 *8*	11.0[†] *15*	503.40	$9/2^+$	307.50	$(7/2)^+$				
196	0.0210 *22*	196.35	$11/2^-$	0.0	$5/2^+$	E3		1.389	α(K)=0.586 *9*; α(L)=0.618 *9*; α(M)=0.1481 *21*; α(N+..)=0.0376 *6* α(N)=0.0330 *5*; α(O)=0.00451 *7*; α(P)=5.27×10^{-5} *8* I_γ: deduced from B(E3), $T_{1/2}$(196.35 level)=58.9 μs *5*.
196.5[&]	≤0.31[†]	503.40	$9/2^+$	307.17	$(5/2)^+$				
196.53 *8*	40.2 *15*	196.55	$(3/2)^+$	0.0	$5/2^+$	E2+M1	0.45 *15*	0.268 *6*	α(K)=0.221 *8*; α(L)=0.0363 *20*; α(M)=0.0080 *5*; α(N+..)=0.00211 *12* α(N)=0.00181 *11*; α(O)=0.000280 *13*; α(P)=2.37×10^{-5} *12* Mult.,δ: deduced from B(E2) and adopted branching ratio. This value overlaps values for J=3/2, 5/2 or 7/2. A_2=−0.042 *11*, A_4=+0.012 *13* for 196.5+195.8 doublet (1977Dr04) 1972Th09 deduce δ=−0.9 *4* from A_2=−0.15 *3*, A_4=−0.075 *25*. In view of the unresolved doublet, this value of δ is suspect. K/L=5.5 for the doublet (1959Be68).
219.3 *2*	0.24 *3*	719.14	$(7/2^+,9/2^+)$	499.79	$(7/2^+)$				
238.90 *15*	0.73 *4*	260.42	$5/2^+$	21.50	$7/2^+$				
243.27 *8*	4.9 *6*	243.28	$7/2^-$	0.0	$5/2^+$				
247.2 *2*	0.029[†] *9*	600.73		353.54	$5/2^-,7/2^-$				
250.9 *2*	0.022[†] *7*	600.73		349.83	$9/2^-$				
256.5 *1*	1.31 *6*	499.79	$(7/2^+)$	243.28	$7/2^-$				
260.2 *1*	0.84[†] *7*	503.40	$9/2^+$	243.28	$7/2^-$				
260.4 *1*	0.23[†] *3*	260.42	$5/2^+$	0.0	$5/2^+$				

$^{151}_{63}Eu_{88}$-3

Coulomb excitation 1977Dr04 (continued)

γ(^{151}Eu) (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Comments
279.6[@] *2*	0.070[@†] *15*	587.06		307.50	$(7/2)^+$	
279.6[@] *2*	0.080[@] *15*	587.06		307.80	$(9/2)^+$	Unresolved doublet at 279.6 proceeding to close levels near 307. Iγ from γγ.
286.00 *8*	7.5[†] *6*	307.50	$(7/2)^+$	21.50	$7/2^+$	(286.0γ+286.3γ)(θ): A_2=+0.067 *6*, A_4=−0.001 *7*. Other: 1972Th09.
						(^{16}O)(286.0γ+286.3γ)(θ): A_2=+0.32 *4*, A_4=+0.04 *5*. After correcting for 286.3γ, A_2=+0.07 *8*, A_4=+0.14 *10* which leads to δ=0.7 *6*.
						K/L=3.6 for 286.0γ+286.3γ (1959Be68).
286.30 *8*	7.3[†] *6*	307.80	$(9/2)^+$	21.50	$7/2^+$	
292.9 *2*	0.220[†] *16*	600.73		307.80	$(9/2)^+$	
293.3 *2*	0.18[†] *2*	600.73		307.50	$(7/2)^+$	
293.3 *2*	0.05[†] *1*	600.73		307.17	$(5/2)^+$	
303.2 *2*	0.25 *4*	499.79	$(7/2^+)$	196.55	$(3/2)^+$	
307.23 *13*	4.3[†] *10*	307.17	$(5/2)^+$	0.0	$5/2^+$	
307.51 *8*	93.9 *10*	307.50	$(7/2)^+$	0.0	$5/2^+$	(307.5γ)(θ): A_2=−0.025 *4*, A_4=+0.008 *5*. Other: 1972Th09.
						(^{16}O)(307.5γ)(θ):A_2=+0.024 *17*, A_4=0.00 *2*.
						δ: 0.27 *7* for J=7/2.
						K/L=6.7 (1959Be68).
307.8 *1*	1.8[†] *2*	307.80	$(9/2)^+$	0.0	$5/2^+$	
[x]332.3[@] *2*	<0.15[@]					Total Iγ=0.20 *4*.
332.3[@] *2*	<0.05[@†]	353.54	$5/2^-$,$7/2^-$	21.50	$7/2^+$	
340.12 *25*	0.15 *3*	600.73		260.42	$5/2^+$	
343.73 *15*	0.28[†] *3*	587.06		243.28	$7/2^-$	
343.73 *15*	0.120[†] *12*	697.21	$5/2^+$	353.54	$5/2^-$,$7/2^-$	
353.6 *2*	0.51 *8*	353.54	$5/2^-$,$7/2^-$	0.0	$5/2^+$	
369.2 *2*	0.10 *3*	719.14	$(7/2^+,9/2^+)$	349.83	$9/2^-$	
383.3 *2*	0.75 *6*	579.8		196.55	$(3/2)^+$	
[x]389.1 *2*	0.080[†] *9*					Transition proceeds to 307.2 level.
389.5 *2*	0.90[†] *6*	697.21	$5/2^+$	307.50	$(7/2)^+$	
412.1 *2*	0.14 *2*	719.14	$(7/2^+,9/2^+)$	307.17	$(5/2)^+$	
450.6 *2*	0.12[†] *2*	757.6	$(3/2^+,5/2^+)$	307.17	$(5/2)^+$	
475.8 *2*	0.98 *15*	719.14	$(7/2^+,9/2^+)$	243.28	$7/2^-$	
481.9 *2*	3.56 *8*	503.40	$9/2^+$	21.50	$7/2^+$	A_2=−0.28 *2*, A_4=−0.00 *2*. Other: 1972Th09.
						δ: 0.84 *30* for J=9/2.
499.6 *2*	2.6[†] *1*	499.79	$(7/2^+)$	0.0	$5/2^+$	(499.6γ+500.6γ)(θ): A_2=−0.12 *4*. Other: 1972Th09.
500.6 *2*	0.52[†] *5*	697.21	$5/2^+$	196.55	$(3/2)^+$	
503.5 *2*	10.60 *12*	503.40	$9/2^+$	0.0	$5/2^+$	A_2=+0.107 *9*, A_4=+0.009 *10*. Other: 1972Th09.
[x]522.7 *2*	0.88 *10*					Possible placement from level energy difference: 719.1-196.55.
552.2[&] *3*	0.11[†] *2*	859.4?		307.17	$(5/2)^+$	
560.6 *3*	0.09[†] *1*	757.6	$(3/2^+,5/2^+)$	196.55	$(3/2)^+$	

$^{151}_{63}Eu_{88}$-4

Coulomb excitation **1977Dr04** **(continued)**

$\gamma(^{151}Eu)$ (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Comments
579.2#& *2*	0.78# *6*	579.8		0.0	$5/2^+$	I_γ: only a small fraction of the intensity may belong here. In (p,2nγ) (1979Lo06), no 579γ was reported where 579.8 level was populated fairly intensely.
579.2# *2*	0.78# *6*	600.73		21.50	$7/2^+$	
600.8 *2*	0.54 *3*	600.73		0.0	$5/2^+$	
697.1 *2*	0.49 *9*	697.21	$5/2^+$	0.0	$5/2^+$	
719.3 *3*	0.24 *7*	719.14	$(7/2^+,9/2^+)$	0.0	$5/2^+$	
757.6 *3*	0.64 *6*	757.6	$(3/2^+,5/2^+)$	0.0	$5/2^+$	

† From $\gamma\gamma$.
‡ 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.
@ Multiply placed with intensity suitably divided.
& Placement of transition in the level scheme is uncertain.
x γ ray not placed in level scheme.

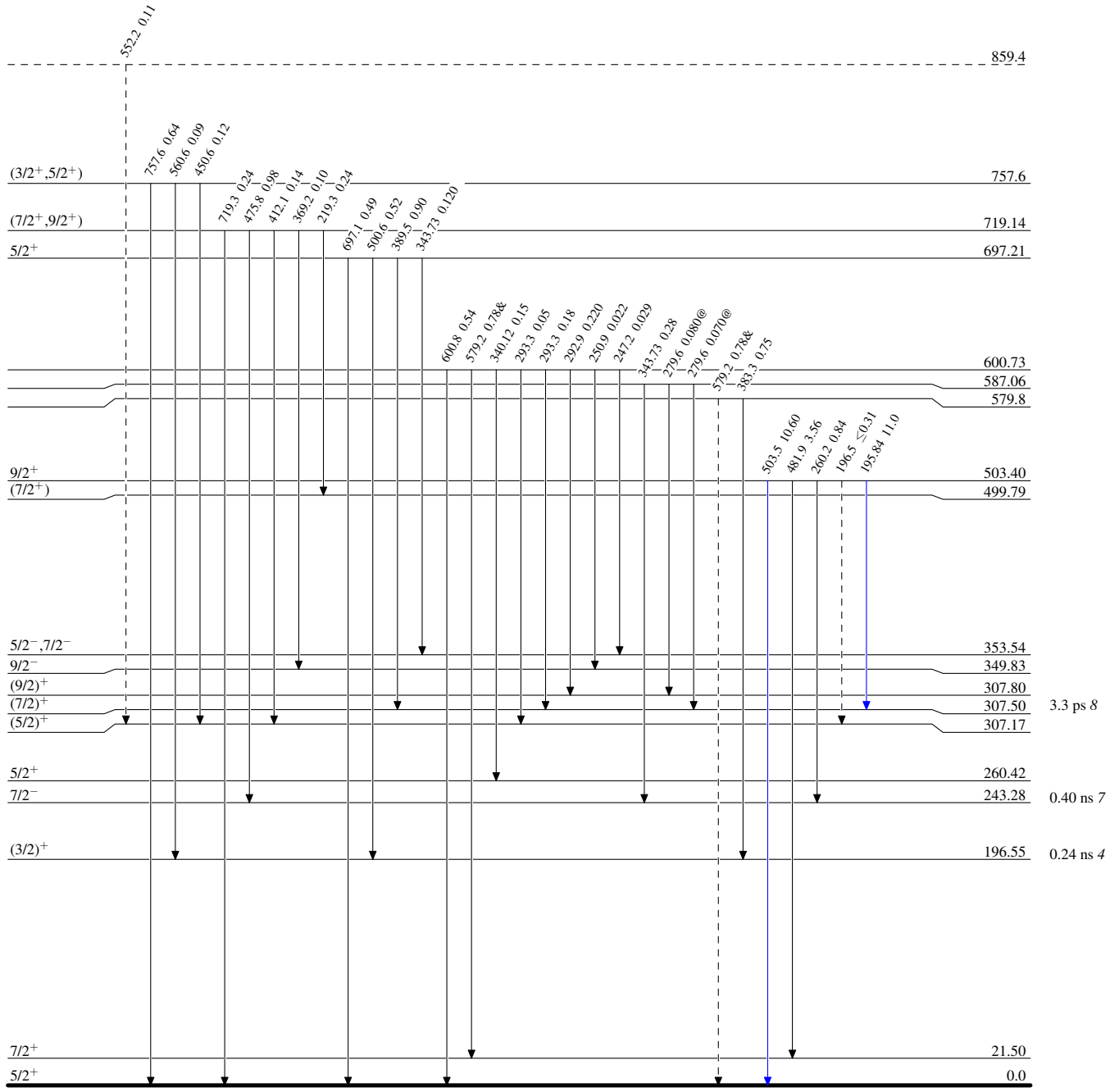
$^{151}_{63}Eu_{88}$-5

Coulomb excitation 1977Dr04

Level Scheme

Intensities: Relative I_γ
& 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)



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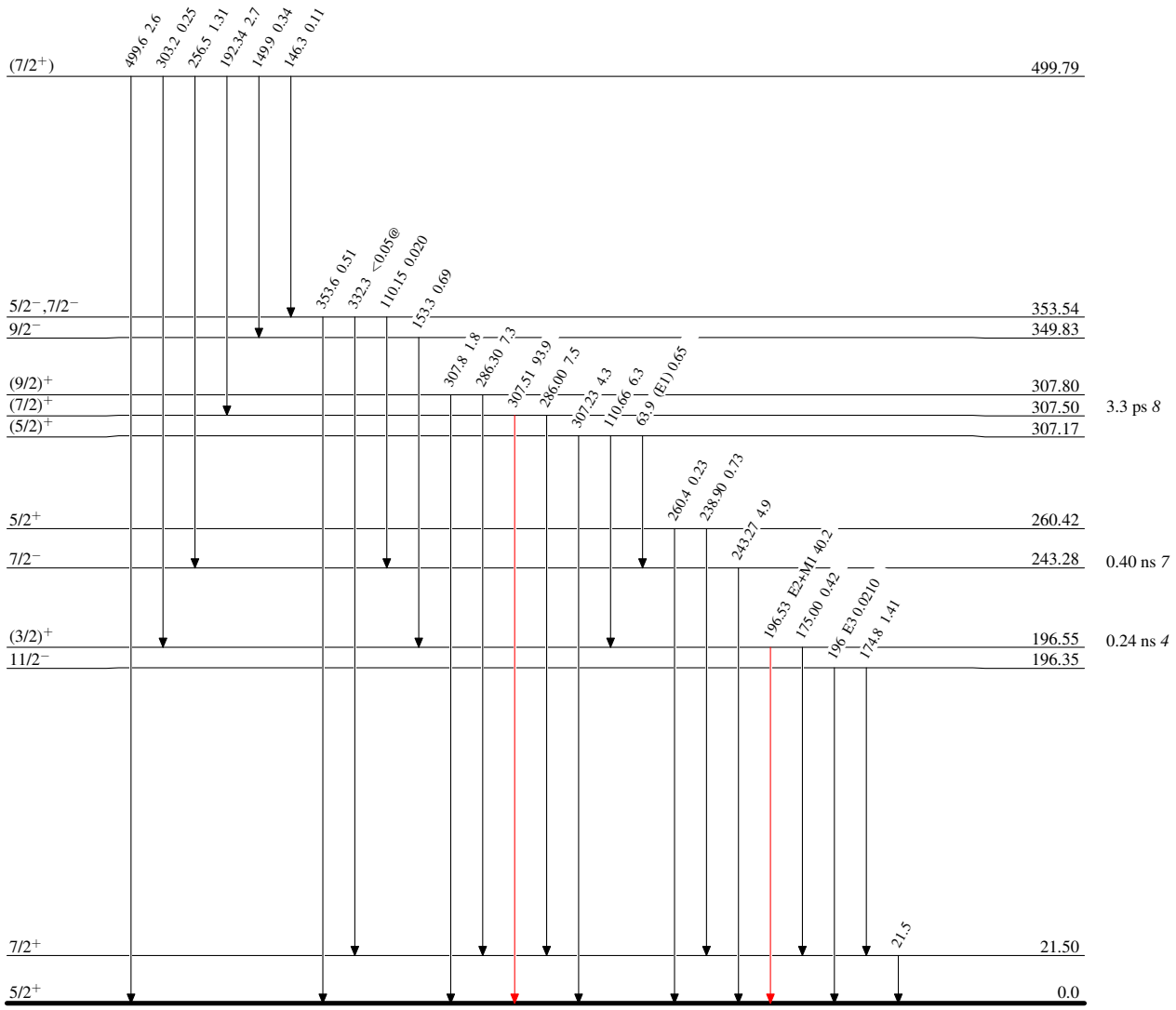
Coulomb excitation 1977Dr04

Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided

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



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