^{40}Ca(^{24}Mg,2pnγ) 2006An31

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Kazimierz Zuber, Balraj Singh	NDS 125, 1 (2015)	25-Jan-2015

2006An31 (also 2005An03,2005Ek01): E=104 MeV. Measured Eγ, $\gamma\gamma$, Iγ, $\gamma(\theta)$ using the CLARION Ge detector array, and the Recoil Mass Spectrometer (RMS). The CLARION array was comprised of ten Ge Clover detectors placed in a three ring configuration at 90°, 132°, and 154° with respect to the beam direction. Comparison of experimental and theoretical branching ratios are given in Table 2 of 2006An31 and levels in Fig.6. using large-scale shell-model calculations (code ANTOINE with GXPF1).

2004Iz01: E=96 MeV ^{40}Ca beam provided by LNL Tandem accelerator, bombarding a ^{24}Mg target. Measured Eγ, Iγ, $\gamma\gamma$, $\gamma\gamma(\theta)$(DCO), $\gamma\gamma$(lin pol) with the EUROBALL Ge-detector array consisting of 26 Clover detectors and 15 Cluster detectors. Evaporated charged particles were detected in the 40-element silicon ΔE-E array ISIS. A total of 27 γ rays are assigned in a level scheme up to 31/2. The level scheme is in agreement with that from 2006An31.

1999Vi12: E=65 MeV. Measured Eγ, $\gamma\gamma$, Iγ(singles and $\gamma\gamma$), and $\gamma\gamma(\theta)$(DCO) using the AYEBALL array with TESSA type detectors, eight EUROGAM detectors and one GAMMASPHERE detector. A total of 23 γ transitions were reported. There is disagreement in parity assignment for bands based on 124 level, as compared to results in 2006An31 and 2004Iz01. Also 1403-keV γ is a doublet, whereas only a single line is shown in 1999Vi12.

^{61}Zn Levels

E(level)[†]	J$^\pi$	T$_{1/2}$	Comments
0.0[e]	3/2$^-$		
88.79[@] *9*	1/2$^-$[#]		
123.90[f] *8*	5/2$^-$[‡]	≈5.5 ns	T$_{1/2}$: γ-intensity balance at 124 level suggests that this level is long-lived, estimated mean lifetime ≈8 ns (2006An31).
419.19[&] *10*	3/2$^-$[#]		
756.44[@] *13*	5/2$^-$[#]		
997.68[e] *15*	7/2$^-$[‡]		
1266.0[f] *5*	9/2$^-$[‡]		
1403.3[&] *3*	7/2$^-$[#]		
2003.4[@] *5*	9/2$^-$[#]		
2269.7[e] *6*	11/2$^-$[‡]		
2399.7[a] *4*	9/2$^+$[‡]		J=9/2$^-$ quoted in 1999Vi12.
2699.5[&] *6*	11/2$^-$		
2798.7[f] *6*	13/2$^-$[‡]		Additional information 1.
3244.5[b] *9*	11/2$^+$[‡]		E(level),J$^\pi$: from Fig. 3 (2004Iz01). (13/2$^-$) quoted in 1999Vi12.
3336.2[a] *6*	13/2$^+$[‡]		J$^\pi$: 13/2$^-$ quoted in 1999Vi12.
3461.6[@] *8*	13/2$^-$		
3495.0 *11*			
3843.8[e] *8*	15/2$^-$[‡]		E(level),J$^\pi$: from Fig. 3 (2004Iz01).
4264.0[b] *8*	15/2$^+$[‡]		
4308.8 *12*	13/2		
4415.0[a] *8*	17/2$^+$[‡]		J=17/2$^-$ quoted in 1999Vi12.
4644.3[f] *8*	17/2$^-$[‡]		
4914.7 *12*			
5195.3[@] *10*	17/2$^-$		
5254.5 *8*			
5467.8 *13*			
5543.0[e] *9*	19/2$^-$[‡]		E(level),J$^\pi$: from Fig. 3 (2004Iz01).
5552.4[b] *8*	19/2$^+$[‡]		

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^{40}Ca(^{24}Mg,2pnγ) 2006An31 (continued)

^{61}Zn Levels (continued)

E(level)[†]	J$^\pi$	Comments
6090.7[a] *13*	21/2+[‡]	J$^\pi$: (21/2−) quoted in 1999Vi12.
6212.0 *10*		
7284.0[d] *9*	21/2−	
7295.4[b] *13*	23/2+[‡]	E(level),J$^\pi$: from Fig. 3 (2004Iz01).
7486.6[a] *16*	25/2+[‡]	
7628.8[c] *10*	23/2−[‡]	
8336.7 *16*		
8496.5?[b] *16*		
8777.3 *16*		
8879.0[d] *14*	25/2−	
9160.9[c] *14*	27/2−[‡]	
10155.0[c] *15*	31/2−[‡]	

[†] From least-squares fit to Eγ data.
[‡] Assignment from 2004Iz01.
[#] Assignment supported in Adopted Levels.
[@] Band(A): 1/2− band.
[&] Band(a): 3/2− band.
[a] Band(B): 9/2+ band.
[b] Band(b): 11/2+ band.
[c] Band(C): 23/2− band.
[d] Band(c): 21/2− band.
[e] Band(D): 3/2− band.
[f] Band(d): 5/2− band.

γ(^{61}Zn)

R_{DCO}=[(I(158°) gated at I(79°,101°,134°))/(I(79°,101°,134°) gated at I(158°))]x ε, where I is the number of counts in a peak and ε is an efficiency multiplication factor (1999Vi12).

R_{DCO}=I(γ_1 at 156°; gated with γ_2 at 77°,103°)/I(γ_1 at 77°,103°; gated with γ_2 at 156°), CLOVER detectors at 77° and 103° are equivalent as far as DCO ratios are concerned. Known stretched E2 transitions were used for gating, such the R_{DCO}=1.0 is expected for stretched quadrupole transitions and $R_{DCO}\approx$0.6 for stretched dipoles, ΔJ=0 transitions have values similar to stretched quadrupole transitions (2004Iz01).

POL=[aN(perpendicular)−N(parallel)]/[aN(perpendicular)+N(parallel)], where a(Eγ)=normalization function determined from the ^{152}Eu source calibration. POL takes positive values for pure stretched electrical radiation and negative values for pure stretched magnetic radiation (2004Iz01).

$R_{154°,96°}$=Yield at 154°/Yield at 96°. Typical values are 1.6-1.7 for ΔJ=2, quadrupole transitions and 0.7-0.8 for ΔJ=1, dipole transitions (2006An31).

E$_\gamma$[†]	I$_\gamma$[†]	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$	Mult.	Comments
88.9 *1*	3.0 *1*	88.79	1/2−	0.0	3/2−	(D)	$R_{154°,96°}$=1.08 *7*. Additional information 2.
123.9 *1*	100 *3*	123.90	5/2−	0.0	3/2−	(M1+E2)	$R_{154°,96°}$=0.55; corrected for the estimated level lifetime. R_{DCO}=0.38 *3* (2004Iz01), 0.82 *7* (1999Vi12). Additional information 3.

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$^{40}Ca(^{24}Mg,2pn\gamma)$ 2006An31 (continued)

$\gamma(^{61}Zn)$ (continued)

E_γ[†]	I_γ[†]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	Comments
241.4 *1*	0.5 *1*	997.68	7/2⁻	756.44	5/2⁻		
295.5 *1*	0.6 *1*	419.19	3/2⁻	123.90	5/2⁻		$R_{154°,96°}$=1.6 *3*.
331.3 *2*	1.2 *1*	419.19	3/2⁻	88.79	1/2⁻	(D)	E_γ: poor fit, level-energy difference=330.7. $R_{154°,96°}$=0.97 *16*.
339.0 *2*	0.9 *1*	756.44	5/2⁻	419.19	3/2⁻		E_γ: poor fit, level-energy difference=336.3. This γ not used in the fitting procedure.
344.8 *2*	0.3 *1*	7628.8	23/2⁻	7284.0	21/2⁻		$R_{154°,96°}$=1.20 *24*.
419.1 *2*	8.9 *3*	419.19	3/2⁻	0.0	3/2⁻		$R_{154°,96°}$=1.11 *6*. R_{DCO}=0.89 *23* (1999Vi12).
440.6 *2*	0.5 *1*	8777.3		8336.7		D	$R_{154°,96°}$=0.71 *18*.
529.4 *3*	0.8 *1*	2798.7	13/2⁻	2269.7	11/2⁻		
578.2 *3*	4.4 *2*	997.68	7/2⁻	419.19	3/2⁻	Q	$R_{154°,96°}$=1.40 *9*. R_{DCO}=0.85 *23* (1999Vi12).
631.7 *3*	1.1 *1*	756.44	5/2⁻	123.90	5/2⁻	D	$R_{154°,96°}$=0.72 *16*.
647.1 *3*	3.4 *1*	1403.3	7/2⁻	756.44	5/2⁻	D	$R_{154°,96°}$=0.66 *6*.
666.6[#] *3*	1.8 *1*	756.44	5/2⁻	88.79	1/2⁻		
696.2 *3*	1.7 *1*	2699.5	11/2⁻	2003.4	9/2⁻	D	$R_{154°,96°}$=0.70 *13*.
737.6 *4*	1.0 *1*	2003.4	9/2⁻	1266.0	9/2⁻		
755.7 *4*	18 *1*	756.44	5/2⁻	0.0	3/2⁻	D	$R_{154°,96°}$=0.60 *3*.
839.2 *4*	3.1 *1*	5254.5		4415.0	17/2⁺		$R_{154°,96°}$=1.18 *10*.
872.7 *4*	73 *2*	997.68	7/2⁻	123.90	5/2⁻	M1+E2	$R_{154°,96°}$=0.64 *3*. R_{DCO}=0.30 *4*. POL=+0.041 *12* (2004Iz01). Additional information 4.
898.9 *4*	2.1 *7*	5543.0	19/2⁻	4644.3	17/2⁻		
908.3 *5*	2.6 *1*	5552.4	19/2⁺	4644.3	17/2⁻	D	$R_{154°,96°}$=0.62 *10*.
936.7 *5*	39 *2*	3336.2	13/2⁺	2399.7	9/2⁺	E2	$R_{154°,96°}$=1.70 *7*. R_{DCO}=1.11*7*. POL=+0.087 *12* (2004Iz01). Additional information 11.
984.3 *5*	3.5 *5*	1403.3	7/2⁻	419.19	3/2⁻		
990.9[‡] *5*	1.4[‡] *3*	5254.5		4264.0	15/2⁺		$R_{154°,96°}$=1.32 *13* for 990.9γ+impurity γ.
994.1[‡] *5*	3.4[‡] *6*	10155.0	31/2⁻	9160.9	27/2⁻	E2	$R_{154°,96°}$=1.48 *7*, combined for 996.7γ+997.0γ+994.1γ. R_{DCO}=0.99 *6*. POL=+0.13 *4* (2004Iz01).
996.7[‡] *5*	27[‡] *6*	997.68	7/2⁻	0.0	3/2⁻	E2	$R_{154°,96°}$=1.48 *7*, combined for 996.7γ+997.0γ+994.1γ. R_{DCO}=0.99 *6*. POL=+0.07 *6* (2004Iz01). Additional information 5.
997.0[‡] *5*	5[‡] *3*	2399.7	9/2⁺	1403.3	7/2⁻		$R_{154°,96°}$=1.48 *7*, combined for 996.7γ+997.0γ+994.1γ.
1005[‡] *1*	10[‡] *1*	2269.7	11/2⁻	1266.0	9/2⁻	D	$R_{154°,96°}$=0.37 *2*, combined for 1006γ+1005γ. Additional information 7. R_{DCO}=0.51 *17* (1999Vi12).
1006[‡] *1*	8.5[‡] *10*	2003.4	9/2⁻	997.68	7/2⁻	D	$R_{154°,96°}$=0.37 *2*, combined for 1006γ+1005γ.
1019 *1*	3.6 *1*	4264.0	15/2⁺	3244.5	11/2⁺	Q	$R_{154°,96°}$=1.73 *13*.
1046 *1*	4.2 *1*	3843.8	15/2⁻	2798.7	13/2⁻		
1066 *1*	6.9 *2*	3336.2	13/2⁺	2269.7	11/2⁻	E1	$R_{154°,96°}$=0.98 *6*. R_{DCO}=0.45 *6*. POL=+0.14 *5* (2004Iz01). Additional information 12.
1079 *1*	35 *1*	4415.0	17/2⁺	3336.2	13/2⁺	E2	$R_{154°,96°}$=1.76 *7*. R_{DCO}=0.99 *6*. POL=+0.072 *14* (2004Iz01). Additional information 14.
1141 *1*	83 *3*	1266.0	9/2⁻	123.90	5/2⁻	E2	$R_{154°,96°}$=1.62 *7*. R_{DCO}=1.15 *9*. POL=+0.096 *25* (2004Iz01). Additional information 6.

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$^{40}Ca(^{24}Mg,2pn\gamma)$ 2006An31 (continued)

$\gamma(^{61}Zn)$ (continued)

E_γ[†]	I_γ[†]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	Comments
1201[#] *1*	2.2 *1*	8496.5?		7295.4	23/2+		
1246 *1*	8.1 *3*	2003.4	9/2−	756.44	5/2−	Q	$R_{154^\circ,96^\circ}$=1.40 *8*.
1273 *1*	27 *1*	2269.7	11/2−	997.68	7/2−	E2	$R_{154^\circ,96^\circ}$=1.77 *8*. POL=+0.10 *4* (2004Iz01). Additional information 8. R_{DCO}=1.2 *3* (1999Vi12).
1278 *1*	2.0 *1*	1403.3	7/2−	123.90	5/2−	D	$R_{154^\circ,96^\circ}$=1.01 *12*.
1289 *1*	11 *1*	5552.4	19/2+	4264.0	15/2+	E2	$R_{154^\circ,96^\circ}$=1.67 *9*. R_{DCO}=0.88 *7*. POL=+0.10 *3* (2004Iz01). Additional information 16.
1396 *1*	9.9 *4*	7486.6	25/2+	6090.7	21/2+	E2	$R_{154^\circ,96^\circ}$=1.93 *10*. R_{DCO}=0.94 *7*. POL=+0.09 *7* (2004Iz01). Additional information 18.
1403[‡] *1*	5.3[‡] *31*	1403.3	7/2−	0.0	3/2−		
1403[‡] *1*	41[‡] *5*	2399.7	9/2+	997.68	7/2−	E1	$R_{154^\circ,96^\circ}$=0.84 *4* for 1403 doublet. R_{DCO}=0.54 *4*. POL=+0.063 *13* for doublet (2004Iz01). Additional information 9.
1433 *1*	6.7 *2*	2699.5	11/2−	1266.0	9/2−	D	$R_{154^\circ,96^\circ}$=1.01 *6*.
1458 *1*	6.6 *3*	3461.6	13/2−	2003.4	9/2−	Q	$R_{154^\circ,96^\circ}$=1.51 *9*.
1466 *1*	19 *1*	4264.0	15/2+	2798.7	13/2−	E1	$R_{154^\circ,96^\circ}$=0.73 *4*. R_{DCO}=0.44 *4*. POL=+0.07 *3* (2004Iz01). Additional information 13.
1531[‡] *1*	46[‡] *3*	2798.7	13/2−	1266.0	9/2−	Q	$R_{154^\circ,96^\circ}$=1.70 *7*, combined for 1531γ+1532γ. R_{DCO}=0.91*7*. POL=+0.03 *8* (2004Iz01). Additional information 10.
1532[‡] *1*	6.3[‡] *7*	9160.9	27/2−	7628.8	23/2−	E2	$R_{154^\circ,96^\circ}$=1.70 *7*, combined for 1531γ+1532γ. R_{DCO}=0.95 *7*. POL=+0.039 *22* (2004Iz01). Additional information 20.
1538 *1*	7.5 *7*	7628.8	23/2−	6090.7	21/2+	E1	$R_{154^\circ,96^\circ}$=0.60 *6*. R_{DCO}=0.48 *3*. POL=+0.090 *17* (2004Iz01). Additional information 19.
1572 *1*	16 *1*	3843.8	15/2−	2269.7	11/2−	Q	$R_{154^\circ,96^\circ}$=1.62 *8*.
1595 *1*	1.9 *1*	8879.0	25/2−	7284.0	21/2−	Q	$R_{154^\circ,96^\circ}$=1.79 *21*.
1624 *1*	3.6 *1*	5467.8		3843.8	15/2−		
1675[‡] *3*	22[‡] *2*	6090.7	21/2+	4415.0	17/2+	E2	$R_{154^\circ,96^\circ}$=1.69 *8* for 1675 doublet. R_{DCO}=0.91 *6*. POL=+0.059 *20* (2004Iz01). Additional information 17.
1675[‡] *4*	4.0[‡] *20*	9160.9	27/2−	7486.6	25/2+		$R_{154^\circ,96^\circ}$=1.69 *8* for 1675 doublet.
1698 *1*	5.8 *3*	5543.0	19/2−	3843.8	15/2−	Q	$R_{154^\circ,96^\circ}$=1.57 *10*.
1733[‡] *1*	3.5[‡] *11*	5195.3	17/2−	3461.6	13/2−	(Q)	$R_{154^\circ,96^\circ}$=1.49 *10* for 1733 doublet.
1733[‡] *1*	1.2[‡] *3*	7284.0	21/2−	5552.4	19/2+		$R_{154^\circ,96^\circ}$=1.49 *10* for 1733 doublet.
1743 *1*	5.4 *3*	7295.4	23/2+	5552.4	19/2+	Q	$R_{154^\circ,96^\circ}$=1.47 *10*.
1799 *1*	2.3 *6*	6212.0		4415.0	17/2+		
1847 *1*	11 *1*	4644.3	17/2−	2798.7	13/2−	E2	$R_{154^\circ,96^\circ}$=1.66 *9*. R_{DCO}=1.00 *12*. POL=+0.12 *5* (2004Iz01). Additional information 15.
1946[#] *1*	1.4 *1*	6212.0		4264.0	15/2+		
1978 *1*	7.7 *3*	3244.5	11/2+	1266.0	9/2−	D	$R_{154^\circ,96^\circ}$=0.78 *6*. R_{DCO}=0.8 *5* (1999Vi12).
2039 *1*	1.9 *1*	4308.8	13/2	2269.7	11/2−	D	$R_{154^\circ,96^\circ}$=0.87 *14*.
2088 *1*	1.7 *1*	7284.0	21/2−	5195.3	17/2−	Q	$R_{154^\circ,96^\circ}$=1.32 *17*.
2116 *1*	3.4 *1*	4914.7		2798.7	13/2−	D	$R_{154^\circ,96^\circ}$=0.81 *9*.
2195 *1*	5.5 *3*	3461.6	13/2−	1266.0	9/2−	Q	$R_{154^\circ,96^\circ}$=1.60 *11*.
2229 *1*	3.4 *1*	3495.0		1266.0	9/2−	Q	$R_{154^\circ,96^\circ}$=1.40 *12*.

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^{40}Ca(^{24}Mg,2pnγ) 2006An31 (continued)

γ(^{61}Zn) (continued)

E_γ †	I_γ †	E_i(level)	J^π_i	E_f	J^π_f	Mult.	Comments
2246 *1*	0.9 *1*	8336.7		6090.7	21/2$^+$		
2273 *1*	2.3 *1*	2399.7	9/2$^+$	123.90	5/2$^-$	Q	$R_{154°,96°}$=1.17 *16*. R_{DCO}=1.6 *7* (1999Vi12).
2639 *1*	2.1 *9*	7284.0	21/2$^-$	4644.3	17/2$^-$		

† From 2006An31.
‡ Multiply placed; intensity suitably divided. Doublet structure.
# Placement of transition in the level scheme is uncertain.

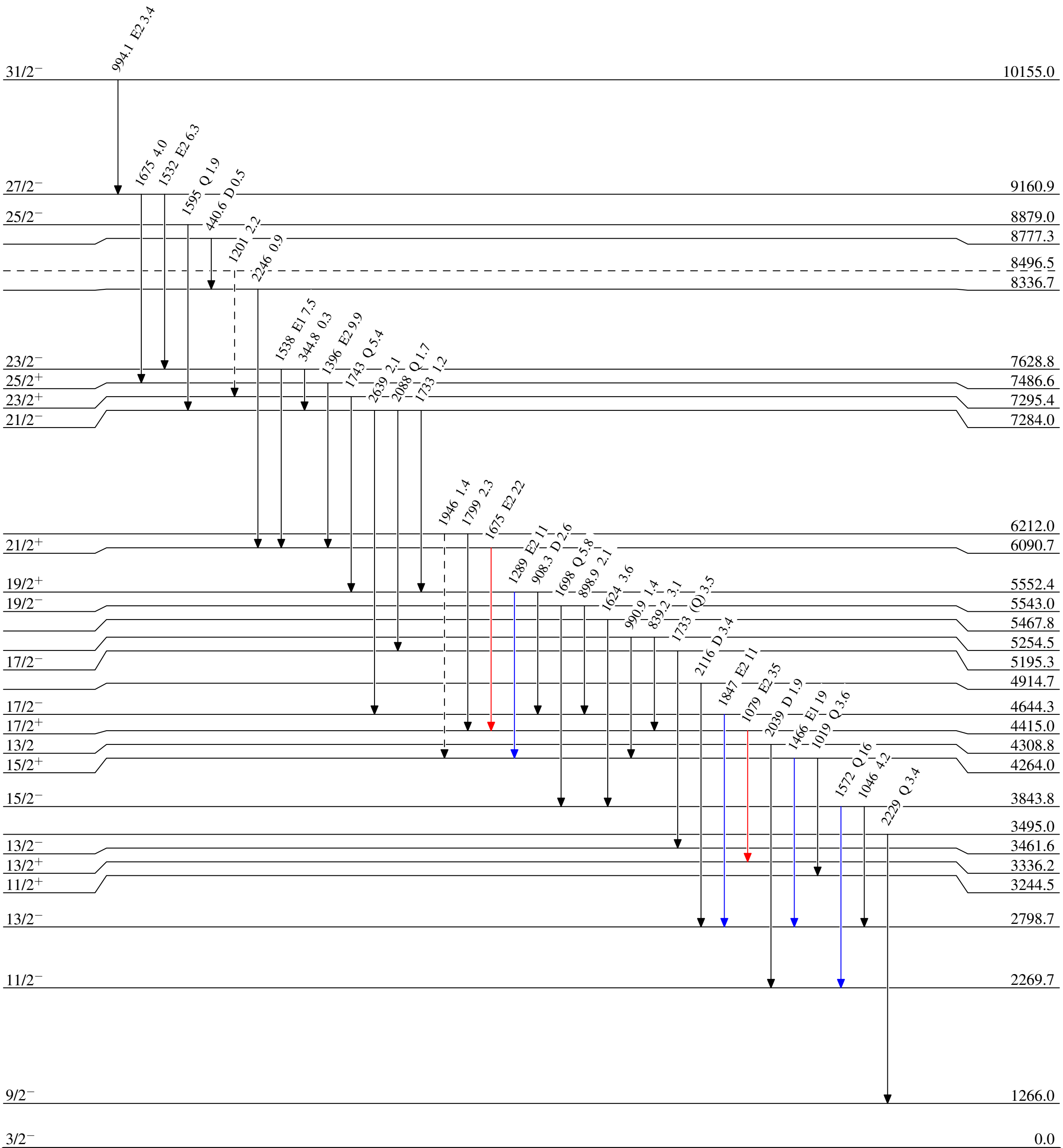
$^{40}Ca(^{24}Mg,2pn\gamma)$ 2006An31

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)

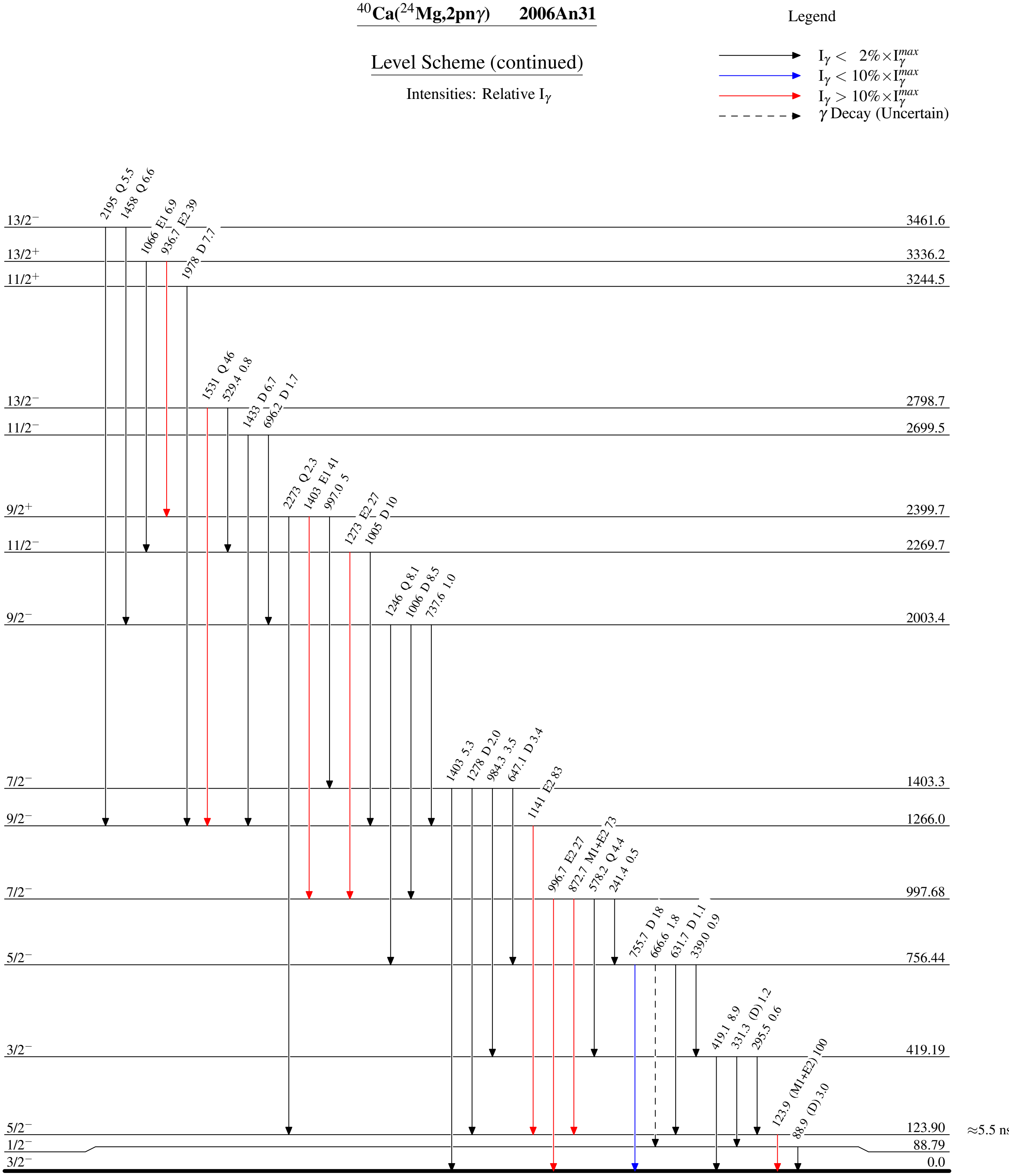


$^{61}_{30}Zn_{31}$

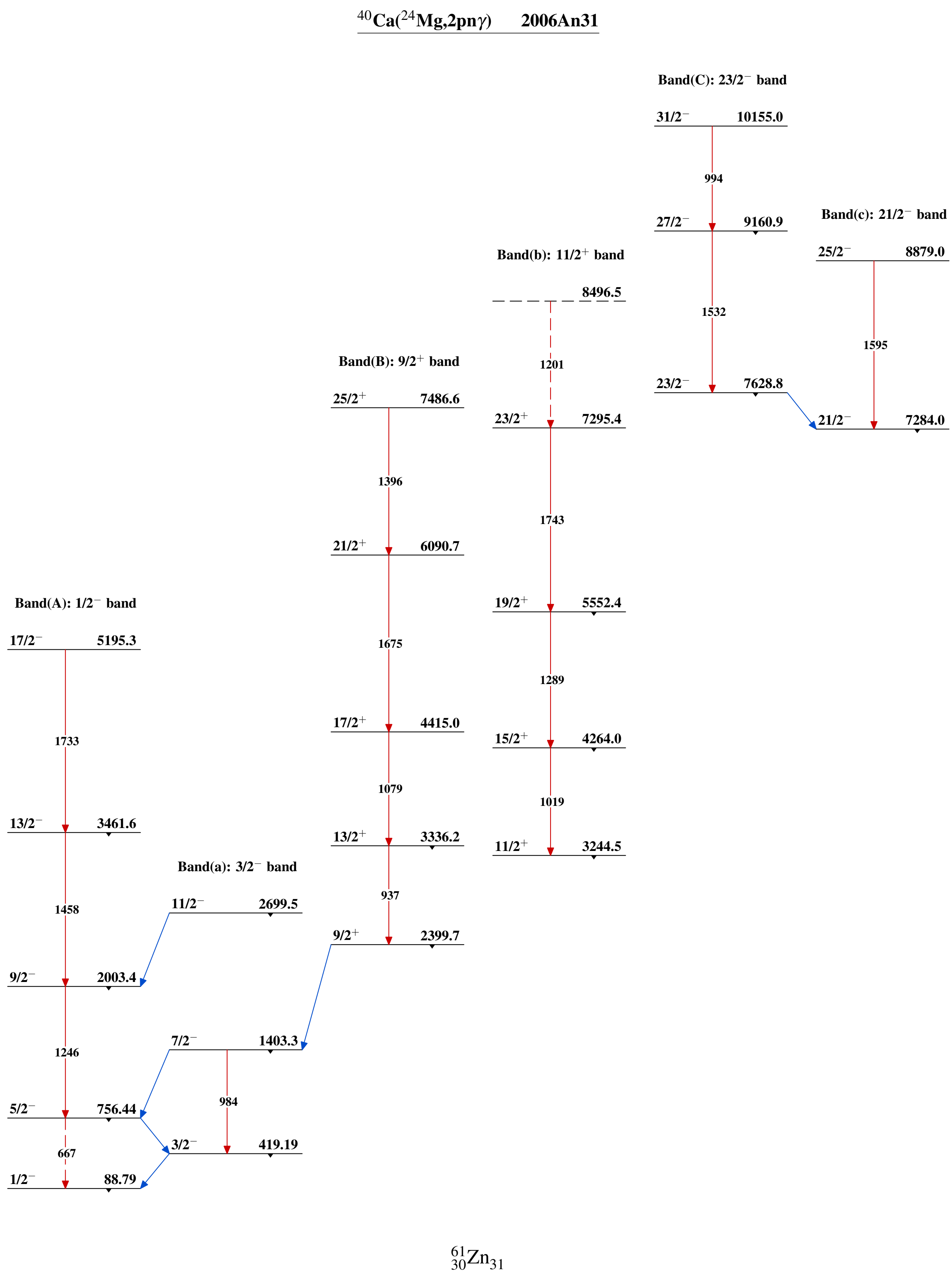
$^{40}Ca(^{24}Mg,2pn\gamma)$ 2006An31

Level Scheme (continued)

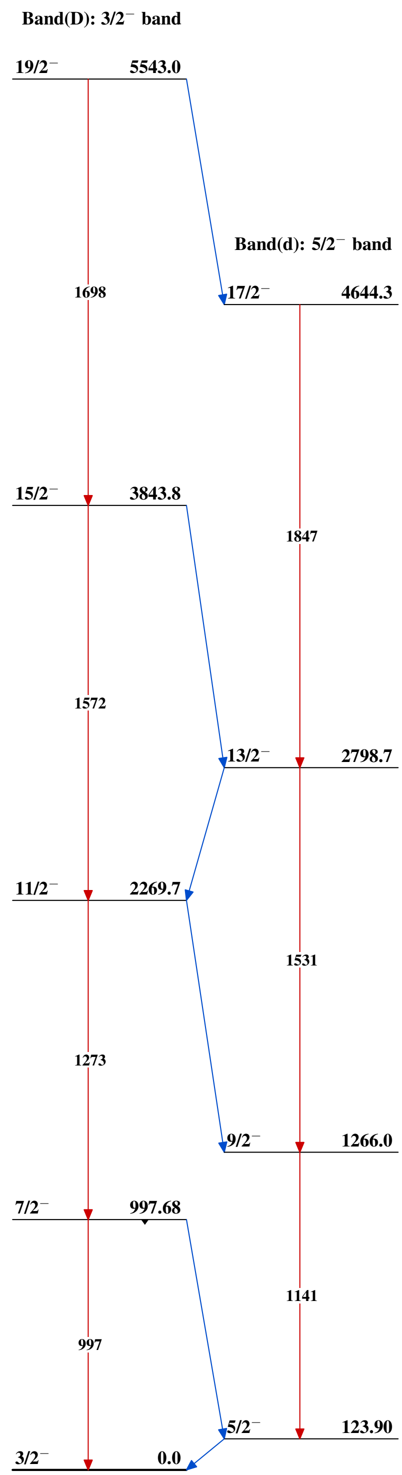
Intensities: Relative I_γ



$^{61}_{30}Zn_{31}$


^{40}Ca(^{24}Mg,2pnγ) 2006An31
Band(A): 1/2⁻ band
Band(a): 3/2⁻ band
Band(B): 9/2⁺ band
Band(b): 11/2⁺ band
Band(C): 23/2⁻ band
Band(c): 21/2⁻ band
31/2⁻ 10155.0
27/2⁻ 9160.9
994
1532
23/2⁻ 7628.8
25/2⁻ 8879.0
1595
21/2⁻ 7284.0
8496.5
1201
23/2⁺ 7295.4
1743
19/2⁺ 5552.4
1289
15/2⁺ 4264.0
1019
11/2⁺ 3244.5
25/2⁺ 7486.6
1396
21/2⁺ 6090.7
1675
17/2⁺ 4415.0
1079
13/2⁺ 3336.2
937
9/2⁺ 2399.7
17/2⁻ 5195.3
1733
13/2⁻ 3461.6
1458
9/2⁻ 2003.4
1246
5/2⁻ 756.44
667
1/2⁻ 88.79
11/2⁻ 2699.5
7/2⁻ 1403.3
984
3/2⁻ 419.19
$^{61}_{30}Zn_{31}$

^{40}Ca(^{24}Mg,2pnγ) 2006An31 (continued)



$^{61}_{30}Zn_{31}$