^{80}Se(^{13}C,4nγ) 2012Sa36

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	NDS 114, 1 (2013)	20-Oct-2012

2012Sa36: E=50 MeV ^{13}C beam provided by the Pelletron Linac facility at TIFR, Mumbai. Target=800 μg/cm^2 ^{80}Se evaporated on Au backing 9 mg/cm^2 thick. Measured Eγ, Iγ, $\gamma\gamma$, $\gamma(\theta)$, $\gamma\gamma(\theta)$(DCO), $\gamma\gamma$(lin pol) using the INGA detector array consisting of eighteen Compton suppressed clover detectors. Deduced levels, J, π, multipolarities, bands, configurations. Comparison with shell-model calculations involving proton and neutron configurations with $p_{3/2}$, $f_{5/2}$, $p_{1/2}$, $g_{9/2}$ orbitals. Wavefunction amplitudes are given for several levels in table II of 2012Sa36.

^{89}Zr Levels

E(level)[†]	J$^\pi$[‡]	Comments
0.0[#]	9/2$^+$	
1944.3[#] *3*	13/2$^+$	
2121.0 *3*	13/2$^-$	
2151.0 *5*	15/2$^{(-)}$	
2159.7[a] *5*	17/2$^-$	
2454.0 *8*	(15/2$^-$)	
2724.9[#] *4*	17/2$^+$	
2928.1[a] *5*	19/2$^-$	
2996.2[#] *5*	21/2$^+$	
3112.0 *5*	19/2$^+$	
3578.0 *5*	23/2$^+$	
3718.2[a] *5*	21/2$^-$	
4278.6 *6*	25/2$^+$	
4525.2[a] *6*	23/2$^-$	
4738.7[#] *5*	25/2$^+$	
5287?		E(level): level not in Table 1.
5382.1 *6*	27/2$^+$	
5496.2[a] *5*	25/2$^-$	
5736.1? *7*	25/2$^{(+)}$	
5753.0 *6*	27/2$^+$	
6029.3 *5*	27/2$^+$	
6074.1[&] *6*	27/2$^-$	
6110.1 *7*	(29/2$^+$)	
6244.1[&] *6*	29/2$^-$	
6354.0 *9*	(29/2$^+$)	J$^\pi$: parity not assigned in Adopted Levels.
6833.1[&] *6*	31/2$^-$	
6954.0 *12*	(31/2$^+$)	J$^\pi$: parity not assigned in Adopted Levels.
6964.2[@] *6*	29/2$^+$	
7420.2[@] *7*	31/2$^+$	
7508.1[&] *7*	33/2$^-$	
8016.1[&] *10*	35/2$^-$	E(level): 8016 keV in Figure 1 (level scheme).
8108.2[@] *8*	33/2$^+$	
8865.2[@] *10*	(35/2$^+$)	
9602.2[@] *13*	(37/2$^+$)	

[†] From least-squares fit to Eγ data.

[‡] As assigned in 2012Sa36 based on DCO ratios, linear polarization and some previously adopted J^π values. Most assignments are the same in Adopted Levels, except that several are placed in parentheses as solid arguments are still lacking.

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^{80}Se(^{13}C,4nγ) 2012Sa36 (continued)

^{89}Zr Levels (continued)

Band(A): g.s. band.
@ Band(B): Band based on $29/2^+$.
& Band(C): Band based on $27/2^-$.
a Band(D): Band based on $17/2^-$.

$\gamma(^{89}Zr)$

R_{DCO}=[I(γ_1) observed at 157° gated on γ_2 at 90°]/ [I(γ_1) observed at 90° gated on γ_2 at 157°]. Expected values are: 0.5 for ΔJ=1, dipole and 1.0 for ΔJ=2, with gate on ΔJ=2 quadrupole; 1.0 for ΔJ=1, dipole and 2.0 for ΔJ=2, with gate on ΔJ=1 dipole. Gates are on ΔJ=2, quadrupole transitions, unless otherwise stated. Only for the 338.0γ from 6074 level, gate is on ΔJ=1, dipole transition.

E_γ †	I_γ ‡	E_i(level)	J_i^π	E_f	J_f^π	Mult.	α #	$I_{(\gamma+ce)}$	Comments
(8.7)		2159.7	$17/2^-$	2151.0	$15/2^{(-)}$	[M1]	35.4 *18*	13.4 *9*	E_γ: from level-energy difference. $I_{(\gamma+ce)}$: from intensity balance at 2160 level.
(30.0)		2151.0	$15/2^{(-)}$	2121.0	$13/2^-$				Additional information 2.
67.9 *7*	0.55 *10*	2996.2	$21/2^+$	2928.1	$19/2^-$				Additional information 8.
115.8 *7*	0.7 *1*	3112.0	$19/2^+$	2996.2	$21/2^+$				Additional information 9.
170.0 *3*	2.10 *1*	6244.1	$29/2^-$	6074.1	$27/2^-$	D			DCO=0.44 *1* Additional information 22.
176.7 *3*	17.78 *5*	2121.0	$13/2^-$	1944.3	$13/2^+$	D			DCO=0.62 *2* Additional information 1.
206.7 *7*	1.13 *1*	2151.0	$15/2^{(-)}$	1944.3	$13/2^+$	D			DCO=0.66 *8* Additional information 3.
214.8 *3*	10.11 *4*	6244.1	$29/2^-$	6029.3	$27/2^+$	(E1)			DCO=0.53 *1* POL=+0.02 *1*.
271.2 *3*	69.0 *3*	2996.2	$21/2^+$	2724.9	$17/2^+$	(E2)			DCO=0.87 *2* POL=+0.01 *2*.
333.0 *7*	0.70 *11*	2454.0	$(15/2^-)$	2121.0	$13/2^-$				Additional information 4.
338.0 *7*	1.14 *1*	6074.1	$27/2^-$	5736.1?	$25/2^{(+)}$	D			DCO=1.04 *9* Mult.: assigned by evaluator from DCO value for gate on ΔJ=1, dipole transition.
370.9@ *7*	<0.5	5753.0	$27/2^+$	5382.1	$27/2^+$				Additional information 15.
387.1 *3*	3.40 *2*	3112.0	$19/2^+$	2724.9	$17/2^+$	D			DCO=0.41 *1* Additional information 10.
456.0 *3*	2.53 *2*	7420.2	$31/2^+$	6964.2	$29/2^+$	(M1)			DCO=0.49 *6* POL=−0.03 *3*.
460.1@ *7*	<0.40	4738.7	$25/2^+$	4278.6	$25/2^+$				Additional information 12.
508.0 *7*	1.81 *5*	8016.1	$35/2^-$	7508.1	$33/2^-$	M1			DCO=0.29 *1* POL=−0.04 *1*.
533.2 *3*	3.81 *5*	6029.3	$27/2^+$	5496.2	$25/2^-$	E1			DCO=0.51 *2* POL=+0.10 *2*.

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^{80}Se(^{13}C,4nγ) 2012Sa36 (continued)

$\gamma(^{89}Zr)$ (continued)

E_γ [†]	I_γ [‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	Comments
548 [@]		5287?		4738.7	$25/2^+$		
565.0 *7*	0.15 *8*	2724.9	$17/2^+$	2159.7	$17/2^-$	D	DCO=0.80 *5* Additional information 5.
573.9 *7*	0.5 *2*	2724.9	$17/2^+$	2151.0	$15/2^{(-)}$		Additional information 6.
581.7 *3*	22.37 *4*	3578.0	$23/2^+$	2996.2	$21/2^+$	M1	DCO=0.53 *1* POL=−0.050 *4*.
589.0 *3*	6.06 *32*	6833.1	$31/2^-$	6244.1	$29/2^-$	M1	DCO=0.40 *2* POL=−0.08 *1*.
600.0 *7*	1.34 *2*	6954.0	$(31/2^+)$	6354.0	$(29/2^+)$		Additional information 26.
601.0 *7*	1.34 *2*	6354.0	$(29/2^+)$	5753.0	$27/2^+$		Additional information 24.
643.4 *3*	4.86 *3*	5382.1	$27/2^+$	4738.7	$25/2^+$	M1	DCO=0.41 *1* POL=−0.10 *2*.
647.2 [@] *7*	<0.5	6029.3	$27/2^+$	5382.1	$27/2^+$		Additional information 16.
675.0 *3*	4.96 *3*	7508.1	$33/2^-$	6833.1	$31/2^-$	M1	DCO=0.54 *8* POL=−0.05 *2*.
688.0 *3*	2.49 *16*	8108.2	$33/2^+$	7420.2	$31/2^+$	(M1)	DCO=0.44 *2* POL=−0.03 *4*.
700.6 *3*	7.34 *3*	4278.6	$25/2^+$	3578.0	$23/2^+$	D	DCO=0.44 *1* Additional information 11.
728.0 *7*	0.5 *1*	6110.1	$(29/2^+)$	5382.1	$27/2^+$		Additional information 20.
737.0 *7*	1.36 *8*	9602.2	$(37/2^+)$	8865.2	$(35/2^+)$		Additional information 29.
748.0 *7*	1.81 *2*	6244.1	$29/2^-$	5496.2	$25/2^-$	E2	DCO=1.04 *8* POL=+0.08 *3*.
757.0 *7*	1.57 *7*	8865.2	$(35/2^+)$	8108.2	$33/2^+$		Additional information 28.
759.0 *7*	0.54 *4*	6833.1	$31/2^-$	6074.1	$27/2^-$		Additional information 25.
768.1 *3*	6.14 *11*	2928.1	$19/2^-$	2159.7	$17/2^-$	(M1)	DCO=0.34 *1* POL=−0.02 *2*.
777.2 *7*	0.10 *5*	2928.1	$19/2^-$	2151.0	$15/2^{(-)}$		Additional information 7. I_γ: 0.1 *5* in 2012Sa36 seems a misprint. Evaluator assigns 0.10 *5*.
780.6 *3*	79.4 *1*	2724.9	$17/2^+$	1944.3	$13/2^+$	E2	DCO=1.06 *1*; A_2=+0.31 *8*; A_4=−0.02 *14* POL=+0.07 *1*.
789.8 *3*	5.30 *1*	3718.2	$21/2^-$	2928.1	$19/2^-$	M1	DCO=0.50 *2* POL=−0.12 *2*.
807.0 *3*	4.31 *3*	4525.2	$23/2^-$	3718.2	$21/2^-$	M1	DCO=0.51 *2* POL=−0.20 *2*.
862.0 *7*	1.62 *1*	6244.1	$29/2^-$	5382.1	$27/2^+$	D	DCO=0.42 *2* Additional information 23.
971.0 *3*	2.17 *1*	5496.2	$25/2^-$	4525.2	$23/2^-$	(M1)	DCO=0.48 *3* POL=−0.03 *5*.
1014.3 *3*	3.67 *2*	5753.0	$27/2^+$	4738.7	$25/2^+$	M1	DCO=0.35 *1* POL=−0.08 *1*.
1160.7 *3*	3.59 *2*	4738.7	$25/2^+$	3578.0	$23/2^+$	(M1)	DCO=0.77 *2* POL=−0.01 *1*.
1211.2 *3*	3.59 *12*	6964.2	$29/2^+$	5753.0	$27/2^+$	M1	DCO=0.60 *3* POL=−0.09 *2*.
1290.6 *3*	8.14 *1*	6029.3	$27/2^+$	4738.7	$25/2^+$	(M1)	DCO=0.47 *1* POL=−0.01 *1*.
1335.4 *7*	1.89 *7*	6074.1	$27/2^-$	4738.7	$25/2^+$	E1	DCO=0.43 *3* POL=+0.16 *4*.
1504.2 *7*	0.5 *1*	6029.3	$27/2^+$	4525.2	$23/2^-$	[M2]	Additional information 17.
1559.0 *3*	7.30 *16*	3718.2	$21/2^-$	2159.7	$17/2^-$	E2	DCO=1.05 *4* POL=+0.08 *2*.
1742.4 *3*	33.4 *2*	4738.7	$25/2^+$	2996.2	$21/2^+$	E2	DCO=0.95 *4* POL=+0.11 *1*.
1750.7 *7*	0.53 *2*	6029.3	$27/2^+$	4278.6	$25/2^+$		Additional information 18.

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^{80}Se(^{13}C,4nγ) 2012Sa36 (continued)

$\gamma(^{89}Zr)$ (continued)

E_γ [†]	I_γ [‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	Comments
1778.0 *3*	5.74 *5*	5496.2	$25/2^-$	3718.2	$21/2^-$	(E2)	DCO=1.10 *6* POL=+0.03 *2*.
1795.5 *7*	0.32 *1*	6074.1	$27/2^-$	4278.6	$25/2^+$		Additional information 19.
1804.1 *7*	0.92 *3*	5382.1	$27/2^+$	3578.0	$23/2^+$		Additional information 13.
1831.5 *7*	0.30 *1*	6110.1	$(29/2^+)$	4278.6	$25/2^+$		Additional information 21.
1918.1 *7*	1.16 *2*	5496.2	$25/2^-$	3578.0	$23/2^+$	(E1)	DCO=0.36 *4* POL=+0.03 *2*.
1944.3 *3*	100.0	1944.3	$13/2^+$	0.0	$9/2^+$	E2	DCO=0.96 *1*; A_2=+0.26 *7*; A_4=−0.06 *10* POL=+0.13 *3*.
2121.0 *3*	8.04 *1*	2121.0	$13/2^-$	0.0	$9/2^+$	M2	POL=−0.11 *5*.
2158.1 *7*	1.09 *3*	5736.1?	$25/2^{(+)}$	3578.0	$23/2^+$		Additional information 14.
2175.0 *7*	1.60 *2*	5753.0	$27/2^+$	3578.0	$23/2^+$	E2	
2225.5 *7*	0.87 *2*	6964.2	$29/2^+$	4738.7	$25/2^+$		Additional information 27.

[†] Uncertainty is stated by 2012Sa36 as 0.3 keV for intense peaks and 0.7 keV for weak peaks. Evaluator assigns 0.3 keV for I$\gamma\geq$2 and 0.7 keV for Iγ<2.

[‡] As per e-mail reply of Sept 11, 2012 from R. Palit, quoted uncertainties are statistical only; systematic uncertainties are ≈5% for Eγ>500 keV and ≈8% for Eγ<500 keV. Compounded uncertainties are used in branching ratios given in Adopted Levels, Gammas dataset.

[#] 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.

[@] Placement of transition in the level scheme is uncertain.

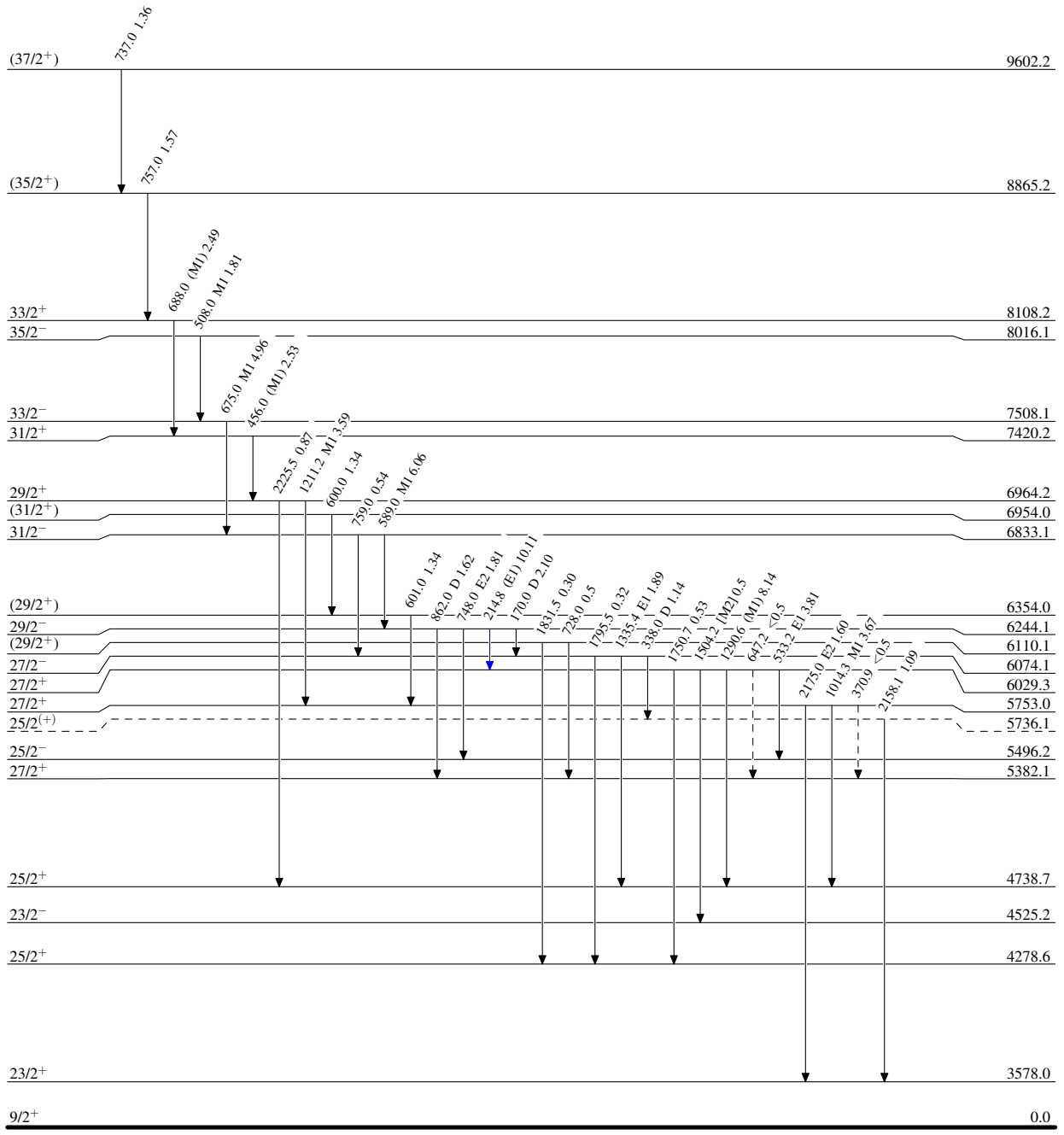
^{80}Se(^{13}C,4nγ) 2012Sa36

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)



$^{89}_{40}Zr_{49}$

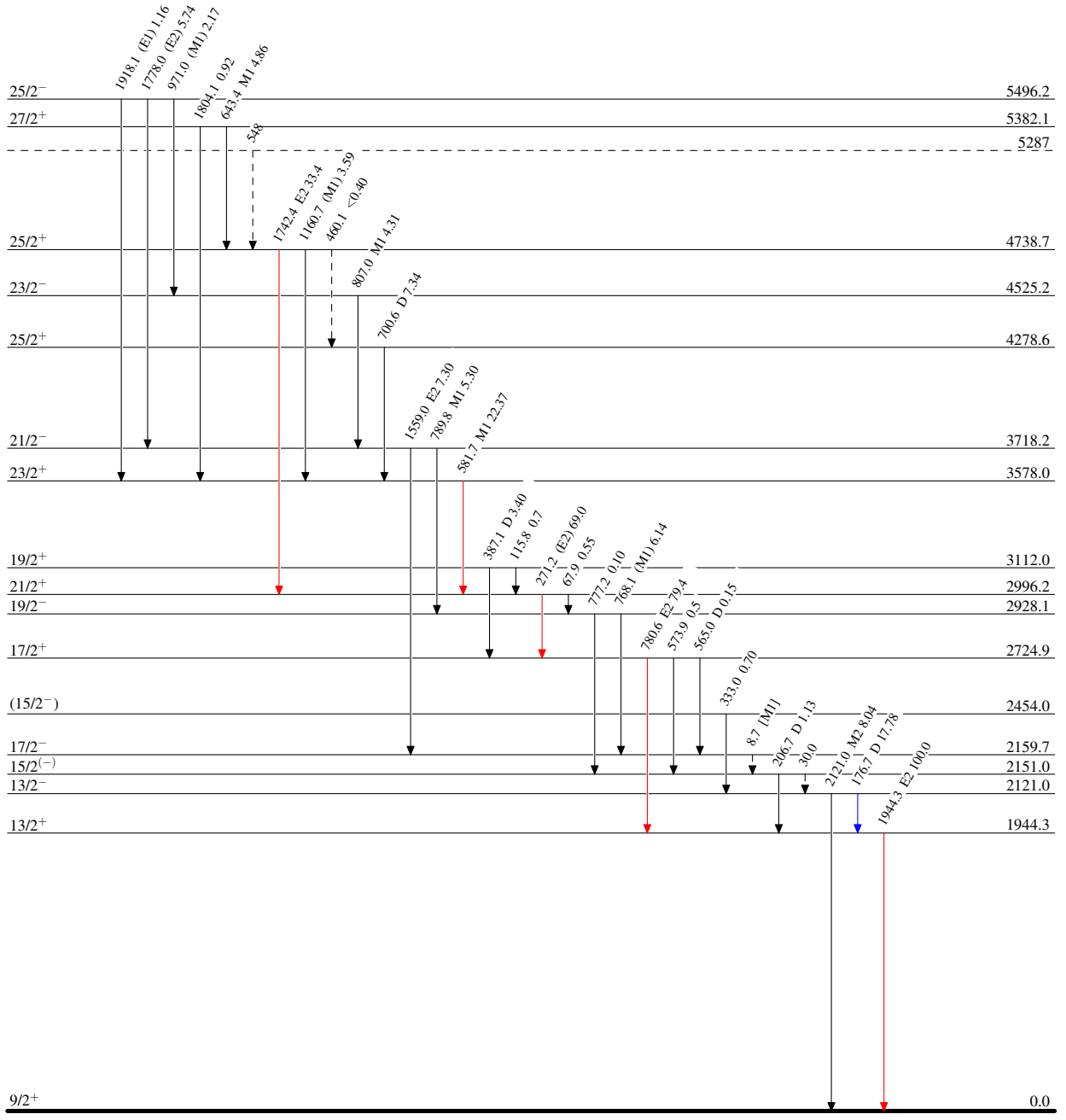
^{80}Se(^{13}C,4nγ) 2012Sa36

Level Scheme (continued)

Intensities: Relative I_γ

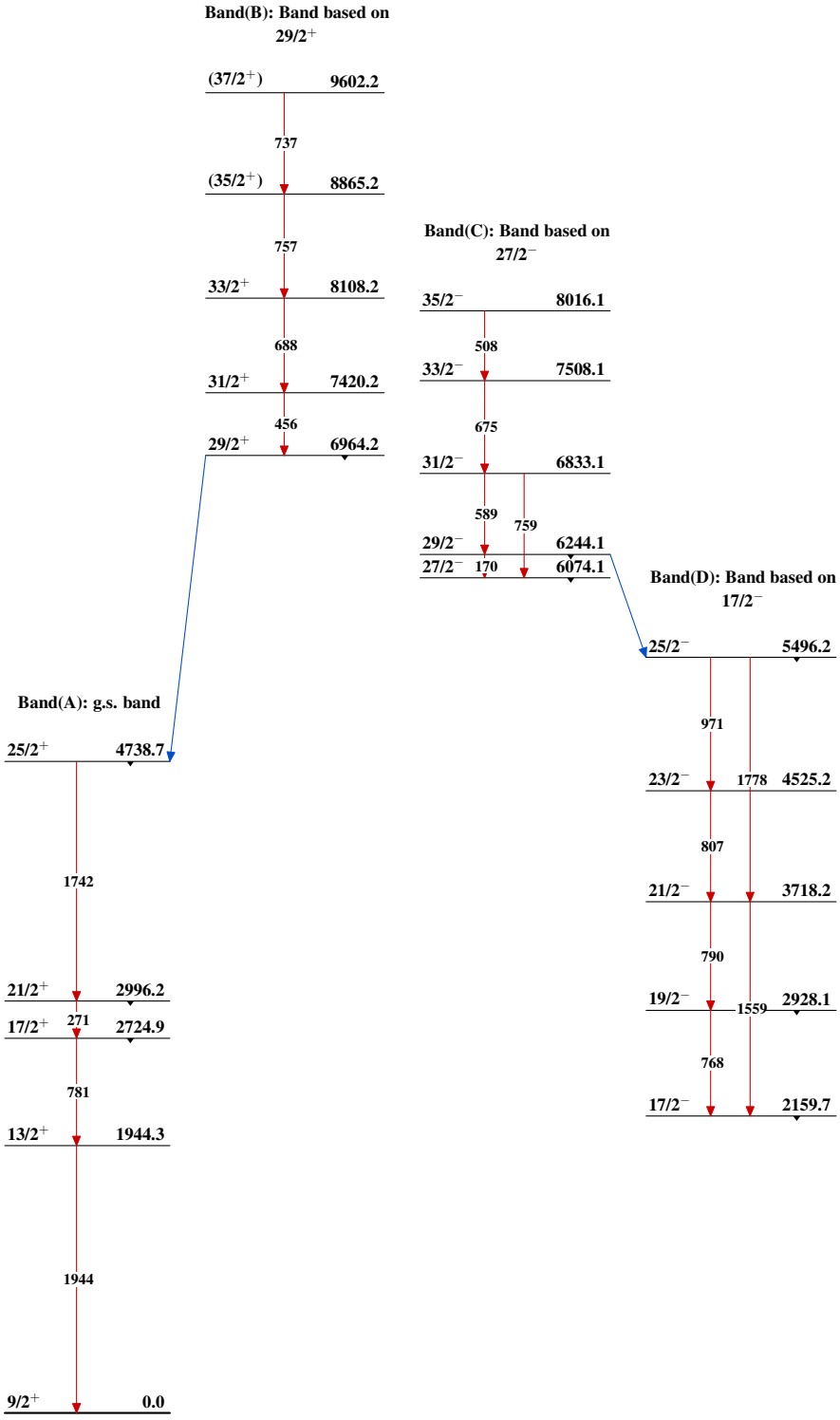
Legend

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



$^{89}_{40}Zr_{49}$

^{80}Se(^{13}C,4nγ) 2012Sa36



$^{89}_{40}Zr_{49}$