^{60}Ni(^{29}Si,2pnγ),^{76}Se(^{12}C,2nγ) 1985Wa10,1977Ko05

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Alexandru Negret, Balraj Singh	NDS 124, 1 (2015)	30-Nov-2014

1985Wa10: ^{60}Ni(^{29}Si,2pnγ): E=70 MeV to 120 MeV. Ge(Li)-NaI anti-Compton spectrometer. Measured Eγ, Iγ, γγ, excitation functions, γ(θ), recoil-distance Doppler shift and Doppler-shift attenuation.
1977Ko05: ^{76}Ge(^{12}C,2nγ): E=36, 38, 44, 52 MeV, measured γγ, γ(θ).
1978Av02: ^{73}Ge(^{16}O,3nγ): E=52 MeV. Enriched target. Measured recoil-distance Doppler shift.
Level scheme is mainly from ^{60}Ni(^{29}Si,2pnγ) (1985Wa10).

^{86}Zr Levels

E(level)[†]	Jπ[‡]	T1/2[#]
0	0+	
751.74 *3*	2+	7.3[@] ps *14*
1666.56 *6*	4+	6.0[@] ps *27*
2669.86 *8*	6+	8[@] ps *4*
2705.61 *7*	(5−)	6.7[@] ps *12*
3016.86 *8*		<15 ps
3029.62 *8*	(5+,6+)	
3271.96 *8*	(6−)	
3298.41 *9*	8+	62[&] ps *6*
3423.31 *8*	(7−)	8.3 ps *14*
3532.62 *9*	8+	<3 ps
3646.35 *9*	(7−)	<7 ps
3792.56 *9*	(7)	
4133.66 *12*	(8−)	
4326.10 *9*	10+	2.1 ps *4*
4418.53 *9*	10+	9 ps *3*
4429.34 *10*	(9−)	7.6 ps *14*
5233.54 *14*	(11−)	12 ps *6*
5388.68 *11*	(11−)	2.8 ps *7*
5396.37 *9*	(12+)	2.6 ps *6*
5646.4 *4*		
5974.72 *15*	(12−)	<1.5 ps
6232.26 *16*	(13−)	4.2 ps *7*
6321.06 *10*	(14+)	5.2 ps *6*
6339.8 *4*	(13−)	
7015.31 *14*	(15+)	<0.7[a] ps
7396.46 *25*	(16+)	<1.0[a] ps

† From least-squares fit to Eγ values.
‡ From Adopted Levels.
# From recoil-distance Doppler shift (1985Wa10), unless indicated otherwise.
@ From recoil-distance Doppler-shift (1978Av02).
& Average of 62 ps *7* (1985Wa10) and 62 ps *6* (1978Av02).
a From Doppler-shift attenuation (1985Wa10).

γ(^{86}Zr)

A_2 and A_4 coefficients are from 1985Wa10.
The following transitions, reported elsewhere, were not seen by 1985Wa10 with the upper limits quoted in parentheses: 371.8γ (Iγ<0.4) and 663.7γ (Iγ<0.1) from 2705.6 level; 987.6γ (Iγ<0.25) from 3029.5 level.

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Intensities in other reactions
Eγ        Iγ in (12C,2nγ)      Iγ in (16O,3nγ)
            1977Ko05             1978Av02
223          14 4
234          31 4                 13 3
629          40 4                 36 5
566           7 3
718          15 4                  6 2
752         100                  100
886          10 4
915          81 5                 80 3
1003         54 11                60 2
1028         15 4                 <5
1039         45 4                  5 3
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E_γ[†]	I_γ[†]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[‡]	δ	α[@]	Comments
223.04 *3*	3.50 *10*	3646.35	(7⁻)	3423.31	(7⁻)				Mult.: A_2=+0.256 *20*, A_4=−0.024 *30* consistent with ΔJ=0, dipole. Additional information 8.
234.205 *15*	26.4 *5*	3532.62	8⁺	3298.41	8⁺	(M1(+E2))	<0.17	0.0211 *6*	α(K)=0.0186 *5*; α(L)=0.00212 *6*; α(M)=0.000369 *11*; α(N+..)=5.59×10^{-5} *15* α(N)=5.23×10^{-5} *15*; α(O)=3.63×10^{-6} *8* B(M1)(W.u.)>0.50 Mult.: A_2=+0.334 *16*, A_4=+0.026 *21* consistent with ΔJ=0, dipole; RUL(E2)=300 suggests δ(E2/M1)<0.17. Additional information 7.
259.943[#] *25*	1.90 *6*	3792.56	(7)	3532.62	8⁺	D+Q			A_2=−0.45 *7*, A_4=+0.17 *8*.
311.25 *3*	1.12 *8*	3016.86		2705.61	(5⁻)				A_2=+0.35 *11*, A_4=0.
359.72 *4*	0.25 *5*	3029.62	(5⁺,6⁺)	2669.86	6⁺				
381.15 *20*	9.0 *10*	7396.46	(16⁺)	7015.31	(15⁺)	(M1+E2)			A_2=−0.44 *3*, A_4=+0.04 *6*.
566.35[#] *4*	3.50 *10*	3271.96	(6⁻)	2705.61	(5⁻)	D+Q			A_2=−0.54 *4*, A_4=+0.04 *5*.
628.55 *4*	61.0 *7*	3298.41	8⁺	2669.86	6⁺	E2			B(E2)(W.u.)=4.1 *4* A_2=+0.265 *8*, A_4=−0.040 *9*. Additional information 5.
694.25 *10*	18.0 *20*	7015.31	(15⁺)	6321.06	(14⁺)	(M1+E2)			A_2=+0.25 *5*, A_4=−0.03 *7*.
710.35[#] *9*	1.00 *15*	4133.66	(8⁻)	3423.31	(7⁻)	D+Q			A_2=−0.50 *16*, A_4=0.
717.70 *4*	17.0 *20*	3423.31	(7⁻)	2705.61	(5⁻)	(E2)			B(E2)(W.u.)=14 *4* A_2=+0.249 *15*, A_4=−0.028 *20*. Additional information 6.
741.18 *6*	4.9 *8*	5974.72	(12⁻)	5233.54	(11⁻)	D			A_2=−0.39 *6*, A_4=+0.09 *9*.
751.74 *3*	105.6 *12*	751.74	2⁺	0	0⁺	E2			B(E2)(W.u.)=14 *3* A_2=+0.275 *14*, A_4=−0.077 *14*. Additional information 1.
753.49[&]	<5	3423.31	(7⁻)	2669.86	6⁺				
815.00 *10*	13.5 *3*	5233.54	(11⁻)	4418.53	10⁺	D			A_2=−0.267 *17*, A_4=+0.07 *5*.
861.70[&]	≤4.2	4133.66	(8⁻)	3271.96	(6⁻)				A_2=+0.15 *11*, A_4=−0.11 *12*.
862.75[&]	≤4.2	3532.62	8⁺	2669.86	6⁺				A_2=+0.15 *11*, A_4=0.
885.90 *4*	25.2 *5*	4418.53	10⁺	3532.62	8⁺	E2			B(E2)(W.u.)=4.5 *16* A_2=+0.260 *17*, A_4=−0.042 *21*. Additional information 10.
914.81 *5*	100.1 *9*	1666.56	4⁺	751.74	2⁺	E2			B(E2)(W.u.)=7 *3* A_2=+0.299 *11*, A_4=−0.040 *18*. Additional information 2.
924.68 *4*	17.1 *3*	6321.06	(14⁺)	5396.37	(12⁺)	E2			B(E2)(W.u.)=7.1 *9*

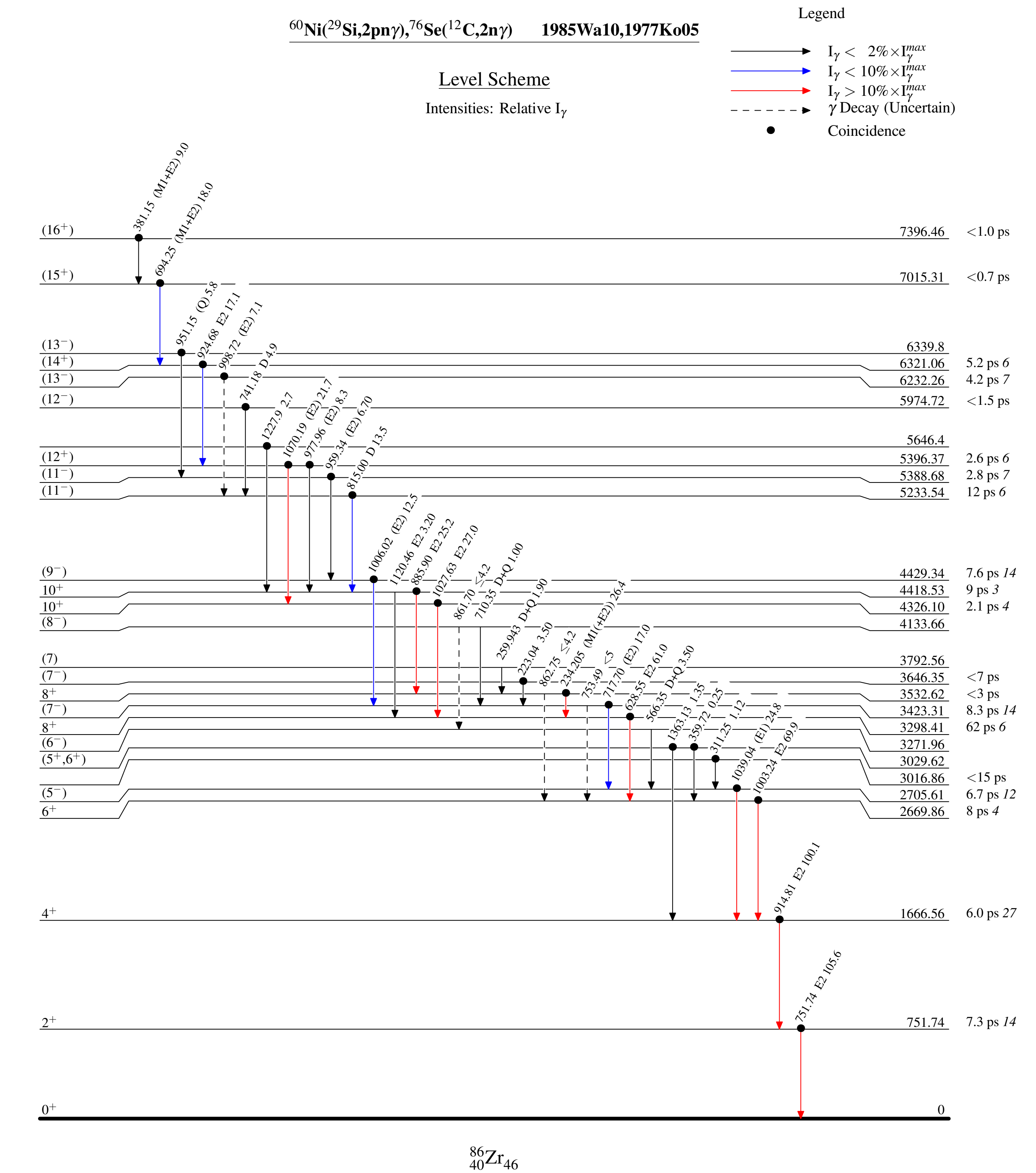
Continued on next page (footnotes at end of table)

^{60}Ni(^{29}Si,2pnγ),^{76}Se(^{12}C,2nγ) 1985Wa10,1977Ko05 (continued)

γ(^{86}Zr) (continued)

E_γ †	I_γ †	E_i(level)	J^π_i	E_f	J^π_f	Mult.‡	Comments
							A_2=+0.301 *10*, A_4=−0.050 *13*.
951.15 *30*	5.8 *5*	6339.8	(13$^-$)	5388.68	(11$^-$)	(Q)	A_2=+0.31 *6*, A_4=−0.04 *7*.
959.34 *4*	6.70 *10*	5388.68	(11$^-$)	4429.34	(9$^-$)	(E2)	B(E2)(W.u.)=11 *3* A_2=+0.21 *3*, A_4=+0.03 *3*.
977.96 *5*	8.3 *3*	5396.37	(12$^+$)	4418.53	10$^+$	(E2)	B(E2)(W.u.)=3.0 *7* A_2=+0.23 *4*, A_4=−0.03 *5*.
998.72& *9*	7.1 *7*	6232.26	(13$^-$)	5233.54	(11$^-$)	(E2)	B(E2)(W.u.)=6.0 *10* A_2=+0.27 *5*, A_4=−0.02 *8*.
1003.24 *5*	69.9 *5*	2669.86	6$^+$	1666.56	4$^+$	E2	B(E2)(W.u.)=3.1 *16* A_2=+0.277 *12*, A_4=−0.051 *15*. Additional information 3.
1006.02 *6*	12.5 *3*	4429.34	(9$^-$)	3423.31	(7$^-$)	(E2)	B(E2)(W.u.)=3.2 *6* A_2=+0.32 *4*, A_4=−0.06 *5*.
1027.63 *3*	27.0 *5*	4326.10	10$^+$	3298.41	8$^+$	E2	B(E2)(W.u.)=10.4 *20* A_2=+0.269 *11*, A_4=−0.044 *11*. Additional information 9.
1039.04 *3*	24.8 *3*	2705.61	(5$^-$)	1666.56	4$^+$	(E1)	B(E1)(W.u.)=4.6×10^{-5} *9* A_2=−0.267 *11*, A_4=+0.024 *16*. Additional information 4.
1070.19 *4*	21.7 *3*	5396.37	(12$^+$)	4326.10	10$^+$	(E2)	B(E2)(W.u.)=5.0 *12* A_2=+0.19 *3*, A_4=0.00 *3*.
1120.46# *8*	3.20 *10*	4418.53	10$^+$	3298.41	8$^+$	E2	B(E2)(W.u.)=0.18 *6* A_2=+0.33 *6*, A_4=−0.19 *8*.
1227.9 *3*	2.7 *3*	5646.4		4418.53	10$^+$		A_2=−0.04 *7*, A_4=+0.07 *10*.
1363.13 *6*	1.35 *15*	3029.62	(5$^+$,6$^+$)	1666.56	4$^+$		A_2=+0.35 *11*, A_4=+0.16 *13*.

† From (^{29}Si,2pnγ) (1985Wa10).
‡ From $\gamma(\theta)$ in 1985Wa10 and 1977Ko05 combined with limits implied by RUL.
# Somewhat uncertain, since not seen in $\gamma\gamma$ (1985Wa10).
@ 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.


^{60}Ni(^{29}Si,2pnγ),^{76}Se(^{12}C,2nγ) 1985Wa10,1977Ko05
Level Scheme
Intensities: Relative Iγ
Legend
Iγ < 2%×Iγ max
Iγ < 10%×Iγ max
Iγ > 10%×Iγ max
γ Decay (Uncertain)
Coincidence
(16+) 7396.46 <1.0 ps
(15+) 7015.31 <0.7 ps
(13−) 6339.8
(14+) 6321.06 5.2 ps 6
(13−) 6232.26 4.2 ps 7
(12−) 5974.72 <1.5 ps
5646.4
(12+) 5396.37 2.6 ps 6
(11−) 5388.68 2.8 ps 7
(11−) 5233.54 12 ps 6
(9−) 4429.34 7.6 ps 14
10+ 4418.53 9 ps 3
10+ 4326.10 2.1 ps 4
(8−) 4133.66
(7) 3792.56
(7−) 3646.35 <7 ps
8+ 3532.62 <3 ps
(7−) 3423.31 8.3 ps 14
8+ 3298.41 62 ps 6
(6−) 3271.96
(5+,6+) 3029.62
3016.86 <15 ps
(5−) 2705.61 6.7 ps 12
6+ 2669.86 8 ps 4
4+ 1666.56 6.0 ps 27
2+ 751.74 7.3 ps 14
0+ 0
381.15 (M1+E2) 9.0
694.25 (M1+E2) 18.0
951.15 (Q) 5.8
924.68 E2 17.1
998.72 (E2) 7.1
741.18 D 4.9
1227.9 2.7
1070.19 (E2) 21.7
977.96 (E2) 8.3
959.34 (E2) 6.70
815.00 D 13.5
1006.02 (E2) 12.5
1120.46 E2 3.20
885.90 E2 25.2
1027.63 E2 27.0
861.70 ≤4.2
710.35 D+Q 1.00
259.943 D+Q 1.90
223.04 3.50
862.75 ≤4.2
234.205 (M1(+E2)) 26.4
753.49 ≤5
717.70 (E2) 17.0
628.55 E2 61.0
566.35 D+Q 3.50
1363.13 1.35
359.72 0.25
311.25 1.12
1039.04 (E1) 24.8
1003.24 E2 69.9
914.81 E2 100.1
751.74 E2 105.6
$^{86}_{40}Zr_{46}$