^{58}Fe(α,nγ),^{48}Ca(^{18}O,5nγ) 1977Wa03,1977Wa07,1978Wa09

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	ENSDF	20-Jan-2020

Includes reactions: ^{60}Ni(d,pγ) from 1975Wi28 and 1968Na15; ^{53}Cr(^{11}B,2npγ) from 1977Wa07.

1977Wa03: Eα=6.5-13.0 MeV. Measured excit, Eγ, Iγ, γγ-coin, γ(θ), linear polarization, DSA, semi, Compton suppression, enriched targets (71% and 87%).

1977Wa07: Eα=6.5-13.0 MeV; ^{53}Cr(^{11}B,2npγ),E=30 MeV. Measured Eγ, Iγ, γγ-coin, γ(θ), linear polarization, lifetime by DSAM, enriched target.

1975Wi28: Eα=8 MeV; ^{60}Ni(d,pγ),E(d)=6 MeV. Measured Eγ, Iγ, nγ-coin, γγ(θ), linear polarization, lifetime by DSAM (also 1974WiZR thesis). For mixing ratios, phase convention is Rose-Brink, thus reversed here to be consistent with Krane-Steffen convention.

1977Wa15: Eα=9.0 MeV. Measured lifetime by recoil distance method.

1978Wa09: ^{48}Ca(^{18}O,5n),E=25-55 MeV; measured Eγ, level lifetimes by Recoil-distance method.

1968Na15: ^{60}Ni(d,pγ),E=5.5 MeV.

All data are from ^{58}Fe(α,nγ) (1977Wa07, 1977Wa03), except as noted.

^{61}Ni Levels

E(level)[†]	J^π[‡]	$T_{1/2}$[#]	Comments
0	3/2$^-$		
67.38 *21*	5/2$^-$		
283.3 *3*	1/2$^-$	24[b] ps *4*	
655.9 *3*	1/2$^-$	17[b] ps *4*	J^π: 1/2$^-$, (3/2$^-$) (1977Wa03).
908.3 *3*	5/2$^-$	0.7[@] ps *4*	J^π: 5/2$^-$ (1977Wa03), 5/2$^-$ (1975Wi28).
1015.0 *3*	7/2$^-$	4.4 ps *6*	$T_{1/2}$: from recoil-distance method (1978Wa09). Other: 6 ps *2* from 1977Wa15. J^π: 7/2$^-$ (1977Wa03), 7/2$^-$ (1975Wi28).
1099.6 *4*	3/2$^-$	0.25[&] ps *+47−11*	J^π: 3/2$^-$ (1977Wa03).
1132.0 *3*	5/2$^-$	0.29[@] ps *5*	J^π: 5/2$^-$ (1977Wa03), 5/2$^-$ (1975Wi28).
1185.7 *4*	3/2$^-$	0.104[@] ps *17*	J^π: 3/2$^-$ (1975Wi28).
1454.5 *3*	7/2$^-$	0.58[@] ps *25*	J^π: 7/2$^-$ (1977Wa03), (5/2$^-$) (1975Wi28).
1609.3 *3*	5/2$^-$	0.26[@] ps *4*	J^π: 5/2$^-$ (1977Wa03), 5/2$^-$ (1975Wi28).
1729.3 *3*	3/2$^-$	0.065[@] ps *11*	J^π: (1/2$^-$),3/2$^-$ (1977Wa03), 3/2$^-$ (1975Wi28).
1807.5 *4*	9/2$^-$	0.6[@] ps *5*	J^π: 9/2$^-$ (1977Wa03).
1987.6 *3*	9/2$^-$	0.51[@] ps *18*	J^π: 9/2$^-$ (1977Wa03).
1997.5 *4*	5/2$^-$	0.042[@] ps *11*	J^π: 5/2$^-$ (1977Wa03).
2018.0 *5*	7/2$^-$	0.26[@] ps *16*	J^π: 7/2$^-$ (1977Wa03), 7/2$^-$ (1975Wi28).
2121.4 *5*	9/2$^+$	0.40[&] ps *+74−12*	J^π: 9/2$^+$ (1977Wa03), 9/2$^+$ (1975Wi28).
2124.0 *7*	1/2$^-$	0.044[@] ps *15*	J^π: (1/2$^-$) (1977Wa03), 1/2$^-$ (1975Wi28).
2128.6 *5*	11/2$^-$	>2 ps	$T_{1/2}$: from 1977Wa03. J^π: 11/2$^-$ (1977Wa03).
2409.5 *4*	9/2$^-$	0.19[a] ps *4*	J^π: 9/2$^-$ (1977Wa07).
3259.1 *5*	(11/2$^-$)	0.46[a] ps *8*	J^π: (11/2$^-$) (1977Wa07).
3298.7 *8*	11/2$^+$	0.60[a] ps *+23−14*	J^π: 11/2$^+$ (1977Wa07).
3426.2 *4*	13/2$^-$	>0.7[a] ps	J^π: 13/2$^-$ (1977Wa07).
3435.5 *6*	13/2$^+$	1.0[a] ps *4*	J^π: 13/2$^+$ (1977Wa07). $T_{1/2}$: other: <1.4 ps (1978Wa09).
3644.4 *9*	(7/2$^+$)		J^π: (7/2$^+$) (1977Wa07).
3665.4 *9*	(9/2$^+$)		J^π: (9/2$^+$) (1977Wa07).
4019.2 *6*	15/2$^+$	>1.4[a] ps	J^π: 15/2$^+$ (1977Wa07).
4818.6 *8*	(17/2$^+$)	<1.1 ps	E(level): seen both in ^{58}Fe(α,nγ) and in ^{53}Cr(^{11}B,p2nγ).

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^{58}Fe(α,nγ),^{48}Ca(^{18}O,5nγ) 1977Wa03,1977Wa07,1978Wa09 (continued)

^{61}Ni Levels (continued)

E(level)[†]	Comments
	$T_{1/2}$: from DSAM (1978Wa09).
5316.2 *12*	E(level): from ^{53}Cr(^{11}B,p2nγ).

[†] From least-squares fit to Eγ data.
[‡] From Adopted Levels. Supporting assignments from this data set based on $\gamma(\theta)$ and linear polarization data of 1977Wa03, 1977Wa07, and 1975Wi28 are given in comments.
[#] From DSA measurements, except as noted. 15% uncertainty due to stopping powers included.
[@] Unweighted average of 1975Wi28 and 1977Wa03.
[&] From 1975Wi28.
[a] From 1977Wa07.
[b] Recoil-distance Doppler-shift method (1977Wa15).

γ(^{61}Ni)

E_i(level)	J^π_i	Eγ[†]	Iγ[†]	E_f	J^π_f	Mult.[‡]	δ[#]	Comments
67.38	5/2⁻	67.4 *5*	100	0	3/2⁻			
283.3	1/2⁻	283.4 *5*	100	0	3/2⁻			
655.9	1/2⁻	372.5 *5*	17 *1*	283.3	1/2⁻			A_2=−0.01 *1*; A_4=0.00 *1*; pol=+0.04 *6*
		588.4 *5*	8 *1*	67.38	5/2⁻			A_2=−0.04 *3*; A_4=0.00 *1*; pol=+0.04 *6*
		656.0 *5*	75 *1*	0	3/2⁻			A_2=−0.01 *1*; A_4=0.00 *1*; pol=0.00 *2*
908.3	5/2⁻	625.0 *7*	6 *1*	283.3	1/2⁻	E2		A_2=+0.21 *3*; A_4=−0.02 *3*
		841.0 *5*	21 *1*	67.38	5/2⁻	M1+E2	+1.83 *20*	A_2=+0.15 *1*; A_4=+0.02 *2*; pol=−0.17 *6* δ=+0.36 to +1.19 (1975Wi28).
		908.3 *5*	73 *2*	0	3/2⁻	M1+E2	−0.18 *5*	A_2=−0.28 *1*; A_4=−0.02 *1*; pol=−0.15 *3* δ=−0.20 *+3−16* (1975Wi28).
1015.0	7/2⁻	947.84[&] *15*	75 *1*	67.38	5/2⁻	M1+E2	+2.46 *15*	A_2=+0.47 *1*; A_4=+0.13 *1*; pol=−0.10 *3* δ: =+2.5 *5* (1975Wi28).
		1015.1[&] *2*	25 *1*	0	3/2⁻	E2		A_2=+0.27 *1*; A_4=−0.09 *1*; pol=+0.45 *6* δ(M3/E2)=+0.03 *+22−12* (1975Wi28).
1099.6	3/2⁻	816.7 *7*	51 *1*	283.3	1/2⁻	M1+E2	+0.23 *7*	A_2=−0.01 *1*; A_4=0.00 *1*; pol=−0.12 *7*
		1032.1 *5*	7 *1*	67.38	5/2⁻			A_2=−0.43 *4*; A_4=+0.03 *5*
		1099.4 *5*	42 *1*	0	3/2⁻			pol=+0.14 *7*
1132.0	5/2⁻	1064.6 *5*	37 *1*	67.38	5/2⁻	M1+E2	+0.14 *12*	A_2=+0.21 *1*; A_4=0.00 *1*; pol=+0.16 *8* δ>+0.84 (1975Wi28).
		1131.9 *5*	63 *1*	0	3/2⁻	M1+E2	−0.47 *9*	A_2=−0.44; A_4=+0.01 *1*; pol=−0.03 *4* δ=−0.36 to −0.70 or <−2.1 (1975Wi28).
1185.7	3/2⁻	529.8 *5*	8 *3*	655.9	1/2⁻			Iγ: other: 12 *3* (1975Wi28).
		902	<4	283.3	1/2⁻			Iγ: other: 5 *2* (1975Wi28).
		1119	<2	67.38	5/2⁻			Iγ: other: 6 *2* (1975Wi28).
		1185.5 *7*	92 *3*	0	3/2⁻			Iγ: other: 77 *8* (1975Wi28). δ>−0.27 (1975Wi28).
1454.5	7/2⁻	1387.2 *5*	25 *3*	67.38	5/2⁻	M1+E2	+2.7 *4*	A_2=+0.44 *2*; A_4=+0.15 *3*; pol=−0.05 *17* δ=+0.36 to +2.75 (1975Wi28).
		1454.4 *5*	75 *3*	0	3/2⁻	E2		A_2=+0.25 *6*; A_4=−0.15 *1*; pol=+0.50 *6* δ: +0.72 +29 −23 (1975Wi28).
1609.3	5/2⁻	477.4 *5*	4 *1*	1132.0	5/2⁻			A_2=+0.25 *7*; A_4=−0.10 *8*
		701.1 *7*	5 *1*	908.3	5/2⁻			A_2=+0.20 *10*; A_4=+0.10 *10*
		1541.7 *5*	54 *2*	67.38	5/2⁻	M1+E2	−0.07 *5*	A_2=+0.16 *1*; A_4=0.00 *2*; pol=+0.35 *10* δ=−0.18 to +0.18 (1975Wi28).
		1609.4 *5*	37 *1*	0	3/2⁻	M1+E2	−0.33 *14*	A_2=−0.40 *1*; A_4=+0.01 *2*; pol=−0.05 *10* δ=−0.18 to −2.75 (1975Wi28).

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^{58}Fe(α,nγ),^{48}Ca(^{18}O,5nγ) 1977Wa03,1977Wa07,1978Wa09 (continued)

γ(^{61}Ni) (continued)

E_i(level)	J^π_i	E_γ†	I_γ†	E_f	J^π_f	Mult.‡	δ#	Comments
1729.3	3/2⁻	820.7 *7*	3@	908.3	5/2⁻			Iγ(821)/Iγ(1662)=0.079 disagrees with 0.41 *3* in Adopted dataset where value is taken from (n,γ) and ε decay. It is possible that the low intensity in (α,nγ) is due to angular distribution effects.
		1073.2 *5*	21 *5*	655.9	1/2⁻			pol=−0.3 *1* I_γ: from 1975Wi28. Other: 22 at 90° (1977Wa03).
		1446.2 *5*	16 *5*	283.3	1/2⁻			pol=−0.1 *1* I_γ: from 1975Wi28. Other: 21 at 90° (1977Wa03).
		1661.9 *5*	38 *6*	67.38	5/2⁻			A_2=−0.01 *1*; A_4=+0.06 *2*; pol=−0.2 *2* I_γ: from 1975Wi28. Other: 29 at 90° (1977Wa03).
		1729.3 *5*	25 *5*	0	3/2⁻			pol=−0.3 *2* I_γ: from 1975Wi28. Other: 25 at 90° (1977Wa03).
1807.5	9/2⁻	792.6 *5*	11 *2*	1015.0	7/2⁻	M1+E2	+0.97 *18*	A_2=+0.57 *2*; A_4=+0.06 *2*; pol=−0.62 *12*
		1740.1 *5*	89 *2*	67.38	5/2⁻	E2		A_2=+0.36 *1*; A_4=−0.10 *1*; pol=+0.53 *5* δ(M3/E2)=+0.01 *3*.
1987.6	9/2⁻	533.2 *5*	13 *1*	1454.5	7/2⁻	M1(+E2)	+0.02 *3*	A_2=−0.18 *1*; A_4=−0.03 *2*; pol=−0.39 *7*
		972.5 *5*	12 *2*	1015.0	7/2⁻	M1+E2	−0.70 *23*	A_2=−079 *2*; A_4=+0.06 *3*; pol=+0.03 *12*
		1079.3 *7*	18 *2*	908.3	5/2⁻	E2		A_2=+0.35 *2*; A_4=−0.11 *2*; pol=+0.38 *11* δ(M3/E2)=+0.01 *3*.
		1920.1 *5*	57 *3*	67.38	5/2⁻	E2		A_2=+0.36 *1*; A_4=−0.10 *1*; pol=+0.39 *10* δ(M3/E2)=+0.02 *3*.
1997.5	5/2⁻	982.3 *5*	11 *1*	1015.0	7/2⁻			A_2=−0.40 *6*; A_4=+0.19 *7*
		1089.4 *5*	16 *1*	908.3	5/2⁻			A_2=+0.34 *4*; A_4=−0.14 *4*
		1930.0 *7*	5 *1*	67.38	5/2⁻			
		1997.3 *7*	68 *2*	0	3/2⁻	M1+E2	−0.27 *6*	A_2=−0.43 *1*; A_4=+0.02; pol=−0.24 *11*
2018.0	7/2⁻	1109.8 *10*	10@	908.3	5/2⁻			
		1950.6 *5*	90@	67.38	5/2⁻	M1(+E2)	−0.02 +2−7	A_2=−0.26 *2*; A_4=−0.03 *2*; pol=−0.4 *1* δ: other: +0.03 *16* (1975Wi28).
2121.4	9/2⁺	1106.5& *2*	100	1015.0	7/2⁻	E1		A_2=−0.28 *1*; A_4=+0.03 *1*; pol=+0.23 *6* δ(M2/E1)=0.00 *3*. Other: +0.03 *28* (1975Wi28).
2124.0	1/2⁻	2124.0 *7*	100	0	3/2⁻			A_2=0.00 *2*; A_4=+03 *2*; pol=0.0 *1*
2128.6	11/2⁻	1114.0& *2*	100	1015.0	7/2⁻	E2		A_2=+0.32 *1*; A_4=−0.11 *1*; pol=+0.44 *4* δ(M3/E2)=−0.02 *2*.
2409.5	9/2⁻	955.0 *5*	17 *2*	1454.5	7/2⁻	M1+E2	−0.10 *5*	A_2=−0.30 *3*; A_4=+0.02 *4*; pol=−0.21 *16*
		1277.5 *5*	12 *2*	1132.0	5/2⁻	E2		A_2=+0.24 *4*; A_4=−0.08 *6*; pol=+0.5 *4* δ(M3/E2)=−0.04 *9*.
		1394.6 *5*	9 *2*	1015.0	7/2⁻	M1+E2		A_2=−1.0 *3*; A_4=+0.1 *2*; pol=0.0 *2* δ: −2.1≤δ≤−0.3.
		2342.0 *7*	62 *3*	67.38	5/2⁻	E2		A_2=+0.33 *2*; A_4=−0.10 *2*; pol=+0.90 *21* δ(E2/M3)=+0.02 *4*.
3259.1	(11/2⁻)	1271.6 *5*		1987.6	9/2⁻	M1+E2		A_2=−0.61 *4*; A_4=+0.03 *5*; pol=0.0 *3* δ: −2.7≤δ≤−0.27.
		1451.5 *7*		1807.5	9/2⁻			
3298.7	11/2⁺	1177.3 *5*	100	2121.4	9/2⁺	M1+E2	+0.63 *8*	A_2=+0.44 *1*; A_4=+0.07 *1*; pol=−0.66 *7*
3426.2	13/2⁻	1297.5 *5*	10 *1*	2128.6	11/2⁻	M1+E2	−2.6 *4*	A_2=−0.72 *5*; A_4=+0.45 *7*; pol=+0.08 *25*
		1438.43& *14*	69 *3*	1987.6	9/2⁻	E2		A_2=+0.28 *1*; A_4=0.13 *1*; pol=+0.51 *8* δ(M3/E2)=−0.06 *4*.
		1618.9 *5*	21 *2*	1807.5	9/2⁻	E2		A_2=+0.29 *2*; A_4=−0.11 *3*; pol=+0.66 *27* δ(M3/E2)=−0.04 *3*.

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^{58}Fe(α,nγ),^{48}Ca(^{18}O,5nγ) 1977Wa03,1977Wa07,1978Wa09 (continued)

γ(^{61}Ni) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[†]	E_f	J^π_f	Mult.[‡]	δ[#]	Comments
3435.5	13/2+	1314.0[&] 2	100	2121.4	9/2+	E2		A_2=+0.28 1; A_4=−0.11 1; pol=+0.58 8 δ(M3/E2)=−0.05 4.
3644.4	(7/2+)	1523.0 7	100	2121.4	9/2+			
3665.4	(9/2+)	1544.0 7	100	2121.4	9/2+			
4019.2	15/2+	584.0[&] 2	28 3	3435.5	13/2+	M1+E2	+0.63 10	A_2=+0.56 3; A_4=+0.10 4; pol=−0.50 23
		593.00[&] 13	72 3	3426.2	13/2−	E1		A_2=−0.33 1; A_4=+0.02 2; pol=+0.56 11 δ(M2/E1)=−0.04 3.
4818.6	(17/2+)	799.4 5	100	4019.2	15/2+			A_2=−0.52 8; A_4=+0.03 10
5316.2		1297 1	100	4019.2	15/2+			

† From (α,nγ) (1977Wa03,1977Wa07), unless otherwise indicated.
‡ From γ(θ) and linear polarization data of 1975Wi28, 1977Wa03, and 1977Wa07.
# With Gaussian distribution of the population of magnetic substates (1977Wa03,1977Wa07).
@ Measured at 90°.
& From 1978Wa09, 1977Wa03, and 1977Wa07.

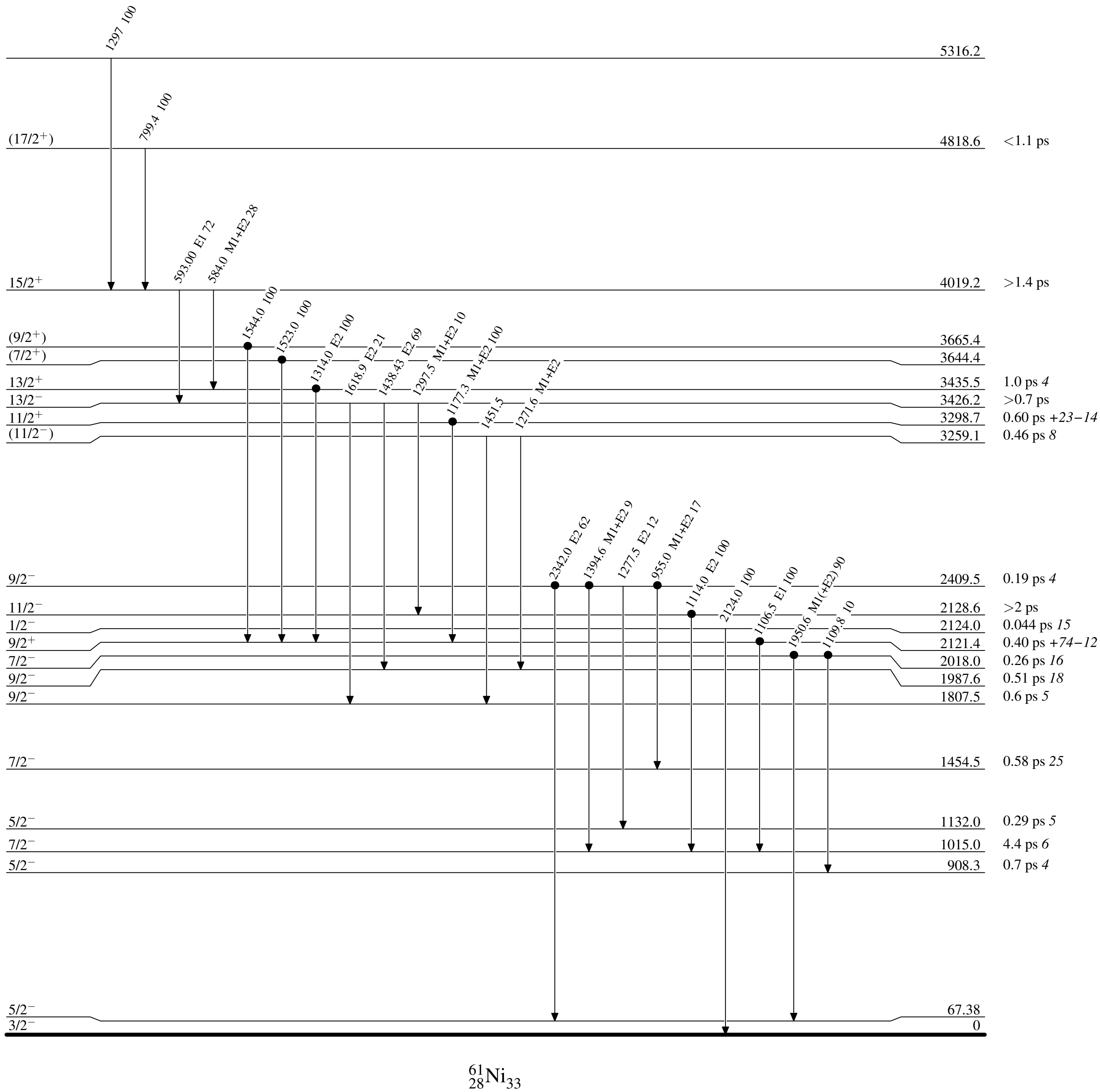
^{58}Fe(α,nγ),^{48}Ca(^{18}O,5nγ) 1977Wa03,1977Wa07,1978Wa09

Legend

Level Scheme

Intensities: % photon branching from each level

● Coincidence



$^{61}_{28}Ni_{33}$

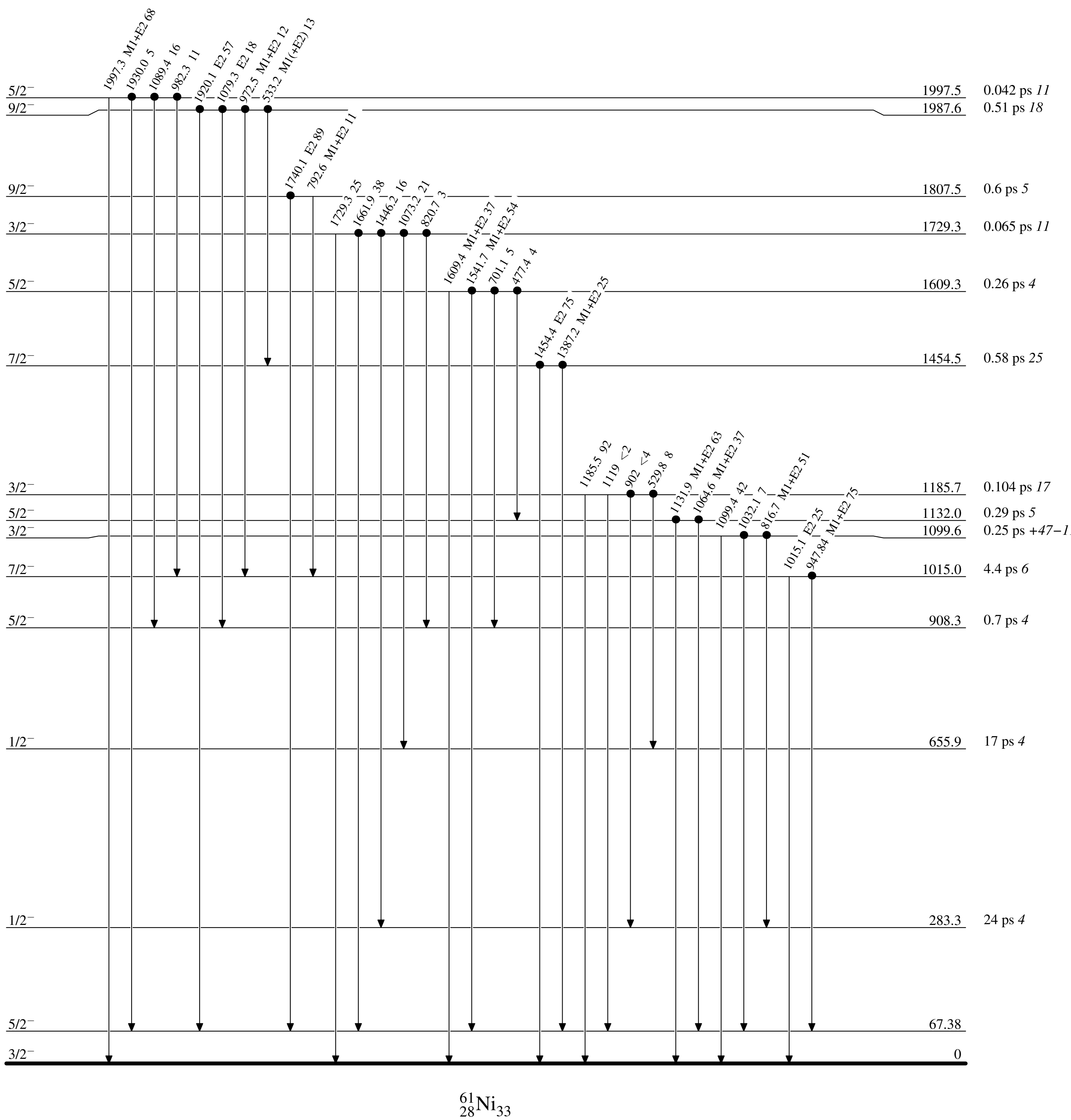
^{58}Fe(α,nγ),^{48}Ca(^{18}O,5nγ) 1977Wa03,1977Wa07,1978Wa09

Legend

Level Scheme (continued)

Intensities: % photon branching from each level

● Coincidence



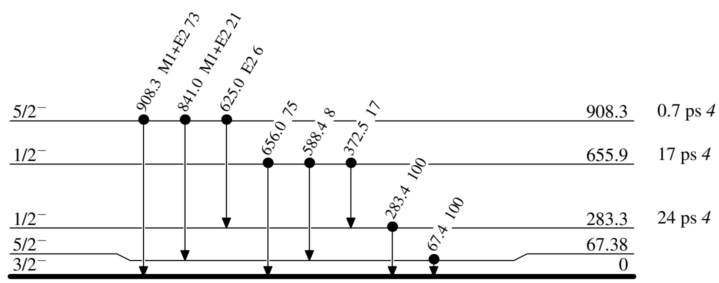
^{58}Fe(α,nγ),^{48}Ca(^{18}O,5nγ) 1977Wa03,1977Wa07,1978Wa09

Legend

Level Scheme (continued)

Intensities: % photon branching from each level

● Coincidence



$^{61}_{28}Ni_{33}$