^{148}Nd(p,2nγ) 1977Ko24

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	N. Nica and B. Singh	NDS 181, 1 (2022)	9-Mar-2022

1977Ko24: E(p)=12-20 MeV. Measured Eγ, Iγ, $\gamma\gamma$-coin, pγ(t), $\gamma(\theta)$, excitation functions, conversion electrons with spectrometer FWHM≤3.5 keV, ce(t) with a pulsed beam. See also 1979KoZE thesis by the first author of 1977Ko24.

^{147}Pm Levels

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$	Comments
0.0	7/2$^+$	2.6234 y *2*	$T_{1/2}$: from Adopted Levels.
91.10 *4*	5/2$^+$	2.6 ns *2*	$T_{1/2}$: 91γ(t), pulsed beam (1977Ko24).
408.18 *7*	9/2$^+$		J$^\pi$: based on E1 feeding from 11/2$^-$ state and M1 decay to 7/2$^+$.
410.57 *5*	3/2$^+$		
489.34 *6*	(7/2)$^+$		J$^\pi$: 5/2 excluded by A_2 and β_2 coefficients obtained in $\gamma(\theta$,H) and $\gamma\gamma(\theta)$, respectively, for 197γ feeding (1977Al34).
531.06 *7*	5/2$^+$		
632.8 *3*	1/2$^+$		J$^\pi$: based on tentative (^{3}He,d), (α,t) data (quoted by 1977Ko24).
641.34 *10*	(3/2,5/2)$^+$		
649.32 *18*	11/2$^-$	12 ns *2*	J$^\pi$: consistent with γ-decay properties, half-life, and syst. E(level): 11/2$^-$ isomer syst: 26-ns ^{143}Pm at 960 keV, 18-ns ^{145}Pm at 795 keV, 35-μs ^{149}Pm at 496 keV. $T_{1/2}$: 12 ns *2* (1977Ko24) 408γ(t), 649γ(t) pulsed beam.
667.18 *9*	11/2$^+$		
680.28 *15*	7/2$^+$		J$^\pi$: from the Adopted Levels.
686.05 *8*	5/2$^+$		
730.70 *14*	9/2$^+$		
807.27 *13*	(5/2,7/2)$^-$		
865.11 *19*	(7/2$^-$,9/2$^-$)		J$^\pi$: from the Adopted Levels.
970.22 *19*	(7/2)$^-$		J$^\pi$: 11/2$^-$ in Adopted Levels.
984.0 *3*			
1041.19 *18*			
1049.2 *4*			
1051.18 *19*	(13/2,15/2)$^-$		
1072.53 *14*	(11/2)$^+$		
1077.51 *16*	(7/2)$^+$		
1119.1 *4*			
1159.42 *18*	(9/2)$^-$		
1213.9 *4*			
1245.75 *20*	(13/2,15/2)$^-$		
1382.1 *5*			
1392.8 *4*	(15/2)$^+$		
1406.36 *16*	(7/2,9/2)$^+$		J$^\pi$: 15/2$^-$ in Adopted Levels.
1434.0 *3*			
1627.8 *6*			

† From least-squares fit to Eγ data (by evaluator).
‡ As proposed by 1977Ko24 based on multipolarities from ce and $\gamma(\theta)$ data. Exceptions are noted.

γ(^{147}Pm)

A_2, A_4 coefficients obtained from γ(θ) at 6 angles, E(p)=16.8 MeV.

E_γ	I_γ †	E_i(level)	J^π_i	E_f	J^π_f	Mult.#	δ@	α&	Comments
91.10 *4*	64.0 *50*	91.10	5/2$^+$	0.0	7/2$^+$	M1+E2	+0.089 *5*	2.03	A_2=−0.021 *8*; A_4≈0 α(K)=1.715 *25*; α(L)=0.249 *4*; α(M)=0.0534 *8* Mult.,δ: from Adopted Gammas.
120.49 *6*	0.6 *2*	531.06	5/2$^+$	410.57	3/2$^+$	M1+E2	+0.048 *21*	0.911	α(K)=0.773 *11*; α(L)=0.1089 *17*; α(M)=0.0233 *4* Mult.,δ: from Adopted Gammas.
194.57 *5*	2.1 *2*	1245.75	(13/2,15/2)$^-$	1051.18	(13/2,15/2)$^-$				
196.6 *3*	1.6‡ *4*	686.05	5/2$^+$	489.34	(7/2)$^+$				
230.77 *8*	7.1 *8*	641.34	(3/2,5/2)$^+$	410.57	3/2$^+$	M1(+E2)		0.138 *13*	α(K)exp=0.010 *2*; K/L=6.3 *13*; A_2=−0.16 *2*; A_4≈0 α(K)=0.111 *17*; α(L)=0.021 *4*; α(M)=0.0046 *9*
241.2 *2*	43.0‡ *40*	649.32	11/2$^-$	408.18	9/2$^+$	E1		0.0248	α(K)exp=0.023 *3*; K/L=6.9 *11* α(K)=0.0212 *3*; α(L)=0.00287 *4*; α(M)=0.000610 *9*
241.4 *3*	14.0 *30*	730.70	9/2$^+$	489.34	(7/2)$^+$	M1,E2		0.121 *13*	α(K)exp=0.08 *3* α(K)=0.098 *16*; α(L)=0.0180 *25*; α(M)=0.0039 *7*
247.0 *2*	1.8 *2*	1406.36	(7/2,9/2)$^+$	1159.42	(9/2)$^-$	E1		0.0233	α(K)exp=0.022 *4* α(K)=0.0199 *3*; α(L)=0.00270 *4*; α(M)=0.000573 *9* Mult.: M1 in Adopted Gammas based on data from 1995Ur01 in (^{136}Xe(^{15}N,4nγ), where authors assumed that the 247.0γ reported in (p,2nγ) was contributed by a 247γ, mult=E1 transition in ^{148}Nd populated in ^{148}Nd(p,2nγ).
259.01 *8*	7.2 *7*	667.18	11/2$^+$	408.18	9/2$^+$	E2+M1	+7.4 *6*	0.0868	α(K)exp=0.065 *12*; A_2=+0.106 *15*; A_4=+0.06 *2* α(K)=0.0669 *10*; α(L)=0.01560 *22*; α(M)=0.00346 *5*
272.2 *2*	3.2‡ *10*	680.28	7/2$^+$	408.18	9/2$^+$				
275.47 *8*	7.0 *6*	686.05	5/2$^+$	410.57	3/2$^+$	M1+E2	−0.21 *3*	0.0923 *14*	α(K)exp=0.085 *12*; A_2=−0.16 *2*; A_4≈0 α(K)=0.0784 *12*; α(L)=0.01099 *16*; α(M)=0.00235 *4*
318.0 *3*	2.8‡ *7*	807.27	(5/2,7/2)$^-$	489.34	(7/2)$^+$				
319.47 *5*	40.0 *20*	410.57	3/2$^+$	91.10	5/2$^+$	M1+E2	−0.34 *7*	0.0611 *12*	α(K)exp=0.052 *5*; K/L=7.0 *10*; A_2=+0.027 *15*; A_4≈0 α(K)=0.0518 *11*; α(L)=0.00734 *11*; α(M)=0.001570 *22*
333.82 *10*	3.6 *4*	1406.36	(7/2,9/2)$^+$	1072.53	(11/2)$^+$	D			A_2=−0.13 *3*; A_4≈0
346.81 *10*	5.1 *5*	1077.51	(7/2)$^+$	730.70	9/2$^+$	M1		0.0508	α(K)exp=0.044 *6*; A_2=−0.043 *14*; A_4≈0 α(K)=0.0433 *6*; α(L)=0.00591 *9*; α(M)=0.001259 *18*
356.5 *2*	1.7 *3*	1434.0		1077.51	(7/2)$^+$				
363.1 *4*	2.0‡ *5*	1049.2		686.05	5/2$^+$				

γ(^{147}Pm) (continued)

E_γ	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[@]	α[&]	Comments
398.24 *5*	36.0 *20*	489.34	(7/2)$^+$	91.10	5/2$^+$	M1+E2	+0.30 *1*	0.0345	α(K)exp=0.030 *3*; K/L=7.5 *12*; A_2=+0.076 *4*; A_4=−0.040 *6* α(K)=0.0293 *5*; α(L)=0.00406 *6*; α(M)=0.000866 *13*
401.85 *8*	14.4 *12*	1051.18	(13/2,15/2)$^-$	649.32	11/2$^-$	E2(+M1)		0.029 *6*	α(K)exp=0.026 *6*; A_2=+0.266 *11*; A_4=−0.09 *2* α(K)=0.024 *6*; α(L)=0.0037 *4*; α(M)=0.00079 *7*
405.34 *12*	4.0 *8*	1072.53	(11/2)$^+$	667.18	11/2$^+$				
408.20 *7*	100.0	408.18	9/2$^+$	0.0	7/2$^+$	M1+E2	+0.57 *3*	0.0304	α(K)exp=0.026 *3*; K/L=7.0 *9*; A_2=+0.230 *11*; A_4=−0.021 *15* α(K)=0.0257 *5*; α(L)=0.00369 *6*; α(M)=0.000790 *12*
410.6 *2*	3.0 *8*	410.57	3/2$^+$	0.0	7/2$^+$				
436.0 *5*	1.7‡ *5*	1406.36	(7/2,9/2)$^+$	970.22	(7/2)$^-$				
438.8 *4*	2.0‡ *5*	1119.1		680.28	7/2$^+$				
439.9 *4*	2.0‡ *5*	531.06	5/2$^+$	91.10	5/2$^+$				
452.0 *5*	1.2‡ *3*	1119.1		667.18	11/2$^+$				
457.0 *5*	4.0‡ *8*	865.11	(7/2$^-$,9/2$^-$)	408.18	9/2$^+$				
489.4 *2*	8.4 *12*	489.34	(7/2)$^+$	0.0	7/2$^+$	M1(+E2)		0.017 *4*	α(K)exp=0.017 *3* α(K)=0.0143 *36*; α(L)=0.0021 *3*; α(M)=0.00045 *7*
492.3 *2*	6.4‡ *12*	1159.42	(9/2)$^-$	667.18	11/2$^+$	E1		0.00427	α(K)exp=0.005 *2*; A_2=−0.15 *4*; A_4≈0 α(K)=0.00366 *6*; α(L)=0.000481 *7*; α(M)=0.0001019 *15*
518.1 *5*	1.6 *4*	1049.2		531.06	5/2$^+$				
531.05 *10*	20.6 *15*	531.06	5/2$^+$	0.0	7/2$^+$	M1+E2		0.014 *4*	α(K)exp=0.013 *2*; A_2=+0.05 *2*; A_4=−0.02 *3* α(K)=0.0116 *30*; α(L)=0.0017 *3*; α(M)=0.00036 *6*
^{x}540.4 *6*	4.6‡ *15*								
541.7 *3*	14.0‡ *20*	632.8	1/2$^+$	91.10	5/2$^+$				
562.0 *2*	10.0 *8*	970.22	(7/2)$^-$	408.18	9/2$^+$	E1		0.00317	α(K)exp=0.0024 *5*; A_2=−0.12 *3*; A_4≈0 α(K)=0.00272 *4*; α(L)=0.000356 *5*; α(M)=7.53×10^{-5} *11*
572.6 *3*	2.0 *3*	1213.9		641.34	(3/2,5/2)$^+$	E1		0.00305	α(K)exp=0.0028 *6* α(K)=0.00261 *4*; α(L)=0.000341 *5*; α(M)=7.22×10^{-5} *11*
576.0 *5*	2.4‡ *6*	984.0		408.18	9/2$^+$				
576.6 *5*	2.2‡ *6*	1627.8		1051.18	(13/2,15/2)$^-$				
588.1 *4*	3.2‡ *6*	1077.51	(7/2)$^+$	489.34	(7/2)$^+$				
589.3 *3*	9.1‡ *15*	680.28	7/2$^+$	91.10	5/2$^+$				
595.0 *4*	2.6‡ *9*	686.05	5/2$^+$	91.10	5/2$^+$				
596.6 *4*	3.8‡ *9*	1245.75	(13/2,15/2)$^-$	649.32	11/2$^-$	E2(+M1)		0.010 *3*	α(K)exp=0.005 *3* α(K)=0.0087 *23*; α(L)=0.00124 *23*; α(M)=0.00027 *5*
630.6 *2*	3.6 *3*	1041.19		410.57	3/2$^+$				

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γ(^{147}Pm) (continued)

E_γ	I_γ†	E_i(level)	J^π_i	E_f	J^π_f	Mult.#	δ@	α&	Comments
639.60 15	16.4 13	730.70	9/2$^+$	91.10	5/2$^+$	E2		0.00653	α(K)exp=0.0059 8; A_2=+0.17 3; A_4=−0.04 5 α(K)=0.00546 8; α(L)=0.000842 12; α(M)=0.000181 3
649.2 3	9.6 8	649.32	11/2$^-$	0.0	7/2$^+$	M2		0.0298	α(K)exp=0.023 3; K/L=6.1 8 α(K)=0.0251 4; α(L)=0.00371 6; α(M)=0.000799 12
664.3 3	9.5 10	1072.53	(11/2)$^+$	408.18	9/2$^+$	E2+M1	+2.0 3	0.00672 24	α(K)exp=0.0051 13; A_2=+0.32 2; A_4=+0.10 3 α(K)=0.00567 21; α(L)=0.000832 24; α(M)=0.000178 5
667.2 2	35.0 20	667.18	11/2$^+$	0.0	7/2$^+$	E2		0.00589	α(K)exp=0.0054 8; K/L=6.0 12; A_2=+0.21 3; A_4=−0.10 5 α(K)=0.00494 7; α(L)=0.000752 11; α(M)=0.0001618 23
679.9 3	5.0 6	680.28	7/2$^+$	0.0	7/2$^+$	E2(+M1)		0.0074 18	α(K)exp=0.0058 12 α(K)=0.0063 16; α(L)=0.00089 17; α(M)=0.00019 4 δ(E2/M1)>0.7 from α(K)exp. γ placement based on branching: Iγ(589γ)/Iγ(680γ)=2.3 5 in ^{147}Nd β^- decay as compared to 1.8 4 in 1977Ko24.
686.08 15	7.5 7	686.05	5/2$^+$	0.0	7/2$^+$	M1+E2		0.0073 18	α(K)exp=0.007 2 α(K)=0.0062 16; α(L)=0.00087 17; α(M)=0.00018 4
716.2 2	8.4 8	807.27	(5/2,7/2)$^-$	91.10	5/2$^+$	E1		0.00189	α(K)exp=0.0021 4; A_2=−0.05 2; A_4≈0 α(K)=0.001627 23; α(L)=0.000210 3; α(M)=4.45×10^{-5} 7 α(N)=1.000×10^{-5} 14; α(O)=1.502×10^{-6} 21; α(P)=9.46×10^{-8} 14
725.6 3	4.3 6	1392.8	(15/2)$^+$	667.18	11/2$^+$	E2		0.00483	α(K)exp=0.0035 7; A_2=+0.26 3; A_4=−0.08 5 α(K)=0.00406 6; α(L)=0.000604 9; α(M)=0.0001297 19
807.2 2	7.6 8	807.27	(5/2,7/2)$^-$	0.0	7/2$^+$	E1		1.49×10^{-3}	α(K)exp=0.0011 3; A_2=−0.02 2; A_4≈0 α(K)=0.001278 18; α(L)=0.0001644 23; α(M)=3.47×10^{-5} 5
865.1 2	10.3 9	865.11	(7/2$^-$,9/2$^-$)	0.0	7/2$^+$	(E1)		1.30×10^{-3}	α(K)exp=0.0017 5; A_2=−0.02 3; A_4≈0 α(K)=0.001115 16; α(L)=0.0001430 20; α(M)=3.02×10^{-5} 5 Mult.: E2 is not ruled out by α(K)exp, but not likely from A_2 value.
^{x}881.7 3	3.8 6								
^{x}947.3 4	4.1 7								
950.2 4	2.5 5	1041.19		91.10	5/2$^+$				
970.3 5	6.0 12	970.22	(7/2)$^-$	0.0	7/2$^+$				
971.5 5	3.2‡ 12	1382.1		410.57	3/2$^+$				
983.9 3	7.7 9	984.0		0.0	7/2$^+$	D			A_2=−0.09 3; A_4≈0
1041.1 5	2.5 5	1041.19		0.0	7/2$^+$				

γ(^{147}Pm) (continued)

† Measured at E(p)=15 MeV, the same as for I(ce).
‡ From $\gamma\gamma$-coin data. In singles, there were interfering lines.
# Determined from α(K)exp and $\gamma(\theta)$, except where noted. α(K)exp values normalized to α(K)(301γ in ^{148}Nd)=0.0412 (E2 theory).
@ From $\gamma(\theta)$ and ce data of 1977Ko24, unless otherwise stated.
& 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.
^{x} γ ray not placed in level scheme.

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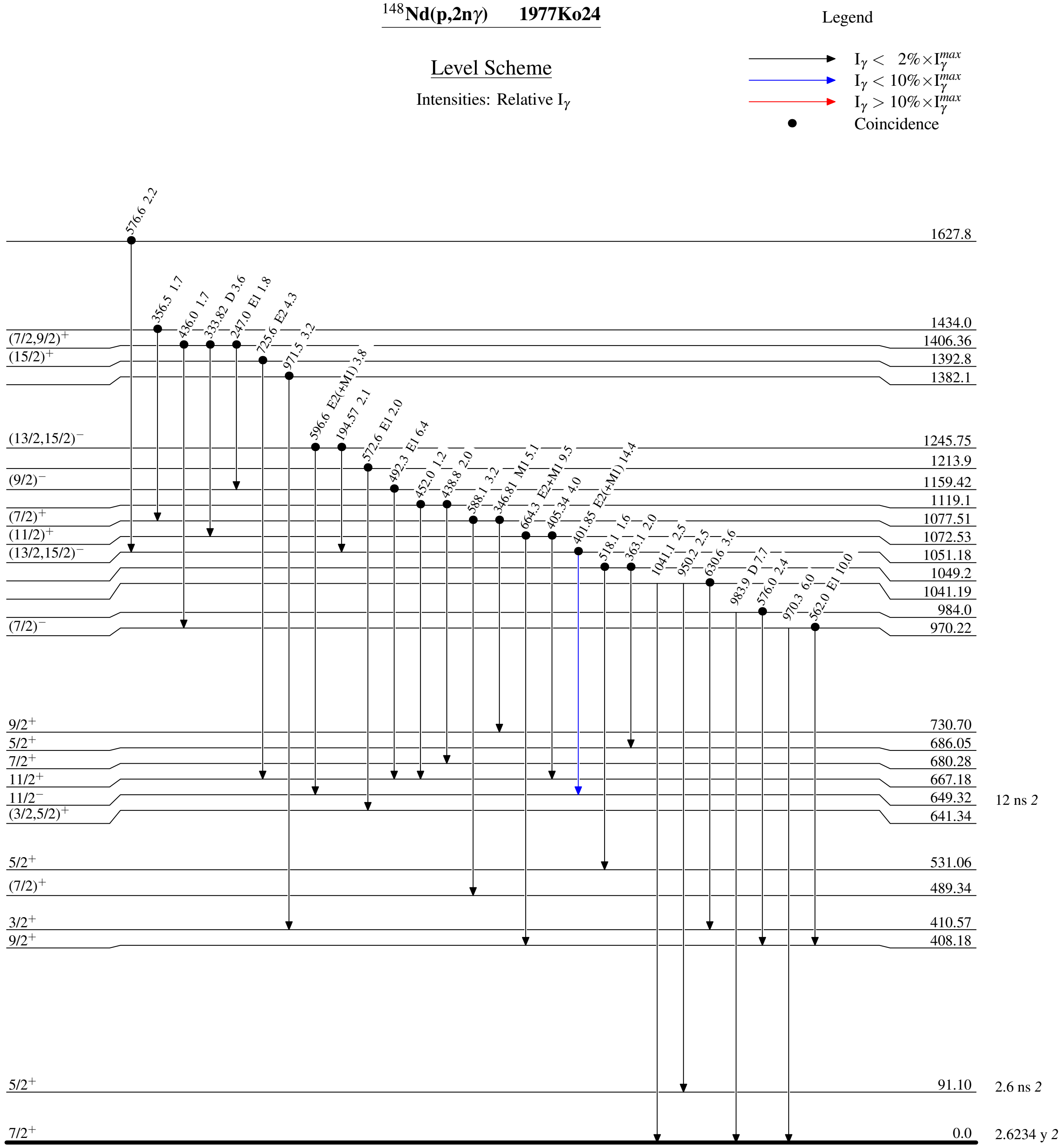
Level Scheme

Intensities: Relative I_γ



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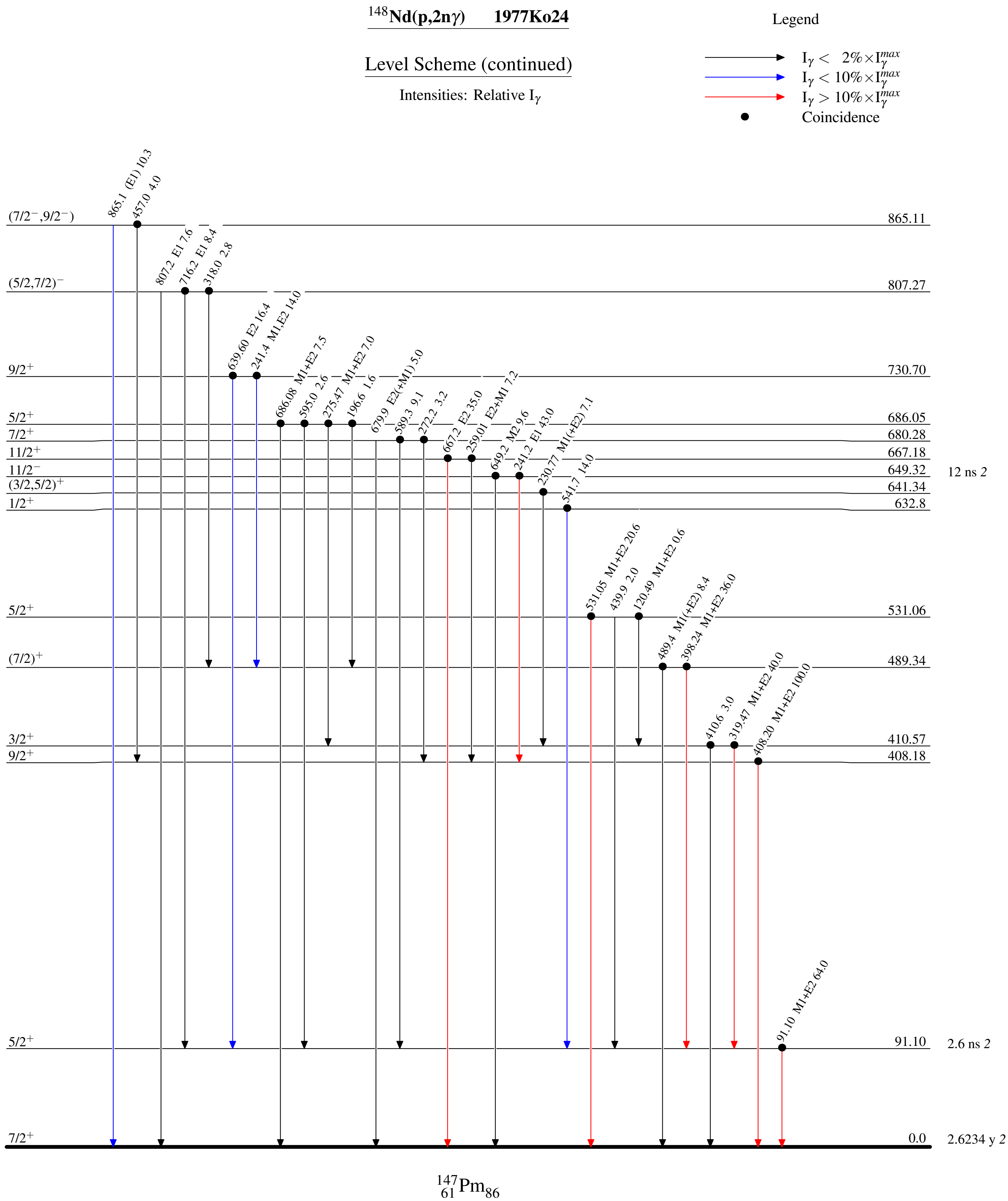

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Level Scheme (continued)
Intensities: Relative Iγ
Legend
Iγ < 2%×Iγ^max
Iγ < 10%×Iγ^max
Iγ > 10%×Iγ^max
Coincidence
(7/2−,9/2−) 865.11
(5/2,7/2)− 807.27
9/2+ 730.70
5/2+ 686.05
7/2+ 680.28
11/2+ 667.18
11/2− 649.32 12 ns 2
(3/2,5/2)+ 641.34
1/2+ 632.8
5/2+ 531.06
(7/2)+ 489.34
3/2+ 410.57
9/2+ 408.18
5/2+ 91.10 2.6 ns 2
7/2+ 0.0 2.6234 y 2
865.1 (E1) 10.3
457.0 4.0
807.2 E1 7.6
716.2 E1 8.4
318.0 2.8
639.60 E2 16.4
241.4 M1,E2 14.0
686.08 M1+E2 7.5
595.0 2.6
275.47 M1+E2 7.0
196.6 1.6
679.9 E2(+M1) 5.0
589.3 9.1
272.2 3.2
667.2 E2 35.0
259.01 E2+M1 7.2
649.2 M2 9.6
241.2 E1 43.0
230.77 M1(+E2) 7.1
541.7 14.0
531.05 M1+E2 20.6
439.9 2.0
120.49 M1+E2 0.6
489.4 M1(+E2) 8.4
398.24 M1+E2 36.0
410.6 3.0
319.47 M1+E2 40.0
408.20 M1+E2 100.0
91.10 M1+E2 64.0
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