^{64}Zn(p,γ), (p,p$'\gamma$), IAR 1975We24,1979Ra12,1982Ra11

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	E. Browne, J. K. Tuli	NDS 111, 2425 (2010)	1-Aug-2009

1979Ra12: (p,γ): E(p)≈2.82-3.03 MeV; measured Eγ, Iγ, $\gamma(\theta)$, excitation functions.
1982Ra11: (p,γ), (p,p$'\gamma$): E(p)=3.17-3.27 MeV; measured Eγ, Iγ, $\gamma(\theta)$, $\gamma\gamma(\theta)$, excitation functions.
1987Ni14,1987Vi01: (p,γ): E(p)=1.1-4.3 MeV; measured Eγ, Iγ, γ yields, Ge(Li), NaI, pair spectrometer. Deduced strength functions for primary E1 transitions.
1975We24: (p,γ): E(p)=1.0-2.2 MeV; measured Eγ, Iγ and γ excitation functions; Ge(Li) detector.
1972Sz01: (p,γ): E(p)=2.84-3.02 MeV; measured γ excitation functions; deduced widths; NaI, Ge(Li) detectors.
1971Ne06: (p,γ): E(p)=2 MeV; measured Eγ and Iγ; Ge(Li) detector.
1973Ne07: (p,γ): E(p)=2 MeV; measured triple $\gamma\gamma(\theta)$; statistical theory analysis; NaI's.
Data are mostly from ^{64}Zn(p,γ) reported in 1975We24, 1979Ra12 and 1982Ra11. See also 1983PaZP.
Others: 1971KeZY, 1973BuYY.

^{65}Ga Levels

E(level)[†]	J$^\pi$[c]	Comments
0	3/2$^-$	
62.0 *2*	(1/2)$^-$	
190.8 *2*	5/2$^-$	J: 5/2 from triple $\gamma\gamma(\theta)$ (1973Ne07).
649.7 *1*	1/2$^-$,3/2$^-$	
809.2 *1*	1/2$^-$,3/2$^-$	
814.9 *2*	3/2$^-$	J: 3/2 from triple $\gamma\gamma(\theta)$ for a level at 821 (1973Ne07).
1075.9 *2*	7/2	
1135?[&] *7*		
1286[&] *7*	(9/2)$^-$	J: 9/2 from $\gamma\gamma(\theta)$ data (1979Ra12).
1298.6 *3*		
1352.9 *5*		
1377.4 *3*	5/2$^-$,7/2$^-$	
1469[a]		
1662.0 *2*	1/2$^-$,3/2$^-$	
1807[a]		
1856[a]	1/2$^-$,3/2$^-$	
1880 *2*		
1966.7 *3*		
1983.1 *5*		
2037[&] *7*	9/2$^+$	E(level): anti-analog state of 1066 level in ^{65}Zn (1979Ra12).
2163 *2*		E(level): also seen by 1987Ni14.
2206.5 *5*	5/2$^-$,7/2$^-$	E(level): also seen by 1987Ni14 at 2208. J: 5/2 consistent with $\gamma\gamma(\theta)$ data for a level at 2210 (1982Ra11).
2280[a]		
2323.8 *5*		
2357[a]		
2388[a]		
2426.6 *10*		
2447.0 *5*		
2470[a]		
2502.9 *5*		
2548[a]		
2575[a]		
2647[a]		
2669[a]		
2704.0 *15*		It is estimated (1975We24) that 40% 10 of the decay of this level is not observed.

Continued on next page (footnotes at end of table)

^{64}Zn(p,γ), (p,p′γ), IAR 1975We24,1979Ra12,1982Ra11 (continued)

^{65}Ga Levels (continued)

E(level)[†]	J$^{\pi}$[c]	Comments
2716[a]		
2754[a]		
2811.0 *15*	(3/2,5/2)	E(level): anti-analog state of the 1370 level in ^{65}Zn (1982Ra11). J=3/2, 5/2 consistent with $\gamma\gamma(\theta)$ data for a level at 2820 (1982Ra11).
2819[a]	3/2$^+$,5/2$^+$	
2906[a]		
2960[a]		
3036[a]		
3143[a]		
3173[a]		
3229[a]		
3250[a]		
3310[a]		
3415[a]		
3488[a]		
5116[b] *1*		
5240[b] *1*		
5298[b] *1*		
5339[b] *1*		
5352[b] *1*	(1/2$^+$)	E(level): corresponds to E(lab)=1431 keV. J$^{\pi}$: most likely from isotropic $\gamma(\theta)$ (1987Vi01).
5384[b] *1*		
5393[b] *1*		
5438[b] *1*		
5467[b] *1*		
5481[b] *1*		
5507[b] *1*		
S(p)+1845.4[‡] *7*		
S(p)+1906.9[‡] *6*		
S(p)+1940.5[‡] *6*		
S(p)+2023.9[‡] *7*		
S(p)+2917[#] *5*		
S(p)+2926[#] *5*	(9/2)	E(p)=2926 *5* (1979Ra12), E(p)=2926 *4* (1972Sz01). J: $\gamma\gamma(\theta)$ data in ^{64}Zn(p,γ) are consistent with J=9/2, $\gamma(\theta)$ data in ^{64}Zn(p,p′γ) are reported to rule out all other J possibilities (1979Ra12).
S(p)+2937[#] *5*		E(p)=2937 *5* (1979Ra12), E(p)=2937 *4* (1972Sz01).
S(p)+2942[#] *5*		
S(p)+3245[@] *5*	(3/2)	Resonance only observed in ^{64}Zn(p,p′γ) channel (1982Ra11). J: from $\gamma(\theta)$ (1982Ra11).
S(p)+3249[@] *5*	(5/2)	J: from $\gamma(\theta)$ in ^{64}Zn(p,p′γ) (1982Ra11).
S(p)+3253[@] *5*	(5/2)	J: from $\gamma(\theta)$ in ^{64}Zn(p,p′γ) (1982Ra11).
S(p)+3259[@] *5*		Resonance only observed in ^{64}Zn(p,p′γ) channel (1982Ra11). J$^{\pi}$: J≥3/2 from $\gamma(\theta)$ (1982Ra11).

[†] For E<5000 E(level) is from 1975We24; for E>5000 E(level)=S(p)+E(p)(lab) where S(p)=3942.6 *6* (2009AuZZ), unless indicated otherwise.

Continued on next page (footnotes at end of table)

^{64}Zn(p,γ), (p,p′γ), IAR 1975We24,1979Ra12,1982Ra11 (continued)

^{65}Ga Levels (continued)

‡ Reported in 1975We24, possibly IAS fragments of the 54 keV level in ^{65}Zn. Note: a band of levels reported at≈5390 (1971Ne06) is probably due to a misprint and should read 5930. Transitions from these states are reported to populate levels at 0, 62, 191, 650, 815, and 1076 (1971Ne06).

Fragments corresponding to the IAS of the 1066 level in ^{65}Zn (1979Ra12). Data for the 6823 *5* level and transitions depopulating it are reported to be typical for all fragments (1979Ra12).

@ Fragments corresponding to the IAS of the 1370 level in ^{65}Zn (1982Ra11). Absolute uncertainty estimated by evaluators as 5, consistent with uncertainties on E(p) reported by same author in 1979Ra12.

& From 1979Ra12. Uncertainty estimated as 7 keV by evaluators from uncertainty on E(p) and from ^{64}Zn(p,γ) spectrum (1979Ra12).

[a] From ^{64}Zn(p,γ) in 1987Ni14; energy determined from average resonance γ spectra; uncertainty not given by authors.

[b] From ^{64}Zn(p,γ) in 1987Vi01; uncertainty not specified by authors; estimated to be 1 keV by the evaluators.

[c] From Adopted Levels; supporting arguments from this data set are indicated in comments.

γ(^{65}Ga)

E_i(level)	J_i^π	E_γ †	I_γ ‡	E_f	J_f^π	Mult.	δ #	Comments
62.0	$(1/2)^-$	62.0 *2*	100	0	$3/2^-$			
190.8	$5/2^-$	190.8 *2*	100	0	$3/2^-$	(M1+E2)		I_γ: 28 *3* (1971Ne06). Mult.: from triple γγ(θ) (1973Ne07) and ΔJ^π. δ: −0.04 *2* or +3.6 *4* (phase convention undefined), from triple γγ(θ) (1973Ne07).
649.7	$1/2^-,3/2^-$	459.0 *2*	6 *3*	190.8	$5/2^-$			
		587.7 *2*	8 *3*	62.0	$(1/2)^-$			
		649.7 *2*	86 *3*	0	$3/2^-$			I_γ: 15.0 *14* (1971Ne06).
809.2	$1/2^-,3/2^-$	618.2 *2*	5 *3*	190.8	$5/2^-$			
		747.4 *2*	5 *3*	62.0	$(1/2)^-$			
		809.2 *2*	90 *3*	0	$3/2^-$			
814.9	$3/2^-$	166[a] *1*		649.7	$1/2^-,3/2^-$			E_γ: from 1971Ne06, not observed by 1975We24. I_γ: 7 *2* (1971Ne06).
		752 *2*	70 *20*	62.0	$(1/2)^-$			
		814.9 *2*	30 *20*	0	$3/2^-$	(M1+E2)		Branching: uncertainty given as 5 in 1975We24. I_γ: 16.0 *15*, for Eγ=820 *3* (1971Ne06). Mult.: from triple γγ(θ) (1973Ne07) and ΔJ^π. δ: +0.12 *6* or −12 *+3−5* (phase convention undefined), for a level at 821 with $J^\pi=3/2^-$, from triple γγ(θ) (1973Ne07).
1075.9	7/2	884.9 *3*	45 *5*	190.8	$5/2^-$			
		1075.9 *2*	55 *5*	0	$3/2^-$			I_γ: 7.0 *16* for Eγ=1079 *3* (1971Ne06).
1286	$(9/2)^-$	1095 *10*		190.8	$5/2^-$	(E2+M3)	−0.07 *7*	E_γ: from level energy difference. Mult.: from γγ(θ) (1979Ra12) and ΔJ^π. δ: from γγ(θ) of 9/2(4786γ)9/2+(751γ)9/2(1095γ)5/2− cascade in 1979Ra12.
1298.6		1107.8 *3*	25 *5*	190.8	$5/2^-$			
		1236.6 *3*	70 *5*	62.0	$(1/2)^-$			
		1299 *3*	5 *3*	0	$3/2^-$			
1352.9		1352.9 *5*	100	0	$3/2^-$			
1377.4	$5/2^-,7/2^-$	1315.3 *5*	30 *5*	62.0	$(1/2)^-$			
		1377.4 *3*	70 *5*	0	$3/2^-$			
1662.0	$1/2^-,3/2^-$	852.7 *3*	37 *2*	809.2	$1/2^-,3/2^-$			

Continued on next page (footnotes at end of table)

^{64}Zn(p,γ), (p,p′γ), IAR 1975We24,1979Ra12,1982Ra11 (continued)

$\gamma(^{65}Ga)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.	δ[#]	Comments
1662.0	1/2$^-$,3/2$^-$	1471.1 *3*	14 *2*	190.8	5/2$^-$			
		1600.0 *3*	43 *2*	62.0	(1/2)$^-$			
		1662.0 *3*	6 *2*	0	3/2$^-$			
1880		1689 *2*	100	190.8	5/2$^-$			
1966.7		1966.7 *3*	100	0	3/2$^-$			
1983.1		1174.0 *8*	15 *5*	809.2	1/2$^-$,3/2$^-$			
		1792.3 *8*	70 *5*	190.8	5/2$^-$			
		1921.0 *8*	15 *5*	62.0	(1/2)$^-$			
2037	9/2$^+$	751 *10*		1286	(9/2)$^-$	(E1+M2)	−0.18 *9*	E_γ: from level energy difference. Mult.: from $\gamma\gamma(\theta)$ (1979Ra12) and ΔJ^π. δ: from $\gamma\gamma(\theta)$ of 9/2(4786γ)9/2+(751γ)9/2(1095γ)5/2$^-$ cascade in 1979Ra12.
2163		1511 *3*	20 *20*	649.7	1/2$^-$,3/2$^-$			
		2101 *3*	65 *10*	62.0	(1/2)$^-$			
		2165 *3*	15 *10*	0	3/2$^-$			
2206.5	5/2$^-$,7/2$^-$	2015.8 *10*	30 *10*	190.8	5/2$^-$			
		2206.5 *5*	70 *10*	0	3/2$^-$	(M1,E2)		Mult.: from $\gamma\gamma(\theta)$ (1982Ra11) and ΔJ^π. δ: δ (E2/M1)≈+0.3 for J(2207)=5/2 and δ(E2+M3)>−3 for J(2207)=7/2, from $\gamma\gamma(\theta)$ of 5/2(4934γ)J(2207γ)3/2$^-$ cascade in 1982Ra11.
2323.8		2323.8 *5*	100	0	3/2$^-$			
2426.6		1617.8 *15*	40 *5*	809.2	1/2$^-$,3/2$^-$			
		1777.0 *20*	15 *5*	649.7	1/2$^-$,3/2$^-$			
		2364.0 *20*	30 *5*	62.0	(1/2)$^-$			
		2426.1 *20*	15 *5*	0	3/2$^-$			
2447.0		2447.0 *5*	100	0	3/2$^-$			
2502.9		1688.2 *10*	10 *10*	814.9	3/2$^-$			
		1693.0 *10*	10 *10*	809.2	1/2$^-$,3/2$^-$			
		1853.5 *10*	10 *10*	649.7	1/2$^-$,3/2$^-$			
		2440.9 *10*	70 *10*	62.0	(1/2)$^-$			
2704.0		2704.0 *15*		0	3/2$^-$			%branching=60 *10*. It is estimated that 40% 10 of the decay of the 2704 level is not observed.
2811.0	(3/2,5/2)	2620.2 *15*	80 *10*	190.8	5/2$^-$	D+Q		Mult.: from $\gamma\gamma(\theta)$ (1982Ra11). δ: ≈−1 for J(2811)=3/2 and<+2 for J(2811)=5/2, from $\gamma\gamma(\theta)$ of 5/2(4330γ)J(2620γ)5/2$^-$ cascade in 1982Ra11.
		2810.7 *25*	20 *10*	0	3/2$^-$			
S(p)+1940.5		4190.3 *12*						
S(p)+2023.9		3230.5 *20*		2754				
S(p)+2917		4777[@] *10*		2037	9/2$^+$			Γ(p)Γ(γ)/Γ=0.031 eV *10* (1979Ra12).
S(p)+2926	(9/2)	4786[@] *10*	93[&] *6*	2037	9/2$^+$	D+Q	−0.14 *+18−9*	Γ(p)Γ(γ)/Γ=0.077 eV *20* (1979Ra12). Γ(p)Γ(γ)/Γ=0.29 eV *5* (1972Sz01). Mult.: from $\gamma\gamma(\theta)$ (1979Ra12). δ: from $\gamma\gamma(\theta)$ of 9/2(4786γ)9/2+(751γ)9/

Continued on next page (footnotes at end of table)

^{64}Zn(p,γ), (p,p$'\gamma$), IAR 1975We24,1979Ra12,1982Ra11 (continued)

$\gamma(^{65}Ga)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.	Comments
							cascade in 1979Ra12.
S(p)+2926	(9/2)	5688[@a] *10*	<4[&]				
		5739[a] *5*	<4[&]	1135?			
		6173[a] *5*					E_γ: reported in 1971KeZY.
		6632[a] *5*	<2[&]				
S(p)+2937		4797[@] *10*		2037	$9/2^+$		$\Gamma(p)\Gamma(\gamma)/\Gamma$=0.040 eV *10* (1979Ra12). $\Gamma(p)\Gamma(\gamma)/\Gamma$=0.20 eV *5* (1972Sz01).
S(p)+2942		4801[@] *10*		2037	$9/2^+$		$\Gamma(p)\Gamma(\gamma)/\Gamma$=0.035 eV *10* (1979Ra12).
S(p)+3249	(5/2)	4330 *6*	24 *2*	2819	$3/2^+$,$5/2^+$	D+Q	$\Gamma(p)\Gamma(\gamma)/\Gamma$=0.014 eV *4* (1982Ra11). Mult.: from $\gamma\gamma(\theta)$ (1982Ra11). δ: ≈+1 for J(2811)=3/2 and≈0 for J(2811)=5/2 from $\gamma\gamma(\theta)$ of 5/2(4330γ)J(2620γ)$5/2^-$ cascade in 1982Ra11.
		4934 *5*	55 *4*	2280		D+Q	$\Gamma(p)\Gamma(\gamma)/\Gamma$=0.031 eV *5* (1982Ra11). Mult.: from $\gamma\gamma(\theta)$ (1982Ra11). δ: ≈−0.2 for J(2207)=5/2 and≈−2 for J(2207)=7/2 from $\gamma\gamma(\theta)$ of 5/2(4934γ)J(2207γ)$3/2^-$ cascade in 1982Ra11.
		6491 *5*	21 *2*				$\Gamma(p)\Gamma(\gamma)/\Gamma$=0.012 eV *3* (1982Ra11).
S(p)+3253	(5/2)	4938 *5*		2280			$\Gamma(p)\Gamma(\gamma)/\Gamma$=0.044 eV *8* (1982Ra11). Branching:>80 for this transition. For upper limit on branchings of unobserved transitions see 1982Ra11.

[†] Except as noted, for Eγ<3000 values are from 1975We24 and the uncertainty is estimated by the evaluators from level energy uncertainties; for Eγ>3000 Eγ is estimated from level energy differences.

[‡] Percent photon branching from each level are given from 1975We24 for Eγ<3000 and from 1979Ra12, 1982Ra11, where available, for Eγ>3000, except as noted. Iγ from 1971Ne06, where available, is given in comments.

[#] Note: values quoted in comments from $\gamma\gamma(\theta)$ in 1982Ra11 are estimated by the evaluators from plots of arctan(δ(1)) against arctan(δ(2)) and are only approximate.

[@] Uncertainty estimated as 10 from ^{64}Zn(p,γ) spectrum in 1979Ra12.

[&] γ branchings, mults., and δ's quoted are reported (1979Ra12) to be typical values for the transitions depopulating all E(p)≈2926 resonance states.

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

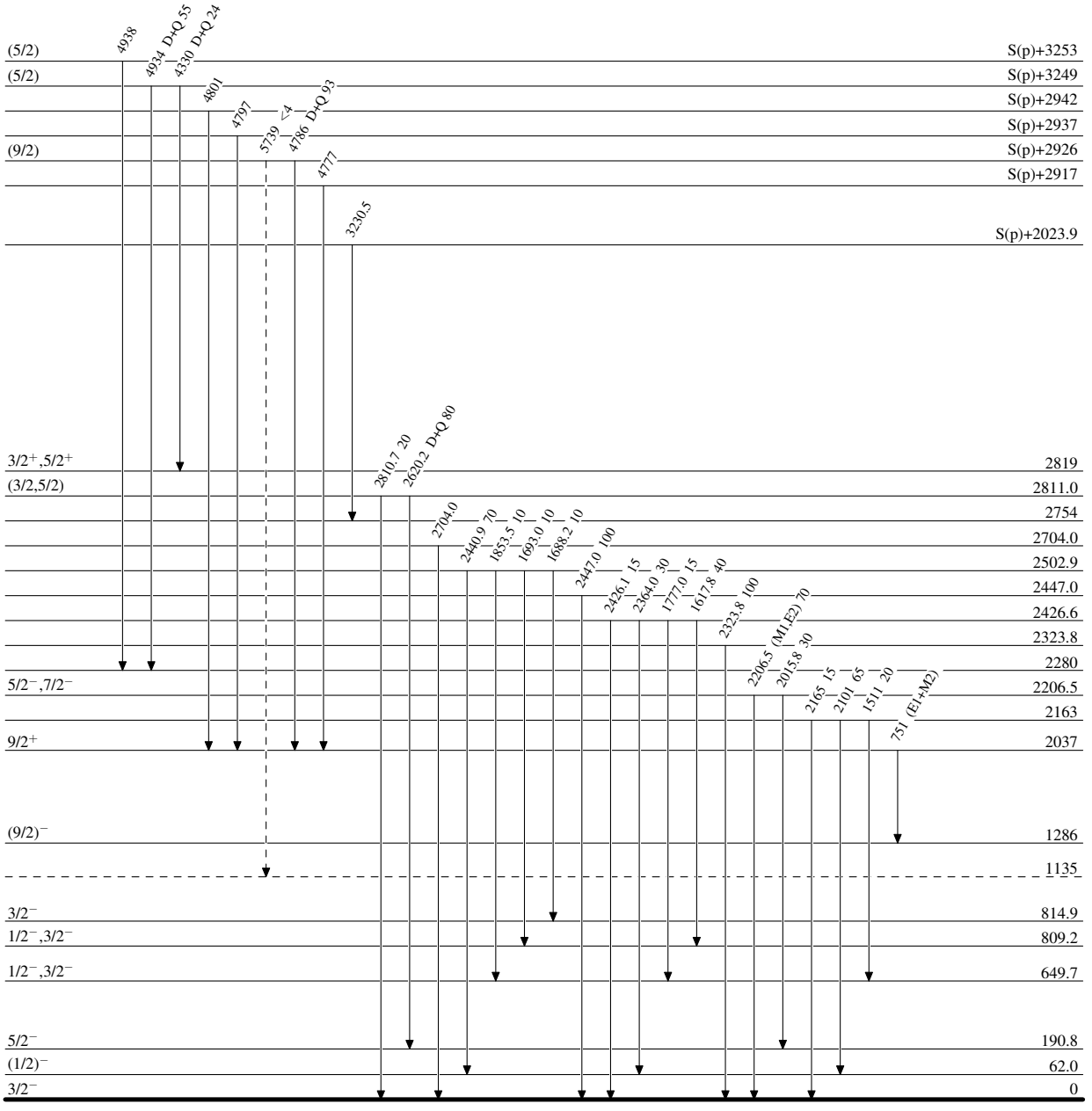
^{64}Zn(p,γ), (p,p′γ), IAR 1975We24,1979Ra12,1982Ra11

Legend

Level Scheme

Intensities: % photon branching from each level

γ Decay (Uncertain)



$^{65}_{31}Ga_{34}$

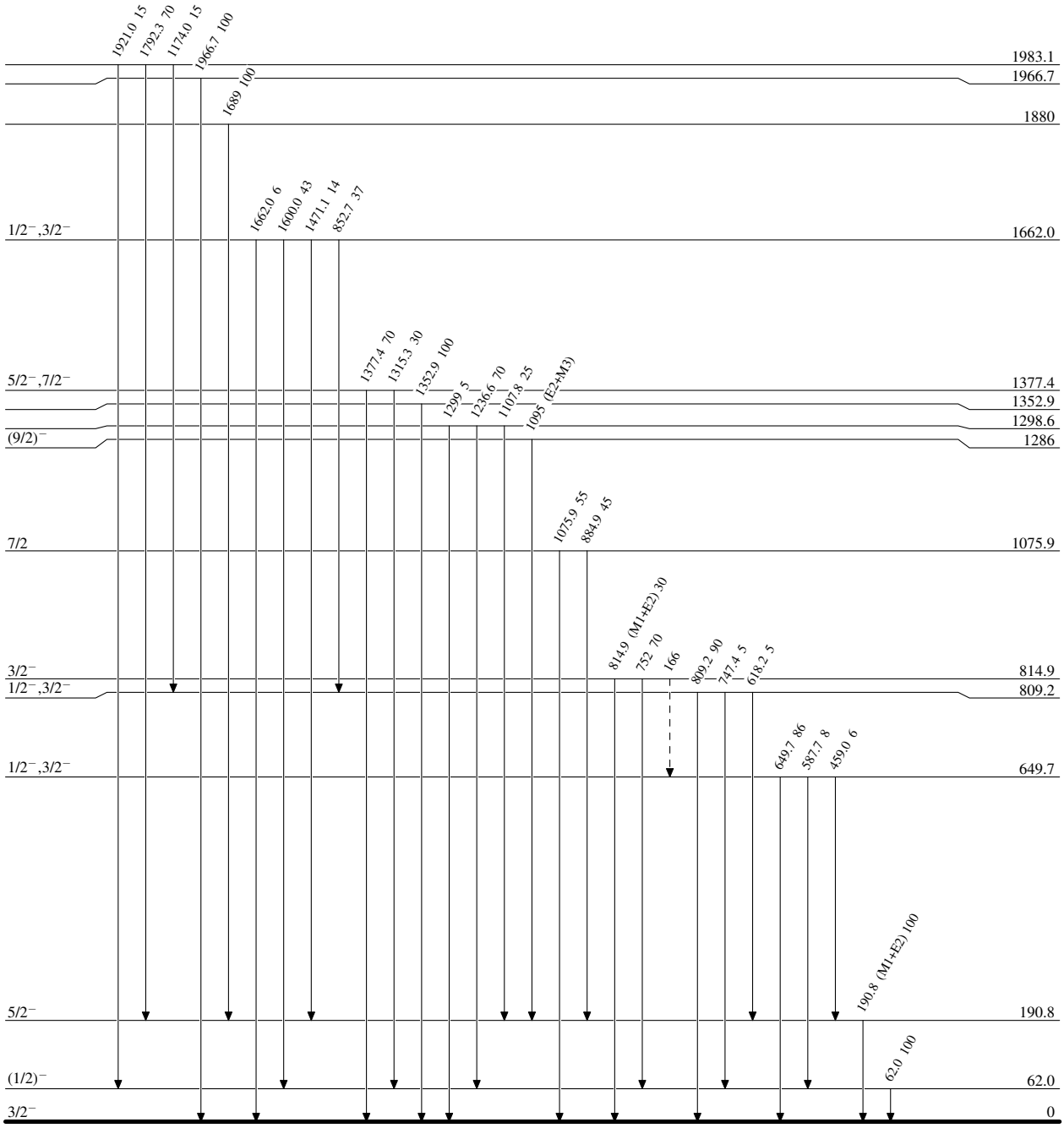
^{64}Zn(p,γ), (p,p′γ), IAR 1975We24,1979Ra12,1982Ra11

Legend

Level Scheme (continued)

Intensities: % photon branching from each level

– – – – – – ► γ Decay (Uncertain)



$^{65}_{31}Ga_{34}$