^{61}Ni(α,pnγ),^{62}Ni(α,p2nγ) 1980Ch28,1983Ka24

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 196,17 (2024)	30-Sep-2023

1980Ch28 (α,pnγ): E=21-35 MeV α beams were produced from the cyclotron at IN2P3, Grenoble. Target was 2.2 mg/cm^2 enriched ^{61}Ni. γ rays were detected with Ge(Li) detectors. Measured Eγ, Iγ, γγ-coin, γ(θ), γ(t), Doppler-shift attenuation. Deduced levels, J, π, $T_{1/2}$, γ-ray multipolarities, mixing ratios, transition strengths. Comparisons with theoretical calculations. Authors also studied ^{63}Cu using ^{60}Ni(α,pγ) and ^{63}Cu(α,α′γ) at E=18.5 MeV, but very limited data are reported.

1983Ka24 (α,p2nγ): E=50 MeV α beam was produced from the Tohoku University cyclotron. Target was a 6 mg/cm^2 metallic foil of enriched ^{62}Ni. γ rays were detected with HPGe and Ge(Li) detectors. Measured γ(θ, H, t) for 342γ from 4498 level. Deduced $T_{1/2}$ and g-factor for 4498 level using the time-integral perturbed angular distributions (TIPAD) method.

^{63}Cu Levels

E(level)†	J^π‡	$T_{1/2}$#	Comments
0.0	3/2$^-$		
670.0 *10*	1/2$^-$		
962.13 *14*	5/2$^-$	1.9 ps +*6*−*3*	
1327.01 *15*	7/2$^-$	0.8 ps +*3*−*2*	
1412.0 *10*	5/2$^-$		
1861.23 *14*	7/2$^-$	1.4 ps +*14*−*10*	
2092.53 *17*	7/2$^-$	1.4 ps +*14*−*7*	
2208.29 *22*	9/2$^-$		
2505.63 *17*	9/2$^+$	1.5 ps +*3*−*2*	
2547.54 *19*	9/2$^-$		
2677.71 *22*	11/2$^-$	0.8 ps +*6*−*2*	J^π: possibly yrast from feeding intensity; E2 γ to 7/2$^-$ level.
3461.15 *22*	11/2$^+$	0.2 ps +*4*−*1*	J^π: J>9/2 from feeding and excitation function of decay γ; 11/2$^+$ from multipolarity and δ of the 956-keV γ.
4129.65 *23*	(13/2$^+$)	2.3 ps +*14*−*7*	J^π: feeding from (15/2$^+$) level, deexcitation to (11/2$^+$) and 9/2$^+$ levels implies J=(11/2, 13/2); (13/2$^+$) from E2 γ to 9/2$^+$ level.
4155.45 *23*	13/2$^+$	3.5 ps *14*	J^π: J>9/2 from intense feeding, E2 γ to 9/2$^+$ level.
4497.8 *3*	17/2$^+$	4.1 ns *1*	J^π: yrast-isomeric state from intense feeding, E2 γ to 13/2$^+$ level. $T_{1/2}$: from τ=5.9 ns *1*, weighted average of 5.9 ns *1* from (α,p2nγ) (1983Ka24) and 6.1 ns *6* from (α,pγ) (1980Ch28), using 342γ(t). g=+0.184 *12*, measured using TIPAD method (1983Ka24).
4576.8 *3*	(15/2$^+$)	2.4 ps +*14*−*10*	J^π: from dipole γ decays to 13/2$^+$ levels and increasing excitation function.
5358.6 *4*	(19/2$^+$)	0.8 ps +*3*−*1*	J^π: from enough feeding, dipole γ decay to 17/2$^+$ level, and increasing excitation function.
5413.1 *4*	(17/2$^+$)	>2 ps	J^π: from D+Q γ decay to (15/2$^+$) level.
6284.8 *4*			
6495.6 *11*			

† From a least-squares fit to γ-ray energies.
‡ From 1980Ch28 based on deduced γ-ray multipolarities and known assignments of low-lying states.
# From DSAM in 1980Ch28, unless otherwise noted.

γ(^{63}Cu)

A_2 and A_4 under comments are from 1980Ch28.

$E_γ$†	$I_γ$†	E_i(level)	$J_i^π$	E_f	$J_f^π$	Mult.‡	Comments
342.3 *2*	48	4497.8	17/2$^+$	4155.45	13/2$^+$	E2	A_2=+0.31 *4*; A_4=−0.21 *6* Mult.,δ: δ(O/Q)=−0.12 *1*; M2,M3 components ruled out by RUL.

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^{61}Ni(α,pnγ),^{62}Ni(α,p2nγ) 1980Ch28,1983Ka24 (continued)

γ(^{63}Cu) (continued)

E_γ[†]	I_γ[†]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[‡]	δ[‡]	Comments
364.9 *2*	15	1327.01	7/2⁻	962.13	5/2⁻	D(+Q)	−0.25 *30*	A_2=−0.44 *7*; A_4=−0.09 *10*
413.1[@] *2*	≈23[&]	2505.63	9/2⁺	2092.53	7/2⁻			A_2=−0.39 *3*; A_4=−0.04 *4*
421.3 *2*	11	4576.8	(15/2⁺)	4155.45	13/2⁺	D(+Q)	−0.07 *+10−30*	A_2=−0.36 *5*; A_4=+0.03 *6*
447.1 *2*	4	4576.8	(15/2⁺)	4129.65	(13/2⁺)	M1+E2	−0.4 *+2−5*	A_2=−0.75 *5*; A_4=−0.1 *5*
469.4 *2*	10	2677.71	11/2⁻	2208.29	9/2⁻	D(+Q)	−0.07 *+10−30*	A_2=−0.37 *11*; A_4=−0.18 *16*
644.4 *2*	40[&]	2505.63	9/2⁺	1861.23	7/2⁻	D(+Q)	−0.05 *+10−30*	A_2=−0.32 *8*; A_4=−0.02 *12*
668.5[a] *2*		670.0	1/2⁻	0.0	3/2⁻			E_γ: multiplet with 668.5γ from 4130 level.
668.5[a] *2*	10	4129.65	(13/2⁺)	3461.15	11/2⁺	D(+Q)	+0.05 *20*	A_2=−0.14 *5*; A_4=−0.22 *8*
686.3 *2*	15	2547.54	9/2⁻	1861.23	7/2⁻	D+Q	−0.18 *+20−40*	A_2=−0.43 *16*; A_4=−0.32 *25*
694.3 *2*	19	4155.45	13/2⁺	3461.15	11/2⁺	M1+E2	−0.32 *+20−40*	A_2=−0.65 *18*; A_4=−0.26 *25*
765.5 *2*	11	2092.53	7/2⁻	1327.01	7/2⁻	D(+Q)	−0.2 *5*	A_2=+0.20 *8*; A_4=−0.01 *10*
836.3 *2*	6	5413.1	(17/2⁺)	4576.8	(15/2⁺)	D+Q	−0.25 *+10−30*	A_2=−0.60 *32*; A_4=+0.01 *30*
860.8 *2*	12	5358.6	(19/2⁺)	4497.8	17/2⁺	M1+E2	−0.32 *+20−40*	A_2=−0.70 *7*; A_4=+0.13 *8*
881.3[@] *2*		2208.29	9/2⁻	1327.01	7/2⁻			
899.1 *2*	29	1861.23	7/2⁻	962.13	5/2⁻	D(+Q)	+0.05 *+10−20*	A_2=−0.17 *4*; A_4=−0.02 *6*
955.5 *2*	29	3461.15	11/2⁺	2505.63	9/2⁺	D+Q	−0.8 *+2−4*	A_2=−1.05 *25*; A_4=+0.01 *22*
962.1 *2*	100	962.13	5/2⁻	0.0	3/2⁻	D(+Q)	−0.3 *3*	A_2=−0.52 *5*; A_4=+0.06 *6*
1130.4 *2*	17	2092.53	7/2⁻	962.13	5/2⁻	M1+E2	−1.0 *4*	A_2=−0.87 *9*; A_4=+0.11 *8*
1137		6495.6		5358.6	(19/2⁺)			
1178.6[@] *2*	≈20[&]	2505.63	9/2⁺	1327.01	7/2⁻			A_2=+0.12 *4*; A_4=+0.07 *7*
1246[#]		2208.29	9/2⁻	962.13	5/2⁻			
1327.0 *2*	76	1327.01	7/2⁻	0.0	3/2⁻	E2		A_2=+0.15 *5*; A_4=−0.13 *9* Mult.,δ: δ(O/Q)=−0.3 *3*; M2,M3 components ruled out by RUL.
1350.7 *2*	26	2677.71	11/2⁻	1327.01	7/2⁻	E2		A_2=+0.19 *4*; A_4=−0.26 *8* Mult.,δ: δ(O/Q)=−0.18 *+2−1*; M2,M3 components ruled out by RUL.
1412[#]		1412.0	5/2⁻	0.0	3/2⁻			
1585.4 *2*	≈7	2547.54	9/2⁻	962.13	5/2⁻			Mult.: A_2≥0.
1624.0 *2*	10	4129.65	(13/2⁺)	2505.63	9/2⁺	(E2)		A_2=+0.07 *10*; A_4=−0.5 *2* Mult.,δ: δ(O/Q)=−0.3 *+4−5* is tentative based on authors′ tentative J^π=(13/2⁺); M2,M3 ruled out by RUL.
1649.8 *2*	59	4155.45	13/2⁺	2505.63	9/2⁺	E2		A_2=+0.32 *4*; A_4=−0.16 *8* Mult.,δ: δ(O/Q)=−0.3 *1*; M2,M3 components ruled out by RUL.
1787.0 *2*	≈17	6284.8		4497.8	17/2⁺			A_2=+0.21 *6*; A_4=+0.01 *8* E_γ: contaminated by a similar γ in ^{60}Ni.
1861.2 *2*	34	1861.23	7/2⁻	0.0	3/2⁻	E2		A_2=+0.27 *3*; A_4=+0.17 *6* Mult.,δ: δ(O/Q)=−0.1 *1*; M2,M3 components ruled out by RUL.
2093[#]	15	2092.53	7/2⁻	0.0	3/2⁻			

† From 1980Ch28.
‡ From measured γ(θ) in 1980Ch28, with magnetic and electric character determined based on RUL and measured $T_{1/2}$ where available.
# From authors′s level scheme in Fig.8 (1980Ch28).
@ Contaminated by similar γ in ^{63}Zn (1980Ch28).

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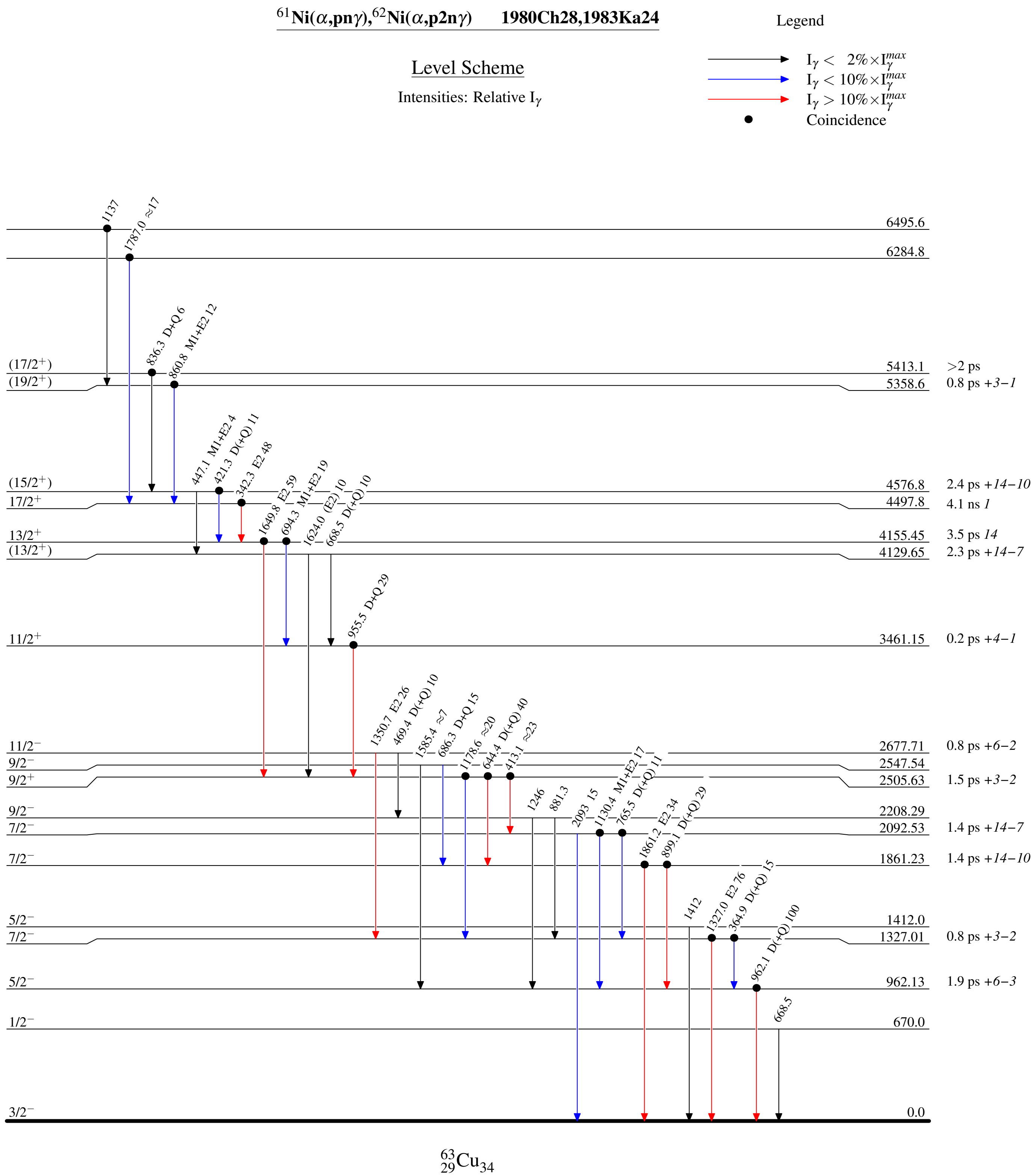
^{61}Ni(α,pnγ),^{62}Ni(α,p2nγ) 1980Ch28,1983Ka24 (continued)

γ(^{63}Cu) (continued)

[&] From (α,$\alpha'\gamma$) reaction (1980Ch28).
[a] Multiply placed.


^{61}Ni(α,pnγ),^{62}Ni(α,p2nγ) 1980Ch28,1983Ka24
Level Scheme
Intensities: Relative Iγ
Legend
Iγ < 2%×Iγ^max
Iγ < 10%×Iγ^max
Iγ > 10%×Iγ^max
Coincidence
6495.6
6284.8
(17/2+) 5413.1 >2 ps
(19/2+) 5358.6 0.8 ps +3−1
(15/2+) 4576.8 2.4 ps +14−10
17/2+ 4497.8 4.1 ns 1
13/2+ 4155.45 3.5 ps 14
(13/2+) 4129.65 2.3 ps +14−7
11/2+ 3461.15 0.2 ps +4−1
11/2− 2677.71 0.8 ps +6−2
9/2− 2547.54
9/2+ 2505.63 1.5 ps +3−2
9/2− 2208.29
7/2− 2092.53 1.4 ps +14−7
7/2− 1861.23 1.4 ps +14−10
5/2− 1412.0
7/2− 1327.01 0.8 ps +3−2
5/2− 962.13 1.9 ps +6−3
1/2− 670.0
3/2− 0.0
1137
1787.0 ≈17
836.3 D+Q 6
860.8 M1+E2 12
447.1 M1+E2 4
421.3 D(+Q) 11
342.3 E2 48
1649.8 E2 59
694.3 M1+E2 19
1624.0 (E2) 10
668.5 D(+Q) 10
955.5 D+Q 29
1350.7 E2 26
469.4 D(+Q) 10
1585.4 ≈7
686.3 D+Q 15
1178.6 ≈20
644.4 D(+Q) 40
413.1 ≈23
1246
881.3
2093 15
1130.4 M1+E2 17
765.5 D(+Q) 11
1861.2 E2 34
899.1 D(+Q) 29
1412
1327.0 E2 76
364.9 D(+Q) 15
962.1 D(+Q) 100
668.5
$^{63}_{29}Cu_{34}$