Nuclear Data Sheets for A = 61^{*}

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Abstract: The evaluated spectroscopic data are presented for known nuclides of mass 61 (Sc,Ti,V,Cr,Mn,Fe,Co,Ni,Cu,Zn,Ga,Ge). Excited-state data are nonexistent for ⁶¹Sc, ⁶¹Ti, ⁶¹V, and ⁶¹Ge. Significant amounts of new data have been added since the previous NDS evaluation of A=61 nuclides (1999Bh04). ⁶¹Sc nuclide is now experimentally known, but without any knowledge of its half-life. The ground state half-lives of ⁶¹Ti and ⁶¹V are now determined. Excited-state data have become available for ⁶¹Cr, ⁶¹Mn and ⁶¹Ga, while for ⁶¹Ge, five excited states were erroneously assigned in the previous evaluation, these have been omitted here. Improved and extensive high-spin excitations are available for ⁶¹Fe, ⁶¹Cu and ⁶¹Zn, including several new superdeformed structures in ⁶¹Cu and ⁶¹Zn. Thermal neutron capture γ -ray data are available in detail from 2004Ra23. The radioactive decay schemes of ⁶¹Sc and ⁶¹Ti are not known, while those for ⁶¹V, ⁶¹Fe and ⁶¹Ge are poorly known. This work benefited from the earlier full evaluations of A=61 published by 1999Bh04, 1983Ek01 and 1975Au05 and the one published in an 'update' mode by 1992Zh31. The data and conclusions presented in the current work supersede those in all the previous evaluations.

Cutoff Date: Literature up to Jan 25, 2015 has been consulted. The main source used for bibliographic information is the NSR database (2011Pr03) at www.nndc.bnl.gov/nsr/.

General Policies and Organization of Material: see <http://www.nndc.bnl.gov/nds/NDSPolicies.pdf>.

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General Comments: The statistical analysis of γ -ray data and deduced level schemes is carried out through computer codes available at NNDC, BNL website: www.nndc.bnl.gov. The direct feedings to excited states in β^- and ϵ decays have generally been computed by the evaluators from $I(\gamma+ce)$ intensity balances at each level; the associated $\log ft$ values are calculated using LOGFT code. The theoretical total internal conversion coefficients corresponding to assigned multipolarities and mixing ratios, are listed in γ -ray tables, when these values are significant (>0.001 or so). These are calculated from BrIcc code: v2.2b (20-Jan-2009) (2008Ki07) with "Frozen Orbitals" approximation, and with implicit uncertainty of 1.4%. The values of measured magnetic dipole moments (μ) and static quadrupole moments (Q) are from compilations by 2014StZZ and 2013StZZ, when available. In cases where weighted averaging procedures have been used, the assigned uncertainty is generally not lower than the lowest in the dataset that is being averaged.

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NUCLEAR DATA SHEETS

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NUCLEAR DATA SHEETS

Skeleton Scheme for A=61

S(p) 18780^{CA}
S(α) 17560^{CA}

S(n) 3090^{SY} S(p) 19590^{SY}
0.0
>620 ns
⁶¹Sc₄₀
21
Q⁻=17280^{SY}
S(α) 11900^{SY}
?%

S(n) 2090^{SY} S(p) 15470^{SY}
(1/2-) 0.0
15 ms
⁶¹Ti₃₉
22
Q⁻=14160^{SY}
S(α) 11860^{SY}
100%

S(n) 5340⁹²⁰ S(p) 16500²⁶⁰
(3/2-, 5/2-) 0.0
48.3 ms
⁶¹V₃₈
23
Q⁻=11950⁹⁰⁰
S(α) 11010²⁸⁰
100%

S(n) 4020²⁵⁰ S(p) 12530²¹⁰
(5/2-) 0.0
237 ms
⁶¹Cr₃₇
24
Q⁻=9290¹³⁰
S(α) 9940²³⁰
S(n) 6846³ S(p) 13242³
100%

S(α) 8821³
(5/2-) 0.0
0.709 s
⁶¹Mn₃₆
25
Q⁻=7178³
S(n) 5579⁴
100%

(9/2+) 861.67
(3/2-) 0.0
5.98 min
⁶¹Fe₃₅
26
Q⁻=3977.1²⁸
100%

Skeleton Scheme for A=61 (continued)

Ground-State and Isomeric-Level Properties				
Nuclide	Level	$J\pi$	$T_{1/2}$	Decay Modes
^{61}Sc	0.0		>620 ns	β^- =?; β^-n =?; β^-2n =?
^{61}Ti	0.0	(1/2-)	15 ms 4	β^- =100; β^-n =?; β^-2n =?
^{61}V	0.0	(3/2-, 5/2-)	48.3 ms 10	β^- =100; β^-n >10; β^-2n =?
^{61}Cr	0.0	(5/2-)	237 ms 11	β^- =100; β^-n =?
^{61}Mn	0.0	(5/2-)	0.709 s 8	β^- =100
^{61}Fe	0.0	(3/2-)	5.98 min 6	β^- =100
	861.67	(9/2+)	238 ns 5	IT=100
^{61}Co	0.0	7/2-	1.649 h 5	β^- =100
^{61}Ni	0.0	3/2-	stable	
^{61}Cu	0.0	3/2-	3.339 h 8	ϵ + β^+ =100
^{61}Zn	0.0	3/2-	89.1 s 2	ϵ + β^+ =100
^{61}Ga	0.0	3/2-	167 ms 3	ϵ + β^+ =100; ϵp <0.25
^{61}Ge	0.0	(3/2-)	44 ms 6	ϵ + β^+ =100; ϵp >62

S(n) 14190^{SY}

Adopted Levels

Q(β^-)=17280 SY; S(n)=3090 SY; S(p)=18780 CA; Q(α)=-17560 CA 2012Wa38,1997Mo25.

Estimated uncertainties (2012Wa38): 1000 for Q(β^-), 1060 for S(n).

Q(β^-) and S(n) from 2012Wa38, S(p) and Q(α) from 1997Mo25.

Q(β^- n)=15190 950, S(2n)=4910 1000 (syst,2012Wa38). S(2p)=42610 (theoretical,1997Mo25).

2009Ta24, 2009Ta05: ⁶¹Sc identified by fragmentation of ⁷⁶Ge beam at 132 MeV/nucleon at NSCL facility using A1900 fragment separator combined with S800 analysis beam line to form a two stage separator system. The transmitted fragments were analyzed event-by-event in momentum and particle identification. The nuclei of interest were stopped in eight Si diodes which provided measurement of energy loss, nuclear charge and total kinetic energy. The time-of-flight of each particle that reached the detector stack was measured in four different ways using plastic scintillators, Si detectors, and parallel-plate avalanche counters. The simultaneous measurement of ΔE signals, the magnetic rigidity, total kinetic energy and the time-of-flight (tof) provided unambiguous identification of the atomic number, charge state and mass number.

1995Ri05: shell model calculations; predicted spin, binding energy, and mass defect.

⁶¹Sc Levels

E(level)	T _{1/2}	Comments
0.0	>620 ns	<p>%β^-=?; %β^-n=? ; %β^-2n=?</p> <p>Measured cross section=8 fb +14-5 for Be target and 74 fb +133-56 for W target (data supplied by O. Tarasov in e-mail reply of Nov 11, 2009, corresponding to figure 2 in 2009Ta05 and figure 8 in 2009Ta24).</p> <p>Theoretical %β^-n=58, %β^-2n=1.5 (1997Mo25).</p> <p>E(level): fragment observed by 2009Ta05 and 2009Ta24 is assumed to be in the ground state of ⁶¹Sc.</p> <p>Jπ: 7/2 (predicted,1997Mo25,1995Ri05), 7/2- from systematics (2012Au07).</p> <p>T_{1/2}: lower limit estimated from time-of-flight=620-650 ns, given in e-mail reply of Sept 23, 2009 from O. Tarasov. Actual half-life is expected to be much longer as suggested by theoretical value of 4.7 ms (1997Mo25), and systematics value of 2 ms (2012Au07).</p>

Adopted Levels

$Q(\beta^-)=14160$ SY; $S(n)=2090$ SY; $S(p)=19590$ SY; $Q(\alpha)=-11900$ SY 2012Wa38.

Estimated uncertainties (2012Wa38): 1080 for $Q(\beta^-)$, 780 for $S(n)$, 920 for $S(p)$, 840 for $Q(\alpha)$.

$Q(\beta^-n)=8820$ 640, $S(2n)=6850$ 720 (syst,2012Wa38). $S(2p)=38160$ (1997Mo25,theory).

^{61}Sc nuclide has been identified but no information about its decay to ^{61}Ti is available.

1997Be70: ^{61}Ti identified in projectile fission of a 750 MeV/nucleon ^{238}U beam incident on a Be target, followed by fragment separation using FRS at GSI facility. Measured production cross section. Nine events were assigned to ^{61}Ti with corresponding cross section of 2.5 nb.

2011Da08 (also 2002MaZN thesis): ^{61}Ti produced in the fragmentation of 57.8 MeV/nucleon ^{86}Kr beam impinged on 50 mg/cm² thick tantalum target using LISE-2000 spectrometer at GANIL facility. Detector system included a three-element Si-detector telescope containing a double-sided silicon-strip detector (DSSSD) backed by a Si(Li) detector and surrounded by four clover type EXOGAM Ge detectors. Product identified by mass, atomic number, charge, energy loss and time-of-flight methods. Measured half-life.

A very weak γ ray at 126.2 reported by 2002MaZN was seen in coincidence with heavy ions. This may either be an isomeric transition in ^{61}Ti or a γ ray in ^{61}V emitted by the decay of ^{61}Ti . But a 127.2 γ has also been reported by 2005Ga01 in the decay of ^{61}V to ^{61}Cr .

Theoretical calculations: 1995Ri05 Shell model calculations (predicted spin, binding energy, mass defect).

 ^{61}Ti Levels

E(level)	J π	T _{1/2}	Comments
0.0	(1/2-)	15 ms 4	<p>$\% \beta^- = 100$; $\% \beta^-n = ?$; $\% \beta^-2n = ?$</p> <p>Theoretical $\% \beta^-n = 0.8$, $\% \beta^-2n = 0.7$ (1997Mo25).</p> <p>Jπ: spin predicted in shell-model calculations (1995Ri05), also in systematics (2012Au07) and theoretical calculations (1997Mo25).</p> <p>T_{1/2}: from 2011Da08, based on time correlation between implantation and β^--ray events in the DSSSD. Fitting procedure included five parameters: β^--detection efficiency, background rate, mother, daughter and granddaughter half-lives.</p>

Adopted Levels

Q(β^-)=11950 900; S(n)=5340 920; S(p)=15470 SY; Q(α)=-11860 SY 2012Wa38.
 Estimated uncertainties (2012Wa38): 1030 for S(p), 760 for Q(α).
 Q(β^- n)=7930 920, S(2n)=8820 910, S(2p)=34780 1080 (syst) (2012Wa38).
 1992We04: first identification of ⁶¹V in fragmentation of a 500 MeV/nucleon ⁸⁶Kr beam incident on a Be target and identified by a zero-degree magnetic spectrometer and separated by FRS at GSI facility. Determined production cross section.
 1999So20 (also 2001So07 and 1999Le67): ⁶¹V produced in the fragmentation of 60.4 MeV/nucleon ⁸⁶Kr beam with ⁵⁸Ni target; LISE3 spectrometer at GANIL facility. Measured half-life of decay of ⁶¹V.
 2003So02: ⁶¹V produced in fragmentation of ⁷⁶Ge³⁰⁺ beam on ⁵⁸Ni target. LISE3 achromatic spectrometer used to separate fragments; measured half-life of ⁶¹V decay and probability of delayed-neutron decay from the observation of 2+ to 0+ transition in ⁶⁰Cr.
 2011Da08 (also 2002MaZN thesis): ⁶¹Ti produced in the fragmentation of 57.8 MeV/nucleon ⁸⁶Kr beam impinging on 50 mg/cm² thick tantalum target using LISE-2000 spectrometer at GANIL facility. Detector system included a three-element Si-detector telescope containing a double-sided silicon-strip detector (DSSSD) backed by a Si(Li) detector and surrounded by four clover type EXOGAM Ge detectors. Product identified by mass, atomic number, charge, energy loss and time-of-flight methods. Measured half-life.
 2014Su07: ⁶¹V beam produced from fragmentation of 120 MeV/nucleon ⁷⁶Ge beam on ⁹Be target, followed by mass separation by A1900 separator at NSCL-MSU accelerator facility. The resulting cocktail ion beam was transported to the Beta Counting System and implanted into a 1-mm-thick double-sided silicon strip detector. Measured E γ , I γ , $\gamma\gamma$ -coin using SeGA array. Deduced levels J, π , estimate of % β^- n Comparisons made with shell-model calculations. No information about the decay of ⁶¹Ti to ⁶¹V is available.
 A very weak γ ray at 126 2 reported by 2002MaZN was seen in coincidence with heavy ions. This may either be an isomeric transition in ⁶¹Ti or a γ ray in ⁶¹V emitted by the decay of ⁶¹Ti. But a 127 2 γ has also been reported by 2005Ga01 in the decay of ⁶¹V to ⁶¹Cr.
 Mass measurement by time-of-flight method: 2011Es06.
 Theoretical calculations: 1995Ri05 Shell model calculations (predicted spin, binding energy, mass defect).

⁶¹V Levels

E(level)	J π	T _{1/2}	Comments
0.0	(3/2-, 5/2-)	48.3 ms 10	<p>%β^-=100; %β^-n>10 (2014Su07); %β^-2n=? %β^-n>10 (2014Su07) from observation and absolute intensity of 644-keV transition in ⁶⁰Cr. Other %β^-n$\geq$6 (2003So02). Theoretical %β^-n=21 (1997Mo25). Jπ: possible configuration=π3/2[321] of f_{7/2} orbital (2005Ga01), assuming small quadrupole deformation. 2014Su07 assign 3/2- or 5/2-, former is more likely if ground state is prolate deformed, the latter is possible if oblate deformation; further 5/2- is less likely due to lack of observation of population of 4+ level in ⁶⁰Cr by β^-n decay mode of ⁶¹V. A 7/2- spherical configuration was predicted in shell-model calculations (1995Ri05). From systematics, 2012Au07 suggest 3/2-, while 5/2- is predicted in theoretical calculations by 1997Mo25. T_{1/2}: weighted average of 49 ms 1 (2014Su07, β(fragment) correlations, decay curve, including daughter and grand-daughter decays, fitted with exponential and constant background), 52.6 ms 42 (2011Da08,2002MaZN, β(fragment) correlations, decay curve, including daughter and grand-daughter decays, fitted with exponential and constant background), and 47.0 ms 12 (2003So02, timing of β and ⁶¹V correlated events, also 47 ms 1 in 2005Ga01; 41 ms 1 quoted in table 3 of 2005Ga01 is a misprint). Other: 43 ms 7 (1999So20, older value from the same experimental group as 2003So02, although a different reaction was used to produce the ⁶¹V activity).</p>

Adopted Levels, Gammas

Q(β^-)=9290 130; S(n)=4020 250; S(p)=16500 260; Q(α)=-11010 280 2012Wa38.
 Q(β^- n)=2440 130, S(2n)=10710 280, S(2p)=31390 420 (syst) (2012Wa38).
 1985Gu14: first identification of ^{61}Cr from fragmentation of ^{86}Kr beam at 33 MeV/nucleon on tantalum and titanium targets using time-of-flight and ΔE -E measurements, LISE spectrometer at GANIL facility.
 1992We04: ^{61}Cr formed in fragmentation of a 500 MeV/nucleon ^{86}Kr beam incident on a Be target and identified by a zero-degree magnetic spectrometer and separated by FRS at GSI facility. Determined production cross section.
 1998Am04: ^{61}Cr formed in fragmentation of 500 MeV/nucleon ^{86}Kr beam incident on Be target, FRS spectrometer at GSI facility. Measured half-life of ^{61}Cr decay.
 1999So20 (also 2001So07 and 1999Le67): ^{61}Cr produced in the fragmentation of 60.4 MeV/nucleon ^{86}Kr beam with ^{58}Ni target; LISE3 spectrometer at GANIL facility. Measured half-life of decay of ^{61}Cr .
 2002MaZN (thesis): ^{61}Cr produced in fragmentation of 57.8 MeV/nucleon ^{86}Kr beam with tantalum target using LISE-2000 spectrometer at GANIL facility. Measured half-life of ^{61}Cr decay.
 2009Cr02: ^{61}Cr produced in $^9\text{Be}(^{76}\text{Ge},X)$ reaction at a beam energy of 130 MeV/nucleon. The ^{76}Ge beam was produced by the coupled cyclotrons at the National Superconducting Cyclotron Laboratory at Michigan State University. Fragments were separated using the A1900 fragment separator. The β and γ spectra were measured using the Beta Counting System and the Segmented Germanium Array, as well as three Si PIN detectors. Measured E_γ , I_γ , $\gamma\gamma$, β , $\beta\gamma$ coin, (fragment) β coin, half-life of the ^{61}Cr ground state.
 Measured mass excess=-41.5 MeV 4 (1990Tu01).
 Mass measurement: 1994Se12.
 2014Su07: shell-model calculations using GXPF1A and KB3G interactions. Predicted levels from GXPF1A calculation are: 0,1/2-; 35,5/2-; 139,3/2-; 575,3/2-; 895,5/2-; 1107,9/2-; 1115,7/2-; 1197,7/2-. Except for possible matching of 35, 5/2- level with ground state, none of the other levels can be easily matched with those deduced from experimental data in 2014Su07.
 1995Ri05: Shell model calculations; predicted binding energy, and mass defect.

 ^{61}Cr Levels

No evidence was found for isomeric states in ^{61}Cr based on $\gamma\gamma$ -coin data in ^{61}V decay study (2014Su07).

Cross Reference (XREF) Flags

A ^{61}V β^- Decay (48.3 ms)

E(level) [†]	J π	XREF	T _{1/2}	Comments
0.0	(5/2-)	A	237 ms 11	% β^- =100; % β^- n=? Theoretical % β^- n=0.6 (1997Mo25). J π : possible configuration=v5/2[303] of f _{5/2} orbital or v1/2[301] of p _{1/2} orbital. From likelihood of β feeding to the ground state, v5/2[303] configuration is favored by 2005Ga01. 5/2- from systematics (2012Au07), 3/2+ from theoretical predictions (1997Mo25). T _{1/2} : weighted average of 233 ms 11 (2009Cr02), 251 ms 22 (1999So20,1999Le67,2001So07). Others: 250 ms 100 (2002MaZN), 0.27 s 2 (1998Am04). J π : dipole γ to (5/2-). J π : dipole γ to (5/2-).
70.8 3	(3/2, 5/2, 7/2)	A		
97.41 23	(3/2, 5/2, 7/2)	A		
224.1 4		A		
401.8 5		A		
450.6 3		A		
564.4 5		A		
631.7 8		A		
715.9 4		A		
773.7 4		A		
1026.6 3		A		
1222.0 5		A		
2061.9 5		A		
2261.4 6		A		

[†] From least-squares fit to E_γ data.

Adopted Levels, Gammas (continued)

$\gamma(^{61}\text{Cr})$					
E(level)	E_γ	I_γ	Mult.	α	Comments
70.8	70.8 3	100	D	0.083 18	Mult.: from Weisskopf estimates and non-observation of a long lifetime for 71-keV level (2014Su07).
97.41	97.7 3	100	D,M1+E2	0.24 21	Mult.: from Weisskopf estimates, and observation of no time delay between the 127- and 98-keV γ rays within the experimental detection limit of ≈ 150 ns (2014Su07).
224.1	126.7 3	100			
401.8	331.0 4	100			
450.6	353.6 5	27 9			
	450.5 3	100 11			
564.4	467.0 4	100			
631.7	407.6 7	100			
715.9	645.0 8	20 8			
	715.9 4	100 12			
773.7	676.4 6	39 17			
	773.7 4	100 22			
1026.6	929.4 4	79 11			
	1026.3 4	100 13			
1222.0	1151.2 4	100			
2061.9	1964.5 4	100			
2261.4	2164.0 5	100			

 ^{61}V β^- Decay (48.3 ms) 2014Su07,2005Ga01

Parent ^{61}V : $E=0.0$; $J^\pi=(3/2^-,5/2^-)$; $T_{1/2}=48.3$ ms 10; $Q(\text{g.s.})=11950$ 900; $\%\beta^-$ decay=100.

$^{61}\text{V}-J, T_{1/2}$: From Adopted Levels of ^{61}V .

$^{61}\text{V}-Q(\beta^-)$: From 2012Wa38.

2014Su07: ^{61}V beam produced from fragmentation of 120 MeV/nucleon ^{76}Ge beam on ^9Be target, followed by mass separation by A1900 separator at NSCL-MSU accelerator facility. The resulting cocktail ion beam was transported to the Beta Counting System and implanted into a 1-mm-thick double-sided silicon strip detector. Measured E_γ , I_γ , $\gamma\gamma$ -coin using SeGA array. Deduced levels J , π , estimate of $\%\beta^-$ -n Comparisons made with shell-model calculations.

2005Ga01: ^{61}V produced in fragmentation of $^{76}\text{Ge}^{30+}$ beam on ^{58}Ni target. LISE3 achromatic spectrometer used to separate fragments; magnetic rigidity was tuned to optimize transmission of ^{62}V and ^{64}Cr fragments. Transmitted nuclei were identified by three consecutive Si detectors where two served for energy loss and time-of-flight measurements while the last determined their residual energies. Measured E_γ , I_γ , I_β , $\gamma\gamma$, $\beta\gamma$ coin, $\gamma(t)$, lifetimes with four Ge detectors placed around a thick Si telescope. Half-lives determined by fitting procedures involving five parameters: half-lives of mother, daughter and grand-daughter nuclei, the β -efficiency and the background rate over the 1 s collecting time. Tentative levels at 97, 310, 450 and 1027 proposed in 2005Ga01, all but the 310 level have been confirmed by 2014Su07.

2003So02: same method of ^{61}V production as in 2005Ga01. measured half-life of ^{61}V decay and probability of delayed-neutron decay from the observation of $2+$ to $0+$ transition in ^{60}Cr .

1999So20 (also 2001So07 and 1999Le67): ^{61}V produced in the fragmentation of 60.4 MeV/nucleon ^{86}Kr beam with ^{58}Ni target; LISE3 spectrometer at GANIL facility. Measured half-lives of decays of ^{61}V and ^{61}Cr .

Theoretical calculations: 1995Ri05 Shell model calculations (predicted spin, binding energy, mass defect).

All data are from 2014Su07.

Energy balance cannot be deduced since the decay scheme is most likely incomplete.

 ^{61}Cr Levels

No evidence was found for isomeric states in ^{61}Cr based on $\gamma\gamma$ -coin data.

A tentative 310-keV level proposed by 2005Ga01 is not confirmed by 2014Su07; it is omitted here.

E(level) [†]	J^π [‡]	$T_{1/2}$ [‡]	Comments
0.0	(5/2-)	237 ms 11	Possible configuration= $\nu 5/2[303]$ of $f_{5/2}$ orbital or $\nu 1/2[301]$ of $p_{1/2}$ orbital. From likelihood of β feeding to the ground state, the former configuration is favored by 2005Ga01.
70.8 3	(3/2, 5/2, 7/2)		
97.41 23	(3/2, 5/2, 7/2)		
224.1 4			
401.8 5			
450.6 3			

Continued on next page (footnotes at end of table)

^{61}V β^- Decay (48.3 ms) 2014Su07,2005Ga01 (continued) ^{61}Cr Levels (continued)E(level)[†]

564.4 5
 631.7 8
 715.9 4
 773.7 4
 1026.6 3
 1222.0 5
 2061.9 5
 2261.4 6

[†] From least-squares fit to $E\gamma$ data.[‡] From Adopted Levels. β^- radiations

$E\beta^-$	E(level)	$I\beta^{-\dagger\ddagger}$	Comments
(9700 900)	2261.4	2.5 8	
(9900 900)	2061.9	2.2 7	
(10700 900)	1222.0	1.4 3	
(10900 900)	1026.6	8.4 8	$I\beta^-$: other: <14 (2005Ga01).
(11200 900)	773.7	3.2 7	
(11200 900)	715.9	6.1 8	
(11300 900)	631.7	1.7 7	
(11400 900)	564.4	1.5 4	
(11500 900)	450.6	5.7 7	$I\beta^-$: other: <17 (2005Ga01).
(11500 900)	401.8	1.7 5	
(11700 900)	224.1	7.1 11	
(11900 900)	97.41	10 6	
(11900 900)	70.8	6.0 12	
(12000 900)	0.0	<40	$I\beta^-$: estimated by 2014Su07.

[†] Apparent β feedings deduced from intensity balances. Since the decay scheme is considered as incomplete, true β feedings cannot be determined, thus no $\log ft$ values are deduced.[‡] Absolute intensity per 100 decays. $\gamma(^{61}\text{Cr})$

$I\gamma$ normalization: Absolute intensities/100 decays of ^{61}V are given in 2014Su07. Based on observation and absolute intensity of the 644-keV transition in ^{60}Cr , $\% \beta^- n > 10$ is estimated by 2014Su07.

$E\gamma$	E(level)	$I\gamma^{\ddagger}$	Mult.	α	Comments
70.8 3	70.8	9.3 8	D	0.083 18	Mult.: from Weisskopf estimates and non-observation of a long lifetime for 71-keV level.
97.7 3	97.41	24.9 8	D,M1+E2	0.24 21	$\alpha(\text{exp})=0.17$ 13 (2014Su07). Mult.: from Weisskopf estimates, and observation of no time delay between the 127- and 98-keV γ rays within the experimental detection limit of ≈ 150 ns.
126.7 3	224.1	8.1 5	[D,E2]	0.09 8	
331.0 4	401.8	1.7 5			
353.6 [†] 5	450.6	1.2 4			
407.6 7	631.7	1.7 7			
450.5 3	450.6	4.5 5			
467.0 4	564.4	1.5 4			
^x 576.7 4		0.7 3			
645.0 [†] 8	715.9	1.0 4			
676.4 6	773.7	0.9 4			
715.9 4	715.9	5.1 6			
773.7 4	773.7	2.3 5			
929.4 4	1026.6	3.7 5			
1026.3 4	1026.6	4.7 6			
1151.2 4	1222.0	1.4 3			

Continued on next page (footnotes at end of table)

^{61}V β^- Decay (48.3 ms) 2014Su07,2005Ga01 (continued)

 $\gamma(^{61}\text{Cr})$ (continued)

E_γ	$E(\text{level})$	$I_\gamma^\dagger$
1964.5 4	2061.9	2.2 7
2164.0 5	2261.4	2.5 8

† Observed only in $\gamma\gamma$ -coin.

‡ Absolute intensity per 100 decays.

x γ ray not placed in level scheme.

Decay Scheme

Adopted Levels, Gammas

$Q(\beta^-)=7178$ 3; $S(n)=6846$ 3; $S(p)=12530$ 210; $Q(\alpha)=-9940$ 230 2012Wa38.

$Q(\beta^-n)=1599$ 4, $S(2n)=12359$ 3, $S(2p)=28490$ 160 (2012Wa38).

1985Ru05: first identification of ^{61}Mn from fragmentation of ^{82}Se beam at 11.5 MeV/nucleon on tungsten target using on-line mass separator at GSI facility.

1999Ha05: 1-GeV proton -induced spallation of uranium UC_2 target at ISOLDE-CERN facility. The laser ionized Mn isotopes were extracted from the ion source and mass separated. Using tape systems measured β -delayed neutron multiscaling, $E\gamma$ and $\gamma\gamma$ coincidence. β -delayed neutron collected by multiscaling measurements using Mainz 4π He neutron counter.

Mass measurements: 2012Na15 (also 2012He13), 1994Se12, 1990Tu01.

2013Ji04: levels, J , π by shell-model calculations.

 ^{61}Mn Levels

Cross Reference (XREF) Flags

A ^{61}Cr β^- Decay (237 ms)

B Coulomb Excitation

C $^{238}\text{U}(^{64}\text{Ni}, X\gamma)$

D $^{238}\text{U}(^{70}\text{Zn}, X\gamma)$

E(level) [†]	$J\pi$	XREF	$T_{1/2}$	Comments
0.0 #	(5/2-) [§]	ABCD	0.709 s 8	<p>$\% \beta^- = 100$.</p> <p>Theoretical $\% \beta^- n = 0.01$ (1997Mo25).</p> <p>$J\pi$: large-scale shell-model predictions and systematics of ground states of odd-A Mn nuclei. Probable allowed β feeding of (3/2-) g.s. in ^{61}Fe from ^{61}Mn decay supports this assignment, and also suggests the same parity for the ground states of ^{61}Mn and ^{61}Fe.</p> <p>$T_{1/2}$: weighted average of 0.708 s 8 (2013Ra17, decay curves for several γ rays) and 0.71 s 1 (1985Ru05, from γ timing). Other: 623 ms 10 (1999Ha05, method not given, possibly β-fragment correlations). Low and discrepant value from 1999Ha05 is probably due to some mixture of impurities. Values obtained from γ-ray measurements, being more specific, are preferred here.</p>
157.1 # 2	(7/2-) [§]	ABCD		<p>$T_{1/2}$: <1.7 ns (minimum flight time between the secondary target and the particle detector (2009Va16).</p>
1034.6 # 3	(9/2-) [§]	BCD		
1142.3 4	(1/2-, 3/2)	A		<p>$J\pi$: γ to (5/2-); probably low spin since not populated in heavy-ion in-beam studies.</p>
1281.8 # 3	(11/2-) [§]	BCD		<p>$J\pi$: $\Delta J=(2)$, (Q) γ to (7/2-).</p>
1497.2 4	(3/2, 5/2, 7/2)	A		<p>$J\pi$: log $ft=4.9$ from (5/2-) parent value.</p>
1860.8 4	(3/2, 5/2, 7/2) [‡]	A		
2031.8? 7		A		
2201.9? 4		C		
2378.2 4	(3/2, 5/2, 7/2) [‡]	A		
2502.2 # 4	(15/2-)	C		<p>$J\pi$: $\Delta J=(2)$, (Q) γ to (11/2-).</p>
2607.5? 5		C		
2753.1 # 5		C		
3131.6 # 6		C		
3572.4 # 7		C		

[†] From least-square fit to $E\gamma$ data.

[‡] γ to (5/2-) suggests 1/2- to 9/2-; 1/2 or 9/2 less likely from apparent β feeding from (5/2-) parent state. Parity would be negative if the β transition is allowed, as suggested by apparent log ft value.

[§] Systematics of $J\pi$ of ground states of odd Mn nuclei and shell-model calculations (2009Cr02, 2008Va08). See also shell-model calculations by 2013Ji04, level spectrum shown in figure 3.

(A): γ cascade based on (5/2-).

Adopted Levels, Gammas (continued)

$\gamma(^{61}\text{Mn})$					
E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	α	Comments
157.1	157.1 2	100	(M1+E2)	0.044 35	E_{γ} : unweighted average of 157.2 5 (β^- data), 157.3 2 ($^{64}\text{Ni}, X\gamma$ data), 156.7 1 ($^{70}\text{Zn}, X\gamma$ data). Weighted average is 156.8 2 but with reduced $\chi^2=3.9$. α : value overlaps M1 and E2. B(E2)(W.u.)=30 4 (2009Va16). B(E2)(W.u.) is obtained by 2009Va16 with constrained B(M1)=0.008 based on $T_{1/2}(157 \text{ level}) < 1.7 \text{ ns}$ (minimum flight time between the secondary target and the particle detector) since mixing ratio of the 157-keV transition could not be obtained from their $\gamma(0)$ data.
1034.6	877.6 3	100	[M1(+E2)]		B(E2)(W.u.)=0 (2009Va16).
	(1035)		[E2]		B(E2)(W.u.) from Coulomb excitation. B(E2)(W.u.)=7.5 15 (2009Va16). B(E2)(W.u.) from Coulomb excitation.
1142.3	1142.2 4	100			
1281.8	247.2 2	20 8			
	1124.6 2	100 20	(Q)		
1497.2	354.8 4	100 13			
	1497.3 5	56 13			
1860.8	1860.8 4	100			
2031.8?	534.6 § 5	100			
2201.9?	920.1 § 2	100			
2378.2	2378.2 4	100			
2502.2	1220.4 2	100	(Q)		
2607.5?	405.6 § 3	100 50			
	1325.7 § 10	100 50			
2753.1	250.9 3	100	(D)		Mult.: $\Delta J=(0)$.
3131.6	378.5 3	100			
3572.4	440.8 3	100			

[†] Weighted averages from all available data, unless noted otherwise.

[‡] Tentative assignment from $\gamma\gamma(0)$ data in $^{238}\text{U}(^{64}\text{Ni}, X\gamma)$.

§ Placement of transition in the level scheme is uncertain.

**(A) γ cascade
based on (5/2-)**

^{61}Cr β^- Decay (237 ms) 2009Cr02

Parent ^{61}Cr : $E=0$; $J\pi=(5/2-)$; $T_{1/2}=237$ ms 11; $Q(\text{g.s.})=9290$ 130; $\%\beta^-$ decay=100.

$^{61}\text{Cr}-Q(\beta^-)$: From 2012Wa38.

$^{61}\text{Cr}-J, T_{1/2}$: From ^{61}Cr Adopted Levels.

2009Cr02: ^{61}Cr produced through the $^9\text{Be}(^{76}\text{Ge}, X)$ reaction at a beam energy of 130 MeV/nucleon. The ^{76}Ge beam was produced by the coupled cyclotrons at the National Superconducting Cyclotron Laboratory at Michigan State University. Fragments were separated using the A1900 fragment separator. The β and γ spectra were measured using the Beta Counting System and the Segmented Germanium Array, as well as three Si PIN detectors. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, β , $\beta\gamma$ coin, (fragment) β coin, half-life of the ^{61}Cr ground state.

Others dealing with production and half-life of ^{61}Cr :

2001So07 (also 1999So20 and 1999Le67): ^{61}Cr produced in the fragmentation of 60.4 MeV/nucleon ^{86}Kr beam with ^{58}Ni target; LISE3 spectrometer at GANIL facility. Measured half-life of ^{61}Cr .

1998Am04: ^{61}Cr formed in fragmentation of 500 MeV/nucleon ^{86}Kr beam incident on a Be target, FRS spectrometer at GSI facility. Measured half-life of decay of ^{61}Cr .

In view of the large Q value of 9.4 MeV, this decay scheme may be incomplete since the levels, currently, are reported only up to 2.4 MeV.

From RADLIST code, deduced total decay energy of 9290 450 keV agrees with 9290 130 expected from Q value.

 ^{61}Mn Levels

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}$	Comments
0.0	(5/2-)	0.709 s 8	$T_{1/2}$: from ^{61}Mn Adopted Levels.
157.2 5	(7/2-)		$E(\text{level}), J\pi$: tentatively assigned from the in beam γ -ray (2008Va08).
1142.3 4	(1/2-, 3/2)		
1497.2 4	(3/2, 5/2, 7/2) §		$J\pi$: 2009Cr02 suggested (3/2-, 5/2-) based on apparent $\log ft$ value, competing (assumed M1) transitions to (5/2-, g.s. and (1/2-, 3/2-), 1142 level.
1860.8 4	(3/2, 5/2, 7/2) §		
2032?			
2378.2 4	(3/2, 5/2, 7/2) §		

[†] From least-squares fit to $E\gamma$ data.

[‡] From Adopted Levels.

§ Negative parity is suggested by the apparent $\log ft$ values.

 β^- radiations

$E\beta^-$	E(level)	$I\beta^-^{\ddagger}$	$\log ft^{\dagger}$	Comments
(6910 130)	2378.2	11 1	4.9	
(7260 § 130)	2032?	5 1	5.4	
(7430 130)	1860.8	20 2	4.8	
(7790 130)	1497.2	20 3	4.9	
(8150 § 130)	1142.3	5 3	5.6	The β feeding to 1142 level treated as uncertain by the evaluators.
(9130 130)	157.2	9 2	5.6	
(9290 130)	0.0	30 5	5.1	$I\beta^-$: 100-(summed β feeding to excited states).

[†] Apparent β feedings and $\log ft$ values deduced by 2009Cr02 from absolute γ -ray intensities. Uncertainties in $\log ft$ values are given by 2009Cr02 as 0.1 to 0.2, but the evaluators omit these here since the decay scheme is most likely incomplete and the $\log ft$ values can be treated as (lower) limits only.

[‡] Absolute intensity per 100 decays.

§ Existence of this branch is questionable.

 $\gamma(^{61}\text{Mn})$

$I\gamma$ normalization: The γ -ray intensities given by 2009Cr02 are absolute values from $\beta\gamma$ -coin data.

$E\gamma$	E(level)	$I\gamma^{\dagger}$	Mult.	α
157.2 5	157.2	9 2	(M1+E2)	0.044 35
354.8 4	1497.2	16 2		
534.6 $\frac{5}{2}$ 5	2032?	5 1		
1142.2 4	1142.3	21 2		
1497.3 5	1497.2	9 2		
1860.8 4	1860.8	20 2		
2378.2 4	2378.2	11 1		

Footnotes continued on next page

^{61}Cr β^- Decay (237 ms) 2009Cr02 (continued) $\gamma(^{61}\text{Mn})$ (continued)

† Absolute intensity per 100 decays.

‡ Placement of transition in the level scheme is uncertain.

Coulomb Excitation 2009Va16

2009Va16: 2.87 MeV/nucleon beam of ^{61}Mn was produced in fission of uranium (UC_x target) induced by 1.4 GeV protons from PS Booster at CERN. The laser ionized (RILIS facility at ISOLDE-CERN) Mn isotopes were extracted from the ion source and mass separated. The 30-keV isobaric beam was bunched in a Penning trap (REXTRAP) and injected in the electron beam ion source (EBIS). The ^{61}Mn beam was accelerated to 2.87 MeV/nucleon and impinged on a ^{109}Ag target. Measured $E\gamma$, $I\gamma$, $\gamma(\theta)$ using MINIBALL Ge detector array. Deduced B(E2) value using GOSIA analysis. Comparison with shell-model calculations. The data were normalized to excitations in the target nucleus ^{109}Ag .

 ^{61}Mn Levels

E(level)†	$J\pi^\dagger$
0.0	(5/2-)
157	(7/2-)
1035	(9/2-)
1282	(11/2-)

† 2009Va16 list values from 2008Va08.

 $\gamma(^{61}\text{Mn})$

$E\gamma^\dagger$	E(level)	Mult.	Comments
157	157	(M1+E2)	B(E2)(W.u.)=30 4 (2009Va16). BE2(W.u.) is obtained by 2009Va16 with constrained BM1=0.008 based on $T_{1/2}(157 \text{ level}) < 1.7 \text{ ns}$ (minimum flight time between the secondary target and the particle detector) since mixing ratio of the 157-keV transition could not be obtained from their $\gamma(\theta)$ data.
878	1035	[M1 (+E2)]	B(E2)(W.u.)=0 (2009Va16).
(1035)	1035	[E2]	B(E2)(W.u.)=7.5 15 (2009Va16).

† 2009Va16 list rounded values from 2008Va08.

$^{238}\text{U}(^{64}\text{Ni},\text{X}\gamma)$ 2010Ch51

2010Ch51: E=430 MeV beam provided by ATLAS facility at ANL. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ coin, prompt (within a time window of 40 ns) and delayed (within a time window of =400 ns) spectra were sorted from 3-dimensional cubes. Gammasphere with 100 Compton-suppressed Ge detectors used for γ -ray measurements.

 ^{61}Mn Levels

E(level) [†]	$J\pi$
0.0 [‡]	(5/2-)
157.3 [‡] 2	(7/2-)
1034.8 [‡] 3	(9/2-)
1281.9 [‡] 3	(11/2-)
2202.0? 4	
2502.3 [‡] 4	(15/2-)
2607.6? 5	
2753.2 [‡] 5	
3131.7 [‡] 6	
3572.5 [‡] 7	

[†] From $E\gamma$ data of 2010Ch51.

[‡] (A): Band based on (5/2-).

 $\gamma(^{61}\text{Mn})$

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\dagger}$	Mult. [‡]	Comments
157.3 2	157.3	>6.5		
247.1 2	1281.9	1.0 3		
250.9 3	2753.2	1.8 4	(D)	Mult.: $\Delta J=(0)$.
378.5 3	3131.7	0.95 19		
405.6 [§] 3	2607.6?	0.20 10		
440.8 3	3572.5	0.27 11		
877.5 2	1034.8	>1.0		
920.1 [§] 2	2202.0?	0.50 20		
1124.6 2	1281.9	5.5 11	(Q)	
1220.4 2	2502.3	2.5 5	(Q)	
1325.7 [§] 10	2607.6?	0.20 10		

[†] From e-mail reply of Jan 3, 2011 from C. Chiara, first author of 2010Ch51.

[‡] Tentative assignments from $\gamma\gamma(0)$ data in 2010Ch51, the statistics were low. 2010Ch51 assign E2 for stretched quadrupole and E1 for $\Delta J=(0)$ dipole.

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

 $^{238}\text{U}(^{70}\text{Zn},\text{X}\gamma)$ 2008Va08

2008Va08: E=460 MeV ^{70}Zn beam provided by LNL Tandem-ALPI accelerator, bombarding a ^{238}U target. CLARA-PRISMA setup was used to identify the projectile-like nuclei in coincidence with the prompt γ rays. PRISMA magnetic spectrometer detected products of multi-nucleon transfer reaction processes. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin using CLARA array of 22 Compton-suppressed Ge Clover detectors. Results are compared with large-scale shell-model calculations employing the GXPFI1A, KB3G and fpg effective interactions.

 ^{61}Mn Levels

In analogy with the lighter odd-even isotopes, 156 keV transition is proposed to feed 5/2- g.s. from low-lying 7/2 state.

E(level) [†]	$J\pi^{\ddagger}$	Comments
0.0	(5/2-)	$J\pi$: from systematics (1985Ru05).
156.7 1	(7/2-)	
1034.6 4	(9/2-)	
1281.8 4	(11/2-)	

[†] From $E\gamma$ data.

[‡] As assigned by 2008Va08 based on systematics of odd-A Mn isotopes (A=57 to 63) and shell-model predictions.

$^{238}\text{U}(^{70}\text{Zn},\text{X}\gamma)$ 2008Va08 (continued)

$\gamma(^{61}\text{Mn})$

$E\gamma^\dagger$	E(level)	$I\gamma^\dagger$
156.7 1	156.7	100 14
247.5 4	1281.8	41 16
878.3 5	1034.6	41 10
1124.6 5	1281.8	82 16

† From (^{61}Mn fragment) γ coincidences.

Adopted Levels, Gammas

Q(β⁻)=3977.1 28; S(n)=5579 4; S(p)=13242 3; Q(α)=-8821 3 2012Wa38.

S(2n)=14399.0 27, S(2p)=25610 240 (2012Wa38).

1957Ri10: ⁶¹Fe first produced and identified in bombardment of Ni and Cu targets with 20 MeV neutrons and 28 MeV deuterons, followed by chemical separation. Measured half-life, β and γ.

Structure calculations:

2010Sr02: levels, J, π, shell-model using GXPF1A nuclear interaction.

2002Ca48: large-scale shell model calculations.

⁶¹Fe Levels

Cross Reference (XREF) Flags

A ⁶¹Mn β⁻ Decay (0.709 s)

B ⁹Be(⁶⁴Ni,Xγ)

C Coulomb Excitation

D ⁶⁴Ni(α,⁷Be)

E ²³⁸U(⁶⁴Ni,Xγ) E=400 MeV

F ²³⁸U(⁶⁴Ni,Xγ) E=430 MeV

E(level) [†]	Jπ [‡]	XREF	T _{1/2}	Comments
0.0 [§]	(3/2-)	ABCDEF	5.98 min 6	%β ⁻ =100. Jπ: shell-model predictions (2008Ho05). (9/2+) -->(5/2-) --->(3/2-) sequence supported for 654.8 -->206.9 cascade in g factor measurement of 861.7 level (2004Ma80). Allowed β transition with log ft=4.7 from ⁶¹ Mn decay to ⁶¹ Fe g.s. gives same parity for ground states of ⁶¹ Fe and ⁶¹ Mn. T _{1/2} : From γ(t) in ⁶¹ Mn β ⁻ decay (1975Br04). Others: 6.0 min 1 (1966Le19,1968Ka22), 5.95 min 20 (1967Eh02), 6.15 min 6 (1967Gr15), 5.76 min 15 (1964Cr07), 6.0 min 5 (1957Ri10).
206.92 [§] 5	(5/2-)	ABC EF		Jπ: ΔJ=1, (M1+E2) γ to (3/2-).
391.30 6	(1/2-)	A		Jπ: γ to (3/2-) gives 1/2 to 7/2-; analogy with 287, 1/2- level in ⁵⁹ Fe supports 1/2-. Shell-model calculations (2013Ra17) predict 1/2- ground state.
629.09 7	(3/2-)	A F		XREF: F(620). Jπ: log ft=4.76 from (5/2-); γ to (1/2-); analogy with a 726, 3/2- level in ⁵⁹ Fe; shell-model calculations (2013Ra17) predict a 3/2- at 696 keV.
861.67 [#] 11	(9/2+)	AB EF	238 ns 5	%IT=100. μ=-1.031 9 (2004Ma80,2014StZZ). Q=0.44 6 (2007Ve05,2014StZZ,2013StZZ). μ: from g factor=-0.229 2 by time-dependent perturbed angular distribution TDPAD method (2004Ma80). Q: from TDPAD method (2007Ve05); value of 0.41 6 in 2007Ve05 re-evaluated by 2013StZZ. In 2007Ve05 value is determined from Q(9/2+ isomer in ⁶¹ Fe)/Q(3/2- isomer in ⁵⁷ Fe)=2.75 13, and Q(98-ns, 3/2- in ⁵⁷ Fe)=+0.15 2. The sign of Q is undetermined. Jπ: ΔJ=2, (M2) γ to (5/2-); v _{g9/2} orbital. T _{1/2} : weighted average of 239 ns 5 from γγ(t) (2004Ma80,2002MaZN); and 237 ns 6 from (⁶¹ Fe)γ(t) (2015Wi02). Other: 250 NS 10 (1998Gr14).
959.53 [§] 9	(7/2-)	A EF		Jπ: ΔJ=1, dipole γ to (5/2-); analogy with a 1023, 7/2- level in ⁵⁹ Fe; shell-model calculations (2013Ra17) predict a 7/2- at 1007 keV.
1013.07 8	(1/2-)	A		Jπ: γ rays to (3/2-) and (5/2-) give 1/2- to 7/2-; analogy with a 1211, 1/2- level in ⁵⁹ Fe; shell-model calculations (2013Ra17) predict a 1/2- at 1349 keV.
1160.98 7	(5/2-)	A		Jπ: log ft=5.68 from (5/2-); Jπ assignments of 1161 and 1253 levels in analogy with ordering of 5/2- and 3/2- levels in ⁵⁹ Fe.
1252.87 7	(3/2-)	A		Jπ: log ft=5.64 from (5/2-); γ to (1/2-); Jπ assignments of 1161 and 1253 levels in analogy with ordering of 5/2- and 3/2- levels in ⁵⁹ Fe.
1262.47 8	(3/2, 5/2, 7/2-)	A		Jπ: log ft=6.4 from (5/2-); γ to (3/2-).
1477.27 11	(9/2-)	A F		Jπ: γ rays to (5/2-) and (7/2-); lack of β feeding from (5/2-) and absence of transition to (3/2-) suggest J>7/2.
1650.12 [#] 17	(13/2+)	DEF		Jπ: ΔJ=2, Q γ to (9/2+). Configuration=v _{g9/2} ⊗(2+ in ⁶⁰ Fe).
1705.2 5	(1/2-, 9/2-)	A F		Jπ: γ to (5/2-); lack of β feeding from (5/2-) and absence of transition to (3/2-) suggest J>7/2 or 1/2.
1893.12 11	(3/2, 5/2-)	A		Jπ: log ft=6.04 from (5/2-); γ to (1/2-); shell-model calculations (2013Ra17) predict a 5/2- at 1881 keV.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{61}Fe Levels (continued)

E(level) [†]	J π [‡]	XREF	Comments
1929.01 10	(3/2-, 5/2-)	A	J π : log ft =6.04 from (5/2-); γ to (1/2-); shell-model calculations (2013Ra17) predict a 3/2- at 1901 keV.
2143.73 7	(3/2-, 5/2-)	A D F	J π : log ft =5.40 from (5/2-); γ to (1/2-).
2510.59 8	(3/2-, 5/2-)	A	J π : log ft =5.43 from (5/2-); γ to (1/2-).
2716.98 15	(5/2-, 7/2)	A	J π : log ft =6.32 from (5/2-); γ to (9/2-).
2964.4 5	(3/2, 5/2, 7/2)	A	J π : log ft =6.37 from (5/2-); γ to (5/2-).
2992.4# 5	(17/2+)	EF	J π : $\Delta J=2$, Q γ to (13/2+). Configuration= $\nu g_{9/2} \otimes (4+ \text{ in } ^{60}\text{Fe})$.
3049.2 3	(5/2-, 7/2)	A	J π : log ft =6.1 from (5/2-); γ to (9/2-).
3079.99 22	(3/2, 5/2, 7/2-)	A	J π : log ft =6.1 from (5/2-); γ to (3/2-).
3513.5 4	(3/2, 5/2-)	A	J π : log ft =6.1 from (5/2-); γ to (1/2-).
3528.6 4	(17/2+, 15/2+)	F	J π : γ s to (17/2+) and (13/2+).
3541.2 7		F	
3714.3 7		F	
4144.3 5	(19/2+)	F	J π : γ to (17/2+).
4292.2 5	(19/2+, 17/2+)	F	J π : γ to (17/2+).
4675.2# 6	(21/2+)	F	

[†] From least-squares fit to $E\gamma$ data for levels populated in γ -ray studies. Reduced $\chi^2=2.1$ is somewhat higher than critical χ^2 of 1.7.

[‡] For high-spin states ($J>9/2$), assignments are based on $\gamma\gamma(\theta)$ data for selected cascades, yrast nature of population of states, decay pattern and systematics of neighboring Fe nuclides.

§ (A): g.s. band.

(B): $\nu 9/2[404]$ band.

 $\gamma(^{61}\text{Fe})$

E(level)	$E\gamma$ [†]	$I\gamma$ [†]	Mult. [‡]	α	Comments
206.92	206.9 1	100	(M1+E2)	0.018 13	B(E2)(W.u.)=17 7 reported in 2009Va16.
391.30	391.2 1	100			
629.09	237.8 1	4.61 6			
	422.2 1	4.55 8			
	629.0 1	100			
861.67	654.75 10	100	(M2)	0.00106	B(M2)(W.u.)=0.0698 15.
959.53	752.6 1	100 3	D		
	959.4 2	23 6			
1013.07	806.6 3	16 4			
	1013.0 1	100 5			
1160.98	201.6 5	3.9 7			
	531.5 3	2.4 6			
	954.1 1	46.8 15			
	1161.0 1	100.0 18			
1252.87	624.0 5	17.1 18			
	861.5 1	10.9 11			
	1046.0 1	100.0 20			
	1252.9 1	81.5 22			
1262.47	1055.3 1	100 7			
	1262.7 1	51 14			
1477.27	517.2 3	17 6			
	1270.4 1	100 21			
1650.12	788.44 12	100	Q		
1705.2	1498.3§ 5	100§			
1893.12	640.5 3	24 7			
	1263.7 5	83 13			
	1501.7 1	100 12			
	1893.9 3	75 18			
1929.01	1537.7 1	42 7			
	1722.1 2	34 7			
	1928.9 2	100 14			
2143.73	982.4 5	4.0 15			
	1130.6 1	11.7 13			

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Fe})$ (continued)

E(level)	E $\gamma^\dagger$	I $\gamma^\dagger$	Mult. ‡	E(level)	E $\gamma^\dagger$	I $\gamma^\dagger$
2143.73	1184.6 5	4.2 13		3049.2	2089.6 5	100 29
	1936.8 1	16.2 20		3079.99	2873.7 3	76 26
	2143.7 1	100.0 25			3079.2 3	100 29
2510.59	1258.5 5	9 4		3513.5	3122.1 4	100
	1350.8 5	11 3		3528.6	536.1 3	
	1498.3 § 5	6.3 § 25			1878.6 4	
	2120.3 5	8.7 21		3541.2	1891.1 6	
	2303.5 1	41 3		3714.3	2064.1 6	
	2510.5 1	100 4		4144.3	1151.9 2	
2716.98	1239.7 1	100		4292.2	763.6 2	
2964.4	2757.4 5	100			1300 [#]	
2992.4	1342.0 6	100	Q	4675.2	1682.7 3	
3049.2	1571.9 3	69 20				

[†] From weighted averages of all available data; most data are available from either β^- decay or from $^{238}\text{U}(^{64}\text{Ni}, X\gamma)$ E=430 MeV.

[‡] From $\gamma\gamma(\theta)$ data (2008Ho05).

§ Multiply placed; intensity suitably divided.

Placement of transition in the level scheme is uncertain.

(A) g.s. band
(B) v9/2[404] band

^{61}Mn β^- Decay (0.709 s) 2013Ra17,1985Ru05

Parent ^{61}Mn : $E=0.0$; $J\pi=(5/2^-)$; $T_{1/2}=0.709$ s 8; $Q(\text{g.s.})=7178$ 3; β^- decay=100.

^{61}Mn -J, $T_{1/2}$: From Adopted Levels of ^{61}Mn .

^{61}Mn - $Q(\beta^-)$: From 2012Wa38.

^{61}Mn - β^- decay: $\beta^-n \leq 0.2$ to first excited state in ^{60}Fe (2013Ra17) from upper limit of intensity of 824γ (from first $2+$ to g.s. in ^{60}Fe). Total β^-n could not be determined due to long half-life of ^{60}Fe . 2013Ra17 use $\beta^-n=0.6$ 1 from 2000HaZL (thesis).

2013Ra17: ^{61}Mn produced in induced fission of uranium at ISOLDE-CERN facility. E(proton)=1.4 GeV beam impinged a UC_x target of thickness 45 g/cm². Reaction products were ionized by RILIS and separated based on their A/Q ratio using a High-Resolution Separator. ^{61}Mn obtained in the reaction was implanted on an aluminized mylar tape for the decay. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin, half-life using three plastic ΔE β detectors and two MiniBall γ -detector clusters. Deduced levels, J, π , β feeding intensities, log ft . Comparison with ^{59}Fe data, and with shell-model calculations.

1985Ru05: first identification of ^{61}Mn from fragmentation of ^{82}Se beam at 11.5 MeV/nucleon on tungsten target using on-line mass separator. Measured $E\gamma$, $I\gamma$, $\beta\gamma$ -, $\gamma\gamma$ -coin, and $T_{1/2}$ by Ge(Li) and plastic scintillator. Three excited states at 207, 391 and 629 keV were proposed through the observation of five γ rays.

1999Ha05: 1-GeV proton-induced spallation of uranium UC_2 target at ISOLDE-CERN facility. The laser ionized Mn isotopes were extracted from the ion source and mass separated. Using tape systems measured β -delayed neutron multiscaling, $E\gamma$ and $\gamma\gamma$ coincidence. β -delayed neutron data were collected by multiscaling measurements using Mainz 4π He neutron counter.

All data are from 2013Ra17.

From RADLIST code, deduced total decay energy is 5962 keV 841 as compared to $Q(\beta^-)=7178$ keV 3, which suggests that the decay scheme is not known well.

 ^{61}Fe Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}$	Comments
0.0	(3/2-)	5.98 min 6	$T_{1/2}$: from Adopted Levels of ^{61}Fe .
206.90 5	(5/2-)		
391.29 6	(1/2-)		
629.08 7	(3/2-)		
861.60 11	(9/2+)	239 ns 5	$T_{1/2}$: from 2004Ma80.
959.47 10	(7/2-)		
1013.07 8	(1/2-)		
1160.97 7	(5/2-)		
1252.86 7	(3/2-)		
1262.46 8	(3/2, 5/2, 7/2-)		
1477.31 11	(9/2-)		
1705.2 5	(1/2-, 9/2-)		
1893.12 11	(3/2, 5/2-)		$J\pi$: 2013Ra17 suggest (1/2-, 3/2-, 5/2-).
1929.00 10	(3/2, 5/2-)		$J\pi$: 2013Ra17 suggest (1/2-, 3/2-, 5/2-).
2143.72 7	(3/2-, 5/2-)		
2510.58 8	(3/2-, 5/2-)		
2717.03 15	(5/2-, 7/2)		
2964.4 5	(3/2, 5/2, 7/2)		
3049.2 3	(5/2-, 7/2)		
3079.98 22	(3/2, 5/2, 7/2-)		
3513.5 4	(3/2, 5/2-)		

† From least-squares fit to $E\gamma$ values. Reduced $\chi^2=2.1$ is somewhat larger than critical $\chi^2=1.7$.

‡ From Adopted Levels. Most of the assignments are based on shell-model calculations using GXPf1A interaction corroborated by β feedings and associated log ft values, and also comparison with the decay scheme of ^{59}Mn to ^{59}Fe .

 β^- radiations

$E\beta^-$	$E(\text{level})$	$I\beta^-^\dagger$	Log ft	Comments
(3665 3)	3513.5	0.12 3	6.1 1	
(4098 3)	3079.98	0.22 5	6.1 1	
(4129 3)	3049.2	0.21 5	6.1 1	
(4214 3)	2964.4	0.13 2	6.37 7	
(4461 3)	2717.03	0.19 3	6.32 7	
(4667 3)	2510.58	1.8 1	5.43 3	
(5034 3)	2143.72	2.7 1	5.40 2	
(5249 3)	1929.00	0.55 5	6.17 4	
(5285 3)	1893.12	0.78 7	6.04 4	

Continued on next page (footnotes at end of table)

^{61}Mn β^- Decay (0.709 s) 2013Ra17,1985Ru05 (continued) β^- radiations (continued)

$E\beta^-$	E(level)	$I\beta^-^\dagger$	Log ft	Comments
(5473 $\frac{1}{2}^+$ 3)	1705.2	<0.11	>7.0	$I\beta^-$: 0.09 2 from intensity balance, but none is expected from $\Delta J\pi$.
(5701 $\frac{1}{2}^+$ 3)	1477.31	<0.09	>7.1	$I\beta^-$: 0.02 7 from intensity balance, but none is expected from $\Delta J\pi$.
(5916 3)	1262.46	0.57 6	6.40 5	
(5925 3)	1252.86	3.25 9	5.64 1	
(6017 3)	1160.97	3.23 9	5.68 1	
(6165 $\frac{1}{2}^+$ 3)	1013.07	<0.30	>6.8	$I\beta^-$: 0.25 5 from intensity balance, but none is expected from $\Delta J\pi$.
(6219 3)	959.47	0.49 7	6.6 1	
(6316 3)	861.60	0.20 2	8.98 ^{1u} 5	$I\beta^-$: 2013Ra17 list <0.22.
(6549 3)	629.08	39.0 6	4.76 1	
(6787 $\frac{1}{2}^+$ 3)	391.29	<0.28	>7.0	$I\beta^-$: 0.21 7 from intensity balance, but none is expected from $\Delta J\pi$.
(6971 3)	206.90	12.6 8	5.38 3	
(7178 3)	0.0	<33	>5.0	$I\beta^-$: 33 1 in 2013Ra17, see text on page 5 of 2013Ra17 for method of estimating g.s. feeding. Authors state that this feeding should be considered as upper limit due to possible missed γ transitions to the ground state of ^{61}Fe . Other: 74% 4 (1985Ru05) is in sharp disagreement with <33 1 from 2013Ra17. It should be noted that γ spectrum observed in 1985Ru05 was much incomplete as compared to that in 2013Ra17.

 † Absolute intensity per 100 decays. $\frac{1}{2}$ Existence of this branch is questionable. $\gamma(^{61}\text{Fe})$

I_γ normalization: Deduced by 2013Ra17, based on $I\beta=33\%$ 1 to g.s. of ^{61}Fe deduced from known normalization of decay scheme of ^{61}Fe to ^{61}Co .

$E\gamma$	E(level)	$I_\gamma^\dagger$	Mult.	α
201.6 5	1160.97	0.24 $\frac{1}{2}^+$ 4		
206.8 1	206.90	54 2	(M1+E2)	0.018 13
237.8 1	629.08	4.61 6		
391.2 1	391.29	7.37 9		
422.2 1	629.08	4.55 8		
517.9 5	1477.31	0.12 $\frac{1}{2}^+$ 4		
531.5 3	1160.97	0.15 4		
624.0 5	1252.86	0.77 $\frac{1}{2}^+$ 8		
629.0 1	629.08	100		
640.5 3	1893.12	0.18 5		
654.7 1	861.60	0.56 6		
752.6 1	959.47	1.89 6		
806.6 3	1013.07	0.21 5		
861.5 1	1252.86	0.49 5		
954.1 1	1160.97	2.88 9		
959.4 2	959.47	0.43 12		
982.4 5	2143.72	0.22 $\frac{1}{2}^+$ 8		
1013.0 1	1013.07	1.30 7		
1046.0 1	1252.86	4.49 9		
1055.3 1	1262.46	1.05 7		
1130.6 1	2143.72	0.65 7		
1161.0 1	1160.97	6.15 11		
1184.6 5	2143.72	0.23 $\frac{1}{2}^+$ 7		
1239.7 1	2717.03	0.53 8		
1252.9 1	1252.86	3.66 10		
1258.5 5	2510.58	0.26 $\frac{1}{2}^+$ 12		
1262.7 1	1262.46	0.54 15		
1263.7 5	1893.12	0.63 $\frac{1}{2}^+$ 10		
1270.4 1	1477.31	0.71 15		
1350.8 5	2510.58	0.31 $\frac{1}{2}^+$ 10		
1498.3 $\frac{1}{2}^+$ 5	1705.2	0.25 $\frac{1}{2}^+$ $\frac{1}{2}^+$ 4		
	2510.58	0.18 $\frac{1}{2}^+$ $\frac{1}{2}^+$ 7		
1501.7 1	1893.12	0.76 $\frac{1}{2}^+$ 9		
1537.7 1	1929.00	0.36 6		
1571.9 3	3049.2	0.24 7		

Continued on next page (footnotes at end of table)

^{61}Mn β^- Decay (0.709 s) 2013Ra17,1985Ru05 (continued) $\gamma(^{61}\text{Fe})$ (continued)

E_γ	E(level)	$I_\gamma^\dagger$	E_γ	E(level)	$I_\gamma^\dagger$	E_γ	E(level)	$I_\gamma^\dagger$
^x 1690.2 5		0.19 6	1936.8 1	2143.72	0.90 11	2757.4 5	2964.4	0.37 [†] 7
1722.1 2	1929.00	0.29 6	2089.6 5	3049.2	0.35 [†] 10	2873.7 3	3079.98	0.26 9
^x 1738.5 5		0.15 6	2120.3 5	2510.58	0.25 [†] 6	3079.2 3	3079.98	0.34 10
^x 1846.7 5		0.16 5	2143.7 1	2143.72	5.54 14	3122.1 4	3513.5	0.32 9
1893.9 3	1893.12	0.57 14	2303.5 1	2510.58	1.18 9	^x 3146.1 10		0.26 10
1928.9 2	1929.00	0.86 12	2510.5 1	2510.58	2.86 12			

[†] From $\gamma\gamma$ -coin data; transition not seen in singles spectrum.[‡] For absolute intensity per 100 decays, multiply by 0.363 7.[§] Multiply placed; intensity suitably divided.^x γ ray not placed in level scheme.

⁶¹Mn β⁻ Decay (0.709 s) 2013Ra17,1985Ru05 (continued)

Decay Scheme

Intensities: I(γ+ce) per 100 parent decays
@ Multiply placed; intensity suitably divided

$^9\text{Be}(^{64}\text{Ni},\text{X}\gamma)$ 2007Ve05,2004Ma80

2007Ve05: ^{61}Fe isomer populated and aligned following the fragmentation of a 64.6 MeV/nucleon ^{64}Ni beam from GANIL accelerator impinging on a 94.1 mg/cm² ^9Be target. Fully stripped fragments selected by the LISE fragment separator and implanted in a CD single crystal. Measured spectroscopic quadrupole moment of the 9/2+ isomer by ion-implantation TDPAD method and four Ge detectors at angles of -24° , -114° , 145° and 66° relative to the secondary beam.

2004Ma80: E=54.7 MeV/nucleon ^{64}Ni beam from GANIL accelerator. Fragmentation process used to produce ^{61}Fe nuclei which were separated using the LISE fragment separator and implanted in a Cu host. Measured half-life and g factor of the 9/2+ isomer by time-dependent perturbed angular distribution TDPAD method and four Ge detectors at angles -45° , -135° , 45° , 135° relative to the secondary beam.

1998Gr14: E=60.3 MeV/nucleon beam of ^{86}Kr from GANIL accelerator using SSISS production target device coupled to the system of the Alpha and LISE3 spectrometers. ^{86}Kr with intensity of 15 pA impinged on a rotating natural Ni target 100 μm thick. Measured E_γ , I_γ and half-life using standard TOF technique.

2015Wi02: measured half-life of the 861, 9/2+ isomer using a new technique of identifying nanosecond isomers produced in secondary reactions with intermediate beam-energy radioactive ions beams at NSCL-MSU facility using S-800 spectrograph for reaction products, GRETINA array for prompt γ rays and CsI(Na) array for delayed transitions. Measured ^{61}Fe ions) $\gamma(t)$.

 ^{61}Fe Levels

Count-rate ratio $R(\theta)$ functions of the 654 keV and 207 keV γ -rays exhibit an opposite phase. This is due to the different multiplicities for the two transitions. The ratio between amplitudes of the two $R(\theta)$ functions is -1.43 ± 0.16 , using GEANT simulations assuming that the 654 keV and 207 keV transition have pure M2 and M1 multiplicities estimated this ratio to be -1.30 ± 0.06 . The good agreement between the two ratio indicates level sequence in ^{61}Fe is indeed 3/2-(g.s.), 5/2- and 9/2+ (2004Ma80).

E(level)	$J\pi^\dagger$	$T_{1/2}$	Comments
0.0	3/2-		
207	5/2-		
861	9/2+	238 ns 5	$\mu = -1.03 \pm 0.02$ from measured g factor $= -0.229 \pm 0.002$ (2004Ma80). $Q = 0.41 \pm 0.06$ (2007Ve05), derived relative to the quadrupole moment of the ^{57}Fe (3/2-, 98 ns) isomer, $Q(9/2+ \text{ isomer in } ^{61}\text{Fe})/Q(3/2- \text{ isomer in } ^{57}\text{Fe}) = 2.75 \pm 0.13$ and $Q(98\text{-ns}, 3/2- \text{ in } ^{57}\text{Fe}) = +0.15 \pm 0.02$. With this value, obtain $Q(^{61}\text{Fe}, 9/2+) = 0.41 \pm 0.06$. The sign of Q is not determined. $T_{1/2}$: weighted average of 239 ns 5 from $\gamma\gamma(t)$ (2004Ma80, 2002MaZN); and 237 ns 6 from $(^{61}\text{Fe})\gamma(t)$ (2015Wi02). Other: 250 ns 10 (1998Gr14).

† From 2004Ma80.

 $\gamma(^{61}\text{Fe})$

E_γ	E(level)	Mult. †
207	207	(M1)
654	861	(M2)

† From 2004Ma80.

Coulomb Excitation 2009Va16

2009Va16: 2.87 MeV/nucleon beam of ^{61}Mn was produced in fission of uranium (uc_x target) induced by 1.4 GeV protons from ps Booster at CERN. The laser ionized (rilis facility at ISOLDE-CERN) Mn isotopes were extracted from the ion source and mass separated. The 30-keV isobaric beam was bunched in a Penning trap (rextap) and injected in the electron beam ion source (ebis). The ^{61}Mn beam was accelerated to 2.87 MeV/nucleon and impinged on a ^{109}Ag target. Measured E_γ , I_γ , $\gamma(\theta)$ using miniball Ge detector array. Deduced $B(E2)$ value using gosia analysis. Comparison with shell-model calculations. The data were normalized to excitations in the target nucleus ^{109}Ag .

 ^{61}Fe Levels

E(level)	$J\pi$
0.0	3/2-
207	5/2-

Coulomb Excitation 2009Va16 (continued) $\gamma(^{61}\text{Fe})$

E_γ	E(level)	Comments
207	207	B(E2)(W.u.)=17 7 (2009Va16).

 $^{64}\text{Ni}(\alpha, ^7\text{Be})$ 1977Co08

1977Co08: $E_\alpha=116.5$ MeV. Reaction products were detected in the focal plane of an Enge split-pole magnetic spectrograph, with a proportional counter backed by a solid-state detector. Particles were identified using the constraints of energy loss in the gas, total energy, and time of flight relative to the cyclotron rf.

 ^{61}Fe Levels

E(level)
0.0
620 20
1690 20
≈ 2130

 $^{238}\text{U}(^{64}\text{Ni}, X\gamma)$ E=400 MeV 2007Lu13

2007Lu13: ^{61}Fe produced in $^{238}\text{U}(^{64}\text{Ni}, X\gamma)$ reaction with beam energy of 400 MeV delivered by the LNL Tandem-ALPI accelerator. Fragments were detected with the PRISMA large acceptance magnetic spectrometer. Measured E_γ , I_γ , $\gamma\gamma$ -coin. using CLARA array containing 22 Compton-suppressed Ge Clover detectors. Comparisons with large-scale shell-model calculations.

 ^{61}Fe Levels

E(level)	$J\pi^\dagger$	$T_{1/2}$	Comments
0.0	(3/2-)		$J\pi$: from Adopted Levels.
206.5 5	5/2-		
860.5 ‡ 12	9/2+	238 ns 5	$T_{1/2}$: from Adopted Levels.
958.9 7	(7/2-)		
1648.7 ‡ 12	(13/2+)		$J\pi$: yrast population favors the 13/2+, spin-parity assignments indicating configuration= $\nu g_{9/2} \otimes (2+ \text{ in } ^{60}\text{Fe})$.
2989.7 ‡ 13	(17/2+)		Configuration= $\nu g_{9/2} \otimes (4+ \text{ in } ^{60}\text{Fe})$.

† Assignments are based on systematics.

‡ (A): 9/2[404] Band.

 $\gamma(^{61}\text{Fe})$

E_γ	E(level)	I_γ	Comments
206.5 5	206.5	68 6	
654	860.5		E_γ , Mult.: 654 γ with mult=M2 reported in 1998Gr14 and Fig. 6 of 2007Lu13.
752.4 4	958.9	29 5	
788.2 2	1648.7	100 7	
1341.0 5	2989.7	53 7	

$^{238}\text{U}(^{64}\text{Ni},\text{X}\gamma)$ E=430 MeV 2008Ho05

2008Ho05: ^{61}Fe produced in $^{238}\text{U}(^{64}\text{Ni},\text{X}\gamma)$ reaction at a beam energy of 430 MeV (25% above the Coulomb barrier) by ATLAS accelerator at ANL. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(\theta)$ using GAMMASPHERE array of 100 Compton-suppressed HPGe detectors. Prompt and delayed coincidence events in various configurations were recorded. Comparisons with shell-model calculations and particle-triaxial-rotor model predictions.

 ^{61}Fe Levels

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}$	Comments
0.0 §	3/2-		
207.00 § 10	5/2-		
861.80 # 15	9/2+	238 ns 5	$T_{1/2}$: from Adopted Levels.
959.51 § 23	7/2-		
1476.6 § 3	(5/2-, 9/2-)		
1650.31 # 18	13/2+		
2992.7 # 4	17/2+	<0.12 ps	$T_{1/2}$: Given $Q_0=+1.15$ estimate the mean lifetime of the 1342 keV, 17/2+ to 13/2+ transition to be $\tau=0.4$ ps.
3528.8 4	(17/2+, 15/2+)		
3541.4 7			
3714.4 7			
4144.6 4	(19/2+)		
4292.4 4	(19/2+, 17/2+)		
4675.4 # 5	(21/2+)		

[†] From least-squares fit to $E\gamma$ data.

[‡] As proposed in 2008Ho05 based on $\gamma\gamma(\theta)$ data for selected transitions, yrast nature of population of states, and shell-model calculations.

§ (A): The g.s. band.

(B): v9/2[404] band.

 $\gamma(^{61}\text{Fe})$

$E\gamma$	E(level)	Mult. [†]	Comments
207.0 1	207.00	D	
517.1 2	1476.6		
536.1 3	3528.8		
654.8 1	861.80	Q	(654.8 γ)(207.0 γ)(θ): $A_2=-0.03$ 4, $A_4=+0.07$ 5 consistent with quadrupole-dipole cascade.
752.5 2	959.51	D	(752.5 γ)(207.0 γ)(θ): $A_2=+0.26$ 4, $A_4=+0.07$ 6 consistent with dipole-dipole cascade.
763.6 2	4292.4		
788.5 1	1650.31	Q	(788.5 γ)(654.8 γ)(θ): $A_2=+0.18$ 4, $A_4=+0.05$ 6 consistent with quadrupole-quadrupole cascade.
1151.9 2	4144.6		
1300 ‡	4292.4		
1342.3 3	2992.7	Q	(1342.3 γ)(788.5 γ)(θ): $A_2=+0.12$ 11, $A_4=0.00$ 16 consistent with quadrupole-quadrupole cascade.
1682.7 3	4675.4		
1878.6 4	3528.8		
1891.1 6	3541.4		
2064.1 6	3714.4		

[†] From angular correlation $\gamma\gamma(\theta)$ analysis.

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

Adopted Levels, Gammas

$Q(\beta^-)=1323.7$ 8; $S(n)=9319.2$ 8; $S(p)=8774$ 3; $Q(\alpha)=-7836.4$ 17 2012Wa38.

$S(2n)=16811.1$ 8, $S(2p)=21950.2$ 25 (2012Wa38).

^{61}Co produced and identified in bombardment of ^{61}Ni with fast fast neutrons followed by chemical separation (Parmley and Moyer: Phys Rev 72, 82 (1947)). Later studies by 1948Ku01 and 1949Pa01 confirmed the isotopic identification.

2011Sr04: shell-model calculations of levels, J , π , $B(E2)$ using GXPF1A, KB3G and fp_g effective interactions.

 ^{61}Co Levels**Cross Reference (XREF) Flags**

A ^{61}Fe β^- Decay (5.98 min)	F $^{62}\text{Ni}(t,\alpha)$
B $^{16}\text{O}(^{48}\text{Ca},p2n\gamma)$	G $^{64}\text{Ni}(p,\alpha)$
C $^{59}\text{Co}(t,p)$	H $^{64}\text{Ni}(p,\alpha\gamma)$
D $^{60}\text{Co}(n,\gamma),(n,n)$: Resonances	I $^{238}\text{U}(^{70}\text{Zn},X\gamma)$
E $^{62}\text{Ni}(d,^3\text{He})$	

E(level) [†]	$J\pi^{\ddagger}$	XREF	$T_{1/2}^{\S}$	Comments
0.0	7/2-	ABC EFGHI	1.649 h 5	% β^- =100. $J\pi$: $L(t,p)=0$; $L(t,\alpha)=L(p,\alpha)=3$. $T_{1/2}$: weighted average of 1.650 h 5 (1951Sm64), 1.66 h 1 (1956Nu02), 1.645 h 7 (1956Ru45), 1.70 h 3 (1962Va23), 1.58 h 3 (1966St11), 1.63 h 3 (1967Gr15,1968Ka21), 1.66 h 7 (1982Ma41). Reduced $\chi^2=1.7$. Others: 1.75 h (1948Ku01), 1.75 h 5 (1949Pa01), 1.70 h 5 (1960Pr05), 1969Ki09.
1027.48 8	3/2-	ABC EFGH	#	XREF: C(1036)F(1031).
1205.09 9	(3/2)-	A C FGH	#	$J\pi$: $L(d,^3\text{He})=L(t,\alpha)=1$; 1027 γ not M3 from $T_{1/2}$ and RUL. XREF: F(1210).
1272 25		F		$J\pi$: $L(t,p)=2$; log $ft=5.85$ from (3/2-); 3/2- from $\sigma(\theta)$ in (p, α).
1285.54 ^c 23	(9/2)-	ABC FGH I	0.55 ps 14	XREF: F(1287).
1325.40 10	(1/2-)	AB FG	#	$J\pi$: $L(t,p)=2$; γ to 7/2-; 9/2- from (p, α); first 9/2- predicted at 1405 keV in shell-model calculations (2011Sr04). XREF: F(1338).
1618.85 17	5/2-, 7/2-	A E GH		$J\pi$: 298(0) probably isotropic in ($^{48}\text{Ca},p2n\gamma$); log $ft=5.90$ from (3/2-); 1/2- favored in (p, α).
1631 7	(5/2, 7/2)-	C F		$J\pi$: $L(d,^3\text{He})=3$. XREF: F(1635).
1645.87 12	(3/2-, 5/2)	A GH		$J\pi$: $L(t,\alpha)=(3)$; $L(t,p)=2$.
1664.3 ^a 4	(11/2-)	B g I	7 ps +7-2	$J\pi$: log $ft=6.20$ from (3/2-); γ rays to 3/2- and 7/2-.
1674 7	(7/2)-	C Fg		$J\pi$: $\Delta J=(2)$, (E2) γ to 7/2-; 7/2- and 11/2- from $\sigma(\theta)$ for a doublet in (p, α). XREF: F(1682).
1889.1 3	(5/2, 7/2)-	A C EFGH		$J\pi$: $L(t,\alpha)=(3)$; $L(t,p)=2$; 7/2- and 11/2- from $\sigma(\theta)$ for a doublet in (p, α). XREF: C(1891)F(1903)H(1891).
1953.19 16	1/2-, 3/2-	A C EFGH		$J\pi$: $L(d,^3\text{He})=3$; 7/2- is suggested from $\sigma(\theta)$ in (p, α), but possible β feeding (log $ft=7.5$) from (3/2-) supports 5/2-.
2011.49 15	(3/2, 5/2)-	A C G		XREF: F(1971).
2230.9 3	(5/2, 7/2)-	A C H		$J\pi$: $L(d,^3\text{He})=L(t,\alpha)=1$.
2238 5	1/2+	EFG		$J\pi$: $L(t,p)=2+4$; log $ft=6.09$ from (3/2-).
2302.99 17	1/2-, 3/2-	A C E GH		$J\pi$: $L(t,p)=2$; γ to (9/2)-; possible γ to 3/2-.
2338.9 ^c 6	(11/2-)	B	1.7 ps +4-3	$J\pi$: $L(d,^3\text{He})=L(t,\alpha)=L(p,\alpha)=0$. XREF: E(2313).
2345.5 8	5/2-, 7/2-	C EFG		$J\pi$: $L(d,^3\text{He})=1$.
2373.8 11	(1/2 to 15/2)-	C G		$J\pi$: $\Delta J=1$, dipole γ to (9/2-). XREF: E(2354)F(2368).
2374.2 ^a 6	(13/2-)	B I		$J\pi$: $L(d,^3\text{He})=L(t,\alpha)=3$; $L(t,p)=0+4$. 3/2,5/2 in (p, α) possibly from $\sigma(\theta)$ shape. XREF: C(2385).
2431.4 [@] 5	(3/2, 5/2)-	A C G		$J\pi$: $L(t,p)=4$.
2448 5	5/2-, 7/2-	EF		$J\pi$: $L(t,p)=2+4$; γ to 3/2-.
2484.5 4	(3/2, 5/2)-	A C G		XREF: F(2459).
				$J\pi$: $L(d,^3\text{He})=3$. XREF: C(2479).
				$J\pi$: $L(t,p)=4$; log $ft=7.21$ from (3/2-); γ to 7/2-.

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Adopted Levels, Gammas (continued)

⁶¹Co Levels (continued)

E(level) [†]	Jπ [‡]	XREF	T _{1/2} [§]	Comments
2499 5	(3/2+, 5/2+)	E		Jπ: L(d, ³ He)=2; L(d, ³ He)=3 fit is poor but not ruled out.
2558.6 8	(3/2+)	G		Jπ: L(p,α)=(2), agreement of σ(θ) data with DWBA.
2571.6 9	3/2+, 5/2+	C EFG		XREF: F(2583).
2642.3 8	(3/2 to 11/2)-	C G		Jπ: L(d, ³ He)=L(t,α)=2. XREF: C(2649).
2706.7 11	(3/2 to 11/2)-	C G		Jπ: L(t,p)=2. 7/2+, 9/2- in (p,α) possibly from σ(θ) shape. XREF: C(2713).
2726.5 10		G		Jπ: L(t,p)=2.
2754.5 4	(3/2-, 5/2)	A C G		XREF: C(2760).
2780.1 10		G		Jπ: log ft=6.07 from (3/2-); γ to 7/2-; L(t,p)=2 or 1+3.
2864.38 18	(3/2, 5/2)-	A C G		Jπ: L(t,p)=2+4; log ft=5.70 from (3/2-).
2893 5	5/2-, 7/2-	EF		Jπ: L(d, ³ He)=L(t,α)=3.
2920.1 5	(3/2-, 5/2)	A G		Jπ: log ft=6.9 from (3/2-); γ to 7/2-.
2952.9 10	(3/2 to 11/2)-	C G		Jπ: L(t,p)=2(+6).
2979.9 10		G		
3000.27 20	(3/2, 5/2)-	A C G		Jπ: L(t,p)=2+4; log ft=5.45 from (3/2-).
3026 5	3/2+, 5/2+	E		Jπ: L(d, ³ He)=2.
3028 25	5/2-, 7/2-	F		Jπ: L(t,α)=3.
3077 4	(3/2 to 11/2)-	C		Jπ: L(t,p)=2.
3104.4 5	(1/2, 3/2, 5/2)	A G		Jπ: log ft=6.5 from (3/2-).
3116.7 11	(3/2+, 5/2+)	G		Jπ: possibly from σ(θ) shape.
3126.7 ^a 6	(15/2-)	B G I		
3130 4	(3/2 to 11/2)-	C		Jπ: L(t,p)=2+4.
3151.7 11		FG		XREF: F(3163).
3176.0 9		G		Jπ: 1/2, 3/2 listed in (p,α) (1979Sm03) corresponds to 3176 and/or 3191 level.
3191.1 6	(3/2-, 5/2)	A G		Jπ: log ft=6.3 from (3/2-); γ to 7/2-.
3197 14	7/2-	C		Jπ: L(t,p)=0+4.
3204.7 3	(3/2-, 5/2-)	A FG		Jπ: log ft=5.39 from (3/2-); γ to 7/2-; L(t,α)=(2).
3218 5	3/2+, 5/2+	E		Jπ: L(d, ³ He)=L(t,α)=2.
3239.2 6	(3/2-, 5/2)	A G		Jπ: log ft=6.4 from (3/2-); γ to 7/2-.
3252 9	7/2-	C		Jπ: L(t,p)=0(+4).
3349.4 11		G		
3357.0 13	(1/2 to 13/2)	C G		Jπ: L(t,p)=2+4, 3.
3365.0 7	(3/2-, 5/2)	A G		Jπ: log ft=6.2 from (3/2-); γ to 7/2-.
3384.3 11		G		
3396.9 12		FG		
3409.7 11		G		
3417 4	(9/2-, 11/2-)	C E		XREF: E(3421).
3428.4 11	(9/2-, 11/2-)	G		Jπ: L(d, ³ He)=(5); L(t,p)=0+3+5 suggests a doublet.
3445.1 12	7/2-	C FG		Jπ: L(d, ³ He)=(5). XREF: F(3467).
3470.8 10	(3/2, 5/2)	G		Jπ: L(t,p)=0+2; L(t,α)=(3).
3471.7 ^c 7	(13/2-)	B I		Jπ: possibly from σ(θ) shape.
3484.8 11	(3/2 to 11/2)-	C G		Jπ: L(t,p)=2+4.
3492.5 14	5/2-, 7/2-	E G		Jπ: L(d, ³ He)=3.
3513.6 11	7/2-	C G		Jπ: L(t,p)=0+2.
3535.6 10	(5/2, 7/2)	C G		Jπ: possibly from σ(θ) shape in (p,α).
3564.7 13		G		
3575.3 13	(3/2 to 11/2)-	C G		Jπ: L(t,p)=2+4.
3599.6 14	(1/2+, 5/2-, 7/2-)	E G		Jπ: L(d, ³ He)=(0,3); σ(θ) better fit with L=3.
3609.4 13	(3/2 to 13/2)	C G		Jπ: L(t,p)=2+4 or 3+5. In (p,α), Jπ=1/2+, 5/2, 7/2 for a doublet possibly from σ(θ) shape.
3654.0 11	(3/2 to 11/2)-	G		Jπ: L(t,p)=2+4.
3658.0 ^b 7	(15/2-)	B I		
3660 4	(3/2 to 17/2)+	C F		Jπ: L(t,p)=5.
3691.5 10	(3/2 to 13/2)+	C G		Jπ: L(t,p)=3+5.
3700.2 15	(1/2 to 15/2)-	C G		XREF: C(3713).
				Jπ: L(t,p)=4.

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Adopted Levels, Gammas (continued) ^{61}Co Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	XREF	T _{1/2} [§]	Comments
3727.8 15	(5/2 to 11/2)-	C G		XREF: C(3732). J π : L(t,p)=2+6.
3752.6 12	(3/2 to 11/2)-	G		J π : L(t,p)=2+4.
3758.2? 15		G		
3775.3@ 11	(5/2, 7/2)	C FG		XREF: F(3782). J π : L(t,p)=1(+3) suggests (5/2+, 7/2+, 9/2+); L(t, α)=(3) gives (5/2-, 7/2-).
3806.3 13	5/2-, 7/2-	E G		J π : L(d, ^3He)=3.
3814.6 15	(3/2 to 11/2)	C G		J π : L(t,p)=(3), 2+4.
3827.3 14		G		
3871.1 12	3/2+, 5/2+	C FG		J π : L(t, α)=2. But L(t,p)=(2+4) suggests negative parity.
3889.8 13	3/2+, 5/2+	E G		J π : L(d, ^3He)=2.
3905.6 12		G		
3915.7 12	(3/2 to 13/2)+	C G		J π : L(t,p)=3+5.
3924.4 13		G		
3937.1 12		G		
3965 25	(5/2-, 7/2-)	C F		XREF: F(3970). J π : L(t,p)=2+4; L(t, α)=(3).
3987 7		C		
4002 5	(1/2+, 5/2-, 7/2-)	E		J π : L(d, ^3He)=(0,3); $\sigma(\theta)$ better fit with L=3.
4071@ 6		C		J π : L(t,p)=3+(6) suggest (1/2:13/2)+ for L=3 and (5/2:19/2)(-) for L=6.
4093.8 ^b 8	(17/2-)	B I	0.76 ps 21	
4152 7	(7/2-)	C E		XREF: E(4159). J π : L(t,p)=(0).
4211 6	(3/2 to 17/2)+	C		J π : L(t,p)=5.
4267 5	(1/2+, 5/2-, 7/2-)	E		J π : L(d, ^3He)=(0,3); $\sigma(\theta)$ better fit with L=3.
4282 4	(5/2 to 11/2)-	C		J π : L(t,p)=2+6.
4349 6	7/2-	C		J π : L(t,p)=0+(6).
4382 5	3/2+, 5/2+	E		J π : L(d, ^3He)=2.
4389 3	7/2-	C		J π : L(t,p)=0+(4+6).
4455 5	3/2+, 5/2+	E		J π : L(d, ^3He)=2.
4499 15	7/2-	C G		XREF: G(4510). J π : L(t,p)=0+4.
4534 6	(5/2 to 11/2)-	C		J π : L(t,p)=2+6.
4622 5	(3/2 to 11/2)-	C		J π : L(t,p)=2+(4,6).
4656 5	3/2+, 5/2+	E		J π : L(d, ^3He)=2.
4671 7	(5/2 to 11/2)-	C		J π : L(t,p)=2+6.
4753 5	3/2+, 5/2+	E G		XREF: G(4730). J π : L(d, ^3He)=2.
4766 5	(3/2 to 11/2)-	C		J π : L(t,p)=2+4.
4802.3 ^b 17	(19/2-)	B		
4838 6	(5/2 to 11/2)-	C		J π : L(t,p)=2+6.
4911 5	(5/2 to 11/2)-	C		J π : L(t,p)=2+(4+6).
4960 5	(5/2)+	C G		J π : L(t,p)=1; 3/2, 5/2 possibly from $\sigma(\theta)$ shape in (p, α).
4990 5	3/2+, 5/2+	E		J π : L(d, ^3He)=2.
5061 5	(3/2, 5/2, 7/2)	E		J π : L(d, ^3He)=(2,3); $\sigma(\theta)$ better fit with L=2.
5081 12	(3/2 to 11/2)-	C		J π : L(t,p)=2+4.
5150 5	(3/2, 5/2, 7/2)	E		J π : L(d, ^3He)=(2,3); $\sigma(\theta)$ better fit with L=3.
5164 5	+	C		J π : L(t,p)=3.
5214@ 5	(3/2 to 13/2)	C		J π : L(t,p)=2+(5).
5271 4	(3/2 to 13/2)+	C		J π : L(t,p)=3+5.
5321 6	(5/2, 7/2, 9/2)	C		J π : L(t,p)=1+3, 0+4. L=0+4 suggests 7/2-; L=1+3 gives 5/2+, 7/2, 9/2.
5388 6	(3/2 to 11/2)-	C		J π : L(t,p)=2.
9320.01	9/2+, 11/2+&	D		
9320.91	9/2+, 11/2+&	D		
9321.19	9/2+, 11/2+&	D		
9321.66	9/2+, 11/2+&	D		

[†] Level energy with $\Delta E < 1$ keV are deduced from least-square fit to the Adopted Gammas. The others are from (p, α) or weighted averages from (t,p) and (d, ^3He). Values from (t, α) are not used due to less precision in this work.

Adopted Levels, Gammas (continued)

⁶¹Co Levels (continued)

- ‡ When L-transfer arguments are used, the target $J\pi=0+$ for (d,³He), (t, α) and (p, α) reactions. Target $J\pi=7/2-$ for (t,p) reaction, which gives negative parity for even L transfer and positive parity for odd L transfer, with several $J\pi$ values possible for $L\geq 1$; for $L=0$, $J\pi=7/2-$, assuming the two neutrons are in $S=0$ state. For high-spin ($J>9/2$), the assignments are based on $\gamma(\theta)$ data for selected transitions, yrast nature of population of states, decay pattern and systematics. No separate arguments are given for the high-spin states.
- § From DSAM in (⁴⁸Ca,p2n γ), unless otherwise stated. Because of incomplete knowledge of the level scheme, the feeding γ transitions are not known. Hence, the value given is considered as an apparent half-life, and as a lower limit.
- # <100 ns from coincidence resolving time of ≈ 40 ns in $\gamma\beta$ -coin in β^- decay.
- @ Possible doublet.
- & S-wave neutron capture in ⁶⁰Cu g.s., $J\pi=5+$.
- a (A): γ cascade based on 11/2-.
- b (B): γ cascade based on (15/2-).
- c (C): γ cascade based on 9/2-.

$\gamma(^{61}\text{Co})$

E(level)	E $\gamma^\dagger$	I $\gamma^\dagger$	Mult.	Comments
1027.48	1027.42 11	100	[E2]	B(E2)(W.u.)>0.00035.
1205.09	177.61 12	4.6 4		
	1205.07 12	100		
1285.54	1285.5 4	100		E γ : weighted average of 1285.7 3 in β^- decay, 1284.5 6 in (⁴⁸ Ca,p2n γ) and 1286.4 9 in (⁷⁰ Zn,X γ).
1325.40	120.34 12	23.9 18		
	297.90 7	100 8		
1618.85	333.0 4	61 10		
	1618.9 2	100 12		
1645.87	440.5 4	3.1 7		
	618.40 16	13.4 11		
	1645.95 16	100 5		
1664.3	379.1 5	25 4		
	1663.6 5	100 15	(E2)	B(E2)(W.u.)=0.36 +14-18.
1889.1	244 ‡	16 ‡ 6		
	603.3 5	41 17		
	1889.0 4	100 20		
1953.19	748.10 18	100 10		
	925.6 3	42 5		
2011.49	686.0 3	9.1 18		
	806.3 4	4.4 11		
	984.1 4	14 3		
	2011.6 2	100 7		
2230.9	945.4 5	100 30		
	1027 § @			
	1205 § @			
	2230.8 4	100 16		
2302.99	349.7 3	23 6		
	657.3 4	32 14		
	978 § @	11 6		
	1097.8 2	100 9		
	1275	88 19		
2338.9	1053.9 7	100	(M1) #	B(M1)(W.u.)=0.0111 23.
2374.2	709.8 5	100	(D) #	
2431.4	542.6 § @ 5	60 30		
	1403.9 5	100 50		
2484.5	2484.4 4	100		
2754.5	2754.4 4	100		
2864.38	561.4 § @ 5	7 4		
	1538.8 3	35 7		
	1659.3 2	100 12		
	1837.2 6	18 4		
2920.1	2920.0 5	100		
3000.27	696.9 4	19 5		
	769.4 5	26 7		
	989.2 4	100 22		
	1381.4 3	66 8		

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Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Co})$ (continued)

E(level)	$E\gamma^\dagger$	$I\gamma^\dagger$	Mult.	Comments
3000.27	1972.7 5	10 3		
3104.4	1899.3 5	100		
3126.7	752.4 5	100 20	(D) #	
	1462.4 8	24.7 11	(Q) #	
3191.1	3191.0 6	100		
3204.7	1879.4 4	100 14		
	1999.8 8	50 17		
	2177.1 7	80 17		
	3204.2 6	17 4		
3239.2	3239.1 6	100		
3365.0	3364.9 7	100		
3471.7	1133.3 7	25.2 10	(D) #	
	1806.9 10	100 12	(D) #	
3658.0	186.4 5	100 12	(D) #	
	531.2 5	41 9	(D) #	
4093.8	435.8 5	100	(D) #	Mult.: $\gamma(\theta)$ consistent with $\Delta J=0$, dipole.
4802.3	708.5 15	100	(D) #	

† From ^{61}Fe β^- decay if a level is populated in this study, otherwise from in-beam γ reaction data. Exceptions are noted.

‡ From $^{64}\text{Ni}(p,\alpha\gamma)$. $I\gamma(245\gamma)/I\gamma(1889\gamma)$ adopted. Note $I\gamma(603\gamma)/I\gamma(1889\gamma)=0.84$ 21 in (p, $\alpha\gamma$).

§ See comment in $^{64}\text{Ni}(p,\alpha\gamma)$.

From $\gamma(\theta)$ in $^{16}\text{O}(^{48}\text{Ca},p2n)$.

@ Placement of transition in the level scheme is uncertain.

(A) γ cascade based on
11/2-

(B) γ cascade based on
(15/2-)

(C) γ cascade based on
9/2-

 $^{61}_{27}\text{Co}_{34}$

^{61}Fe β^- Decay (5.98 min) 1975Br04

Parent ^{61}Fe : $E=0$; $J\pi=(3/2^-)$; $T_{1/2}=5.98$ min 6; $Q(\text{g.s.})=3977.1$ 28; $\%\beta^-$ decay=100.

$^{61}\text{Fe}-J, T_{1/2}$: From Adopted Levels of ^{61}Fe .

$^{61}\text{Fe}-Q(\beta^-)$: from 2012Wa38.

1975Br04: Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ coin, $\gamma\gamma$ anti-coin, $\gamma(t)$, semi.

1967Gu06: Measured $E\gamma$, $I\gamma$, β spectra, $\gamma\gamma$, $\beta\gamma$ coin, half-life of ^{61}Fe seven γ rays reported.

1967Gr15: Measured ^{61}Fe half-life, γ and β spectra, $\beta\gamma$ and $\gamma\gamma$ coin, seven γ rays reported.

1967Eh02: Measured $E\gamma$, $I\gamma$, $\gamma\beta$ coin.

1966St11: Measured $E\gamma$, $I\gamma$, ^{61}Fe half-life.

Source produced by $^{64}\text{Ni}(n,\alpha)$ (1984Qa04, 1968Ka22, 1966St11), $^{64}\text{Ni}(d,\alpha p)$ (1978LeZA) and $W(^{82}\text{Se}, X)$ (1985Ru05).

1957Ri10: ^{61}Fe produced in bombardment of Ni and Cu targets with 20 MeV neutrons and 28 MeV deuterons, measured half-life, β , γ .

From RADLIST code, deduced total decay energy is 4032 keV 174 is consistent with $Q(\beta^-)=3977$ keV 3, which suggests that the decay scheme is reasonably complete.

 ^{61}Co Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}$	Comments
0.0	7/2-		
1027.49 8	3/2-	§	
1205.10 8	(3/2)-	§	
1285.72 21	(9/2)-		
1325.41 9	(1/2-)	§	
1618.88 17	5/2-, 7/2-		
1645.89 11	(3/2-, 5/2)		
1889.0 3	(5/2, 7/2)-		$J\pi$: note that 7/2 is inconsistent with $\log ft=7.5$ from (3/2-).
1953.20 16	1/2-, 3/2-		
2011.50 14	(3/2, 5/2)-		
2230.9 3	(5/2, 7/2)-		
2303.00 16	1/2-, 3/2-		
2431.5 4	(3/2, 5/2)-		
2484.5 4	(3/2, 5/2)-		
2754.5 4	(3/2-, 5/2)		
2864.39 17	(3/2, 5/2)-		
2920.1 5	(3/2-, 5/2)		
3000.30 20	(3/2, 5/2)-		
3104.4 5	(1/2, 3/2, 5/2)		
3191.1 6	(3/2-, 5/2)		
3204.7 3	(3/2-, 5/2-)		
3239.2 6	(3/2-, 5/2)		
3365.0 7	(3/2-, 5/2)		

† From least-squares fit to $E\gamma$ data.

‡ From Adopted Levels.

§ <100 ns from $\gamma(t)$; resolving time ≈ 40 ns in $\gamma\gamma$ and $\beta\gamma$ coin (1967Eh02).

 β^- radiations

$E\beta^-$	$E(\text{level})$	$I\beta^-^{\dagger\ddagger}$	$\log ft$	Comments
(612 3)	3365.0	0.042 9	6.2 1	
(738 3)	3239.2	0.055 13	6.4 1	
(772 3)	3204.7	0.62 8	5.39 6	
(786 3)	3191.1	0.080 14	6.3 1	
(873 3)	3104.4	0.071 22	6.5 2	
(977 3)	3000.30	1.30 17	5.45 6	
(1057 3)	2920.1	0.067 14	6.9 1	
(1113 3)	2864.39	1.19 13	5.70 5	
(1223 3)	2754.5	0.74 10	6.07 6	
(1493 3)	2484.5	0.118 15	7.21 6	
(1546 § 3)	2431.5	<0.17	>7.1	
(1674 3)	2303.00	1.53 21	6.30 6	
(1746 § 3)	2230.9	<0.10	>7.6	
(1966 3)	2011.50	4.8 5	6.09 5	
(2024 3)	1953.20	0.95 11	6.85 5	
(2088 3)	1889.0	0.24 5	7.5 1	

Continued on next page (footnotes at end of table)

${}^{61}\text{Fe}$ β^- Decay (5.98 min) 1975Br04 (continued) β^- radiations (continued)

$E\beta^-$	E(level)	$I\beta^{-\dagger\dagger}$	Log ft	Comments
(2331 3)	1645.89	7.6 6	6.20 4	$E\beta^-$: measured value: 2500 100 ($I\beta=13\%$) (1967Gu06).
(2358 3)	1618.88	0.18 8	7.9 2	
(2652 3)	1325.41	26.3 24	5.90 4	$E\beta^-$: measured value: 2630 100 ($I\beta=54\%$) (1967Gu06).
(2691 § 3)	1285.72	<0.05	>8.6	
(2772 3)	1205.10	35.4 22	5.85 3	$E\beta^-$: measured value: 2800 100 ($I\beta=31\%$) (1967Gu06).
(2950 3)	1027.49	15 3	6.3 1	$E\beta^-$: measured values: 2850 70 (1967Gu06), 2860 (1967Eh02).
(3977 § 3)	0.0	<10	>7.1	$I\beta^-$: from counting of β^- and γ (1967Eh02).

† From $I(\gamma+ce)$ intensity imbalance at each level.

‡ Absolute intensity per 100 decays.

§ Existence of this branch is questionable.

 $\gamma({}^{61}\text{Co})$

I_γ normalization: from $\Sigma I(\gamma+ce)$ to g.s.=95 5, assuming <10% β feeding to g.s.

$E\gamma$	E(level)	$I_\gamma^{\dagger\dagger}$	Mult.	α	$E\gamma$	E(level)	$I_\gamma^{\dagger\dagger}$
120.34 12	1325.41	12.2 9	[M1+E2]	0.14 12	1275	2303.00	1.4 3
177.61 12	1205.10	4.6 4	[M1+E2]	0.03 3	1285.7 3	1285.72	0.85 13
297.90 7	1325.41	51 4			1381.4 3	3000.30	0.92 11
333.0 4	1618.88	0.51 8			1403.9 5	2431.5	0.27 12
349.7 3	2303.00	0.37 9			1538.8 3	2864.39	0.63 11
440.5 4	1645.89	0.50 10			1618.9 2	1618.88	0.84 10
542.6 § 5	2431.5	0.15 7			1645.95 16	1645.89	16.0 8
561.4 § 5	2864.39	0.13 6			1659.3 2	2864.39	1.78 20
603.3 5	1889.0	0.17 7			1837.2 6	2864.39	0.32 7
618.40 16	1645.89	2.14 17			1879.4 4	3204.7	0.60 8
657.3 4	2303.00	0.51 22			1889.0 4	1889.0	0.41 8
686.0 3	2011.50	0.92 18			1899.3 5	3104.4	0.17 5
696.9 4	3000.30	0.26 7			1972.7 5	3000.30	0.14 4
748.10 18	1953.20	1.85 17			1999.8 8	3204.7	0.30 10
769.4 5	3000.30	0.37 9			2011.6 2	2011.50	10.1 7
806.3 4	2011.50	0.44 11			2177.1 7	3204.7	0.48 10
925.6 3	1953.20	0.78 9			2230.8 4	2230.9	0.25 4
945.4 5	2230.9	0.25 7			2484.4 4	2484.5	0.28 3
978 §	2303.00	0.17 9			2754.4 4	2754.5	1.76 20
984.1 4	2011.50	1.4 3			2920.0 5	2920.1	0.16 3
989.2 4	3000.30	1.4 3			3191.0 6	3191.1	0.19 3
1027.42 11	1027.49	98 5			3204.2 6	3204.7	0.10 2
1097.8 2	2303.00	1.60 13			3239.1 6	3239.2	0.13 3
1205.07 12	1205.10	100			3364.9 7	3365.0	0.10 2

† Relative intensity normalized to $I_\gamma(1205.07\gamma)=100$.

‡ For absolute intensity per 100 decays, multiply by 0.420 24.

§ Placement of transition in the level scheme is uncertain.

^{61}Fe β^- Decay (5.98 min) 1975Br04 (continued)

Decay Scheme

 $(3/2^-)$ 0.0 5.98 min $^{61}_{26}\text{Fe}_{35}$ % β^- =100 $Q^-(\text{g.s.})=3977.1^{28}$ Intensities: I(γ +ce) per 100 parent decays **$^{16}\text{O}(^{48}\text{Ca}, p2n\gamma)$ 1996Re18**

1996Re18: ^{61}Co produced in $^{16}\text{O}(^{48}\text{Ca}, p2n)$ reaction at a beam energy of 110 MeV. Measured E_γ , I_γ , $\gamma(\theta)$, p_γ , $n_{p\gamma}$ and $p\gamma\gamma$ coin, lifetimes by the Doppler shift attenuation method (DSAM).

 ^{61}Co Levels

E(level) [†]	$J\pi^\ddagger$	$T_{1/2}^\S$	Comments
0.0	$7/2^-$		
1028.0 5	$(3/2^-)$		
1284.5 & 5	$9/2^-$	0.55 ps 14	
1326.0 9	$(1/2^-)$		$J\pi$: 1/2 consistent with isotropic $\gamma(\theta)$.
1663.8 # 6	$11/2^-$	7 ps +7-2	
2338.1 & 8	$(11/2^-)$	1.7 ps +4-3	
2373.8 # 7	$(13/2^-)$		
3126.2 # 7	$(15/2^-)$		

Continued on next page (footnotes at end of table)

¹⁶O(⁴⁸Ca,p2n γ) 1996Re18 (continued)

⁶¹Co Levels (continued)

E(level) [†]	J π [‡]	T _{1/2} [§]
3471.0& 8	(13/2-)	
3657.4@ 8	(15/2-)	
4093.1@ 9	(17/2-)	0.76 ps 21
4801.6@ 18	(19/2-)	

[†] From a least-squares fit to E γ data.

[‡] From 1996Re18 based on $\gamma(\theta)$ data and decay pattern, assuming yrast type of level population. See also Adopted Levels for confirming or different assignments in some cases.

[§] From Doppler shift attenuation method (DSAM). Because of the incomplete nature of the decay scheme, the side feeding into the gamma transitions used for T_{1/2} determination is not well known. Hence, the intrinsic lifetimes of the states could not be accurately deduced, and only apparent lifetimes, and should be treated as lower limits.

(A): γ cascade based on 11/2-.

@ (B): γ cascade based on (15/2-).

& (C): γ cascade based on 9/2-.

$\gamma(^{61}\text{Co})$

Angular distributions for two angles I γ (135°)/I γ (90°), measuring the anisotropy using the 90° and 135° detectors, negative value of A₂ is for dipole transition and positive value for quadrupole or a J to J dipole transition. Mixed dipole/quadrupole transitions can have either positive or negative value of A₂.

E γ	E(level)	I γ [†]	Mult. [‡]	Comments
186.4 5	3657.4	29 4	(D)	A ₂ =-0.10 13. I γ (135°)/I γ (90°)=0.93 9.
298.0 7	1326.0	1 1		A ₂ =+0.17 38. I γ (135°)/I γ (90°)=1.1 4.
379.1 5	1663.8	25 4		A ₂ =-0.04 15. I γ (135°)/I γ (90°)=0.97 12.
435.7 5	4093.1	28 5	(D)	A ₂ =-0.13 15. I γ (135°)/I γ (90°)=0.91 11.
531.2 5	3657.4	12 3	(D)	A ₂ =+0.45 29. I γ (135°)/I γ (90°)=1.4 3. $\gamma(\theta)$ consistent with $\Delta J=0$, dipole transition.
708.5 15	4801.6	28 6	(D)	A ₂ =-0.16 12 for the unresolved doublet: 708.5 and 710.0 keV. I γ (135°)/I γ (90°)=0.89 8.
710.0 5	2373.8	42.7 6	(D)	I γ : deduced from p- γ - γ coin data. A ₂ =-0.16 12 for the unresolved doublet: 708.5 and 710.0 keV. I γ (135°)/I γ (90°)=0.89 8.
752.4 5	3126.2	18.2 40	D	A ₂ =-0.24 21. I γ (135°)/I γ (90°)=0.84 14. $\Delta J=1$ transition.
1028.0 5	1028.0	6.4 9		A ₂ =-0.13 27. I γ (135°)/I γ (90°)=0.91 20.
1053.9 7	2338.1	24.5 6	D	A ₂ =-0.27 19. I γ (135°)/I γ (90°)=0.82 14. $\gamma(\theta)$ consistent with a $\Delta J=1$ transition.
1133.3 7	3471.0	7.3 3	(D)	A ₂ =+0.06 29. I γ (135°)/I γ (90°)=1.1 3.
1284.5 6	1284.5	92.7 8		
1462.4 8	3126.2	4.5 2	Q	A ₂ =+0.5 5. I γ (135°)/I γ (90°)=1.5 5.
1663.8 7	1663.8	100 14	(E2)	A ₂ =+0.38 13. I γ (135°)/I γ (90°)=1.35 17.
1806.5 10	3471.0	29 4	(D)	A ₂ =-0.13 14. I γ (135°)/I γ (90°)=0.91 10.

[†] Relative intensities from p- γ data, normalized to I γ (1663.8 γ)=100, unless indicated otherwise.

[‡] From $\gamma(\theta)$ and $\Delta J\pi$.

$^{59}\text{Co}(\text{t},\text{p})$ 1985Fo02,1971Hu01

1985Fo02: E=15 MeV, measured $\sigma(\text{E}(\text{p}),\theta)$, $\theta=11.25^\circ-86.25^\circ$ (lab) in steps of 7.5° by using a multiangle spectrograph with focal plane of nuclear emulsion plates; FWHM=30 keV. DWBA analysis.

1971Hu01: E=11.82 MeV. Measured $\sigma(\text{E}(\text{p}),\theta)$, 9 angles (c.m.) between $\approx 5^\circ$ and $\approx 72^\circ$, magnetic spectrograph. FWHM=20 keV.

Absolute uncertainty in energy is quoted by the authors as 15–25 keV due to problems in calibration curve, relative uncertainties are better.

$J\pi(^{61}\text{Co g.s.})=7/2^-$.

All data are from 1985Fo02, except as noted.

 ^{61}Co Levels

E(level)	$L^\dagger$	$d\sigma/d\Omega(\text{max})$ ($\mu\text{b/sr}$)	Comments
0.0	0	947	$L=0$, $\sigma_{\text{max}}=4820$ $\mu\text{b/sr}$ (1971Hu01).
1036 7	2	46	$L=2$,for 1026 group, $\sigma_{\text{max}}=56$ $\mu\text{b/sr}$ (1971Hu01).
1205 4	2+(4)	11	$L=2$,for 1213 15 group, $\sigma_{\text{max}}=13$ $\mu\text{b/sr}$ (1971Hu01).
1297 7	2	38	$L=2$,for 1286 15 group, $\sigma_{\text{max}}=44$ $\mu\text{b/sr}$ (1971Hu01).
1631 7	0+2	25	$L=0$,for 1620 15 group, $\sigma_{\text{max}}=54$ $\mu\text{b/sr}$ (1971Hu01).
1674 7	2	142	$L=2$,for 1660 15 group, $\sigma_{\text{max}}=192$ $\mu\text{b/sr}$ (1971Hu01).
1891 4	2	8.8	
1954 4	4	4.4	
2012 4	2+4	4.1	
2236 4	2	24	$L=2$,for 2239 20 group, $\sigma_{\text{max}}=28$ $\mu\text{b/sr}$ (1971Hu01).
2307 4	2+4	15	$L=2+4$,for 2313 20 group, $\sigma_{\text{max}}=15$ $\mu\text{b/sr}$ (1971Hu01).
2350 4	0+4	52	$L=0+2$,for 2348 20 group, $\sigma_{\text{max}}=74$ $\mu\text{b/sr}$ (1971Hu01).
2385 4	4	14	$L=4$,for 2386 20 group, $\sigma_{\text{max}}=9$ $\mu\text{b/sr}$ (1971Hu01).
2433 4	2+4	14	$L=2+4$,for 2436 25 group, $\sigma_{\text{max}}=13$ $\mu\text{b/sr}$ (1971Hu01).
2479 6	4	4.8	
2574 4	1, 1+2	70	$L=2$,for 2568 25 group, $\sigma_{\text{max}}=40$ $\mu\text{b/sr}$ (1971Hu01).
2649 4	2	98	$L=2$,for 2639 25 group, $\sigma_{\text{max}}=122$ $\mu\text{b/sr}$ (1971Hu01).
2713 5	2	16	$L=2$,for 2728 25 group, $\sigma_{\text{max}}=18$ $\mu\text{b/sr}$ (1971Hu01).
2760 7		15	$L=2$ or (1+3) or (2+4),better fitted with $L=1+3$ (1985Fo02).
2871 4	2+4	8.3	$L=2$,for 2765 25 group, $\sigma_{\text{max}}=14$ $\mu\text{b/sr}$ (1971Hu01).
2953 4	2(+6)	9.3	$L=2$,for 2882 25 group, $\sigma_{\text{max}}=11$ $\mu\text{b/sr}$ (1971Hu01).
3004 4	2+4	24	$L=2$,for 2975 25 group, $\sigma_{\text{max}}=13$ $\mu\text{b/sr}$ (1971Hu01).
3077 4	2	8.0	$L=2$,for 3017 25 group, $\sigma_{\text{max}}=29$ $\mu\text{b/sr}$ (1971Hu01).
3130 4	2+4	37	L : 2 for a 3017 25 group (1971Hu01).
3197 14	0+4	23	$L=(2+4)$,for 3151 25 group, $\sigma_{\text{max}}=29$ $\mu\text{b/sr}$ (1971Hu01).
3252 9	0(+4)	16	$L=(0+2)$,for 3220 25 group, $\sigma_{\text{max}}=33$ $\mu\text{b/sr}$ (1971Hu01).
3362 5	2+4, 3	31	$L=(2+4,3)$,for 3394 25 group, $\sigma_{\text{max}}=31$ $\mu\text{b/sr}$ (1971Hu01).
3417 4	0+3+5	60	$L=0+2$,for 3450 25 group (doublet), $\sigma_{\text{max}}=130$ $\mu\text{b/sr}$ (1971Hu01).
3480 4	2+4	56	
3535 5		38	$L=0+2$,for 3515 25 group, $\sigma_{\text{max}}=110$ $\mu\text{b/sr}$ (1971Hu01).
3609 4	2+4, 3+5	33	$L=2+3$ or 2+4, or 1+3+6 (1985Fo02).
3660 4	5	9.0	$L=2+4$,for 3578 25 group, $\sigma_{\text{max}}=35$ $\mu\text{b/sr}$ (1971Hu01).
3696 4	3+5	50	$L=2+4$,for 3653 25 group, $\sigma_{\text{max}}=33$ $\mu\text{b/sr}$ (1971Hu01).
3732 5	2+6	16	L : 4 for a 3713 25 group (1971Hu01).
3776 4	1(+3)	19	$L=2+4$,for 3746 25 group, $\sigma_{\text{max}}=52$ $\mu\text{b/sr}$ (1971Hu01).
3816 5	(3), 2+4	24	$L=(2+4)$,for 3870 25 group, $\sigma_{\text{max}}=25$ $\mu\text{b/sr}$ (1971Hu01).
3915 6	3+5	36	$L=2+4$,for 3965 25 group, $\sigma_{\text{max}}=32$ $\mu\text{b/sr}$ (1971Hu01).
3987 7	2+4, 0+4+6	18	
4071 6	3+(6)	49	
4152 7	(0)	22	
4211 6	5	18	
4282 4	2+6	17	
4349 6	0+(6)	31	
4389 3	0+(4+6)	40	
4499 15	0+4	38	
4534 6	2+6	22	
4622 5	2+(4, 6)	22	
4671 7	2+6	45	
4766 5	2+4	17	
4838 6	2+6	18	
4911 5	2+(4+6)	27	
4960 5	1	68	

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⁵⁹Co(t,p) 1985Fo02,1971Hu01 (continued)

⁶¹Co Levels (continued)

E(level)	L [†]	dσ/dΩ(max) (μb/sr)
5081 12	2+4	22
5164 5	3	28
5214 5	2+(5)	45
5271 4	3+5	59
5321 6	1+3,0+4	32
5388 6	2	28

[†] From DWBA analysis of σ(θ).

⁶⁰Co(n,γ),(n,n): Resonances 2006MuZX

2006MuZX: evaluation of neutron resonance data.

1979An26: E(n)=0.01–3000 eV; measured σ(E). ⁶¹Co resonances deduced parameters.

Jπ(⁶⁰Co g.s.)=5+.

⁶¹Co Levels

E(level) [†]	Jπ	L	Comments
9319.1?	9/2+, 11/2+	0	Fictitious level corresponding to a negative value of resonance energy. E(n)(lab)=−0.100 keV, Γ _γ =(1.2) eV.
9320.01	9/2+, 11/2+	0	E(n)(lab)=0.820 keV, 2gΓ _n =3.2 eV 5, Γ _γ =(0.5) eV.
9320.91	9/2+, 11/2+	0	E(n)(lab)=1.740 keV, 2gΓ _n =6.7 eV 13, Γ _γ =(0.5) eV.
9321.19	9/2+, 11/2+	0	E(n)(lab)=2.020 keV, 2gΓ _n =44 eV 6, Γ _γ =(0.5) eV.
9321.66	9/2+, 11/2+	0	E(n)(lab)=2.505 keV, 2gΓ _n =9.71 eV 15, Γ _γ =(0.5) eV.

[†] S(n)+E(n)(c.m.), where S(n)(⁶¹Co)=9319.2 8 (2012Wa38).

⁶²Ni(d,³He) 1984Ma60

1984Ma60: E=78 MeV. Measured σ(E(³He)), σ(θ) θ(lab)=7.5°–32.8° with magnet spectrometer of QQDDQ system, ΔE–E detectors, FWHM=25 keV. Enriched to 96.64% Ni target. DWBA analysis, shell-model, particle–vibration-model calculations.

Summed C²S: 5.6 for 1f_{7/2}^{−1} with centroid at 470 keV, 0.7 for 2p_{3/2}^{−1} with centroid at 1200 keV, 1.5 for 2s_{1/2}^{−1} with centroid at 2240 keV, 3.6 for 1d_{3/2}^{−1} with centroid at 3560 keV.

⁶¹Co Levels

E(level)	Jπ	L [†]	C ² S [§]	Comments
0.0	7/2− [‡]	3	4.47	
1028 5	3/2− [‡]	1	0.59	
1619 5		3	0.44	C ² S: for L+1/2.
1888 5		3	0.21, 0.12	
1953 5		1	0.06, 0.05	
2238 5		0	1.50	
2313 5		1	0.08, 0.06	
2354 5		3	0.25, 0.15	
2448 5		3	0.11, 0.06	
2499 5		(2,3) #	0.05, 0.03	S=0.04 for 7/2− and 0.08 for 5/2−.
2574 5		2	1.35, 0.90	
2893 5		3	0.19, 0.11	
3026 5		2	0.20, 0.14	
3218 5		2	0.37, 0.25	
3421 5		(5)	0.09, 0.20	
3491 5		3	0.29, 0.16	
3599 5		(0,3) @	0.09	S=0.14 for 7/2− and 0.24 for 5/2−.

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$^{62}\text{Ni}(\text{d},^3\text{He})$ 1984Ma60 (continued) **^{61}Co Levels (continued)**

E(level)	$L^\dagger$	$C^2S^\S$	Comments
3800 5	3	0.15, 0.09	
3889 5	2	0.24, 0.16	
4002 5	(0, 3)@	0.08	S=0.12 for 7/2- and 0.22 for 5/2-.
4159 5			
4267 5	(0, 3)@	0.08	S=0.13 for 7/2- and 0.23 for 5/2-.
4382 5	2	0.33, 0.22	
4455 5	2	0.37, 0.25	
4656 5	2	0.41, 0.27	
4753 5	2	0.23, 0.15	
4990 5	2	0.12, 0.08	
5061 5	(2, 3)#	0.11, 0.07	S=0.10 for 7/2- and 0.18 for 5/2-.
5150 5	(2, 3)@	0.09, 0.06	S=0.07 for 7/2- and 0.13 for 5/2-.

† From DWBA analysis of $\sigma(\theta)$.

‡ From Adopted Levels.

§ From $(\text{d}\sigma/\text{d}\Omega)_{\text{exp}} = [\text{NC}^2\text{S}/(2J+1)](\text{d}\sigma/\text{d}\Omega)_{\text{dw}}$, $N=2.363$. When two values are listed, first corresponds to $L-1/2$ and the second to $L+1/2$.

$\sigma(\theta)$ is fitted somewhat better with $L=2$ transfer.

@ $\sigma(\theta)$ is fitted somewhat better with $L=3$ transfer.

 $^{62}\text{Ni}(\text{t},\alpha)$ 1971Hu01,1966B115

1971Hu01: E=12 MeV. Measured $\sigma(E\alpha)$, $\theta=20^\circ$, 27.5° , 35° , magnetic spectrograph. Distorted-wave analysis.

1966B115: E=15.0 MeV. Measured $\sigma(E\alpha, \theta)$, 12 angles (c.m.) between 12° and 47° , semi, enriched target. Distorted-wave analysis. FWHM=40–55 keV. 18 groups reported up to 4 MeV with uncertainties ranging from 15 to 35 keV.

 ^{61}Co Levels

Listed cross sections are at 20° , except at 27.5° for 1635 and 1682 groups from 1971Hu01.

E(level) †	$J\pi^\ddagger$	$L^\S$	$S^\#$	Comments
0.0	7/2-	[3]	4.77	$\text{d}\sigma/\text{d}\Omega=3.30 \mu\text{b}/\text{sr}$. S: 4.91 (1966B115).
1031 15	3/2-	[1]	0.33	$\text{d}\sigma/\text{d}\Omega=234 \mu\text{b}/\text{sr}$. S: 0.41 (1966B115).
1210 25				$\text{d}\sigma/\text{d}\Omega=(25) \mu\text{b}/\text{sr}$.
1272 25				$\text{d}\sigma/\text{d}\Omega=(34) \mu\text{b}/\text{sr}$.
1287 25				$\text{d}\sigma/\text{d}\Omega=(33) \mu\text{b}/\text{sr}$.
1338 25				$\text{d}\sigma/\text{d}\Omega=(25) \mu\text{b}/\text{sr}$.
1635 25	7/2-	[3]	0.48	S: 0.83 (1966B115) for 1627+1674, assuming $J\pi=7/2-$. $\text{d}\sigma/\text{d}\Omega=171 \mu\text{b}/\text{sr}$.
1682 25	(5/2-)	[3]	0.28	See comment for 1635 group. $\text{d}\sigma/\text{d}\Omega=99 \mu\text{b}/\text{sr}$.
1903 25				$\text{d}\sigma/\text{d}\Omega=95 \mu\text{b}/\text{sr}$.
1971 25	3/2-	[1]	0.09	$\text{d}\sigma/\text{d}\Omega=44 \mu\text{b}/\text{sr}$. S: from 1966B115, not given in 1971Hu01.
2258 25	1/2+	[0]	1.22	$\text{d}\sigma/\text{d}\Omega=1.34 \text{ mb}/\text{sr}$. S: 1.41 (1966B115).
2368 25	7/2-	[3]	(0.24)	$\text{d}\sigma/\text{d}\Omega=129 \mu\text{b}/\text{sr}$.
2459 25				$\text{d}\sigma/\text{d}\Omega=75 \mu\text{b}/\text{sr}$.
2583 25	3/2+	[2]	1.03	$\text{d}\sigma/\text{d}\Omega=580 \mu\text{b}/\text{sr}$. S: 1.24 (1966B115).
2895 25	7/2-	[3]	0.19	$\text{d}\sigma/\text{d}\Omega=94 \mu\text{b}/\text{sr}$. S: 0.15 (1966B115).
3028 25	7/2-	[3]	0.26	$\text{d}\sigma/\text{d}\Omega=126 \mu\text{b}/\text{sr}$. S: 0.15 (1966B115).
3163 25				$\text{d}\sigma/\text{d}\Omega=47 \mu\text{b}/\text{sr}$.
3208 25	(3/2+)	[2]	0.37	$\text{d}\sigma/\text{d}\Omega=209 \mu\text{b}/\text{sr}$. S: 0.37 (1966B115).
3396 25				$\text{d}\sigma/\text{d}\Omega=60 \mu\text{b}/\text{sr}$.

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$^{62}\text{Ni}(t,\alpha)$ 1971Hu01,1966Bl15 (continued) **^{61}Co Levels (continued)**

E(level) [†]	$J\pi^{\ddagger}$	$L^{\S}$	$S^{\#}$	Comments
3467 25	(7/2-)	[3]	0.40	$d\sigma/d\Omega=170$ $\mu\text{b/sr}$. S: 0.33 (1966Bl15).
3585 25	(3/2+)	[2]	0.26	$d\sigma/d\Omega=143$ $\mu\text{b/sr}$. S: 0.04 (1966Bl15).
3664 25				$d\sigma/d\Omega=44$ $\mu\text{b/sr}$.
3782 30	(7/2-)	[3]	0.30	$d\sigma/d\Omega=115$ $\mu\text{b/sr}$. S: 0.18 (1966Bl15).
3869 30	3/2+	[2]	0.24	$d\sigma/d\Omega=128$ $\mu\text{b/sr}$. S: 0.31 (1966Bl15).
3970 30	(7/2-)	[3]	0.31	$d\sigma/d\Omega=113$ $\mu\text{b/sr}$. S: 0.17 (1966Bl15).

[†] From 1971Hu01. Values from 1966Bl15 for 18 groups are in agreement with those from 1971Hu01.

[‡] Assumed for determination of S factors. Source of $J\pi$ values is not clearly stated in 1971Hu01, but these seem to be from table IV in 1966Bl15, except for 1682 and 2368 which seem to be from (t,p) data in 1971Hu01.

[§] As implied by listed $J\pi$ values. 1971Hu01 and 1966Bl15 state measuring angular distributions, but no L-values are listed in these papers.

[#] From 1971Hu01. Distorted wave normalization factor used is 23.4. Values from 1966Bl15 are in good agreement.

 $^{64}\text{Ni}(p,\alpha)$ 1976Ma24,1979Sm03

1976Ma24 (also 1978Jo08): E(p)=14 MeV. Measured $E\alpha$, magnetic spectrograph, spectra taken at $\theta=16^\circ, 30^\circ, 60^\circ, 90^\circ, 120^\circ$ and 140° . FWHM=10–14 keV, enriched target. In 1978Jo08, $\sigma(\theta)$ data at E=15 MeV for 11 angles between 20° and 80° (c.m. system) are presented for 0, 2232 and 2559 levels, and L-transfers deduced from comparison with DWBA calculations.

1979Sm03: E(p)=30 MeV. Measured $\sigma(E\alpha,\theta)$, ΔE -E telescope, FWHM ≈ 60 keV, 14 angles between 7.5° and 70° , enriched target. Angular distribution data shown for 18 groups, seven of which are compared with DWBA calculations. Uncertainty in level energies is 12 keV.

1969Co05: E=9.5, 10 MeV. Measured $E\alpha$, magnetic spectrograph. FWHM=20–30 keV. Energies of 22 groups reported up to 3103 keV with uncertainties ranging from 4 to 10 keV.

 ^{61}Co Levels

E(level) [†]	$J\pi$	$L^{\ddagger}$	Comments
0.0	7/2- [#]	3	
1028.2 6	3/2- [#]		
1206.1 8	3/2- [#]		
1285.6 9	9/2- [#]		
1323.2 13	1/2- [#]		
1619.3 7			
1646.0 7			
1664.5 7	(7/2- and 11/2-) [#]		E(level): doublet (1979Sm03).
1889.3 7	7/2- [#]		
1953.3 8			
2014.4 11			
2231.9 9	1/2+ [#]	0	
2303.7 8			
2345.5 8	3/2, 5/2 [@]		
2373.8 11			
2432.2 9			
2483.9 10			
2558.6 8	3/2+ [#]	(2)	
2571.6 9			
2642.3 8	7/2+, 9/2- [@]		
2706.7 11			
2726.5 10			
2756.5 16			
2780.1 10			
2867.1 11			

Continued on next page (footnotes at end of table)

$^{64}\text{Ni}(\text{p},\alpha)$ 1976Ma24,1979Sm03 (continued) **^{61}Co Levels (continued)**

E(level) [†]	J π	Comments
2922.2	10	
2952.9	10	
2979.9	10	
2998.4	9	
3102.4	16	
3116.7	11	3/2+, 5/2+ [@]
3126.3	11	
3151.7	11	
3176.0	9	J π : 1/2,3/2 listed for a 3.18 MeV level in 1979Sm03 which corresponds 3176 and/or 3190 level. See comment for 3176 level.
3190.3	12	
3203.9	10	
3239.8	11	
3349.4	11	
3357.0	13	
3364.4	13	
3384.3	11	$\sigma(\theta)$ distribution shown in 1979Sm03 but no conclusions drawn.
3396.9	12	
3409.7	11	
3428.4	11	
3445.1	12	
3470.8	10	3/2, 5/2 [@]
3484.8	11	
3492.5	14	
3513.6	11	
3535.6	10	5/2, 7/2 [@]
3564.7	13	
3575.3	13	
3599.6?	14	
3609.4	13	1/2+, 5/2, 7/2 [@] J π : for a doublet (1979Sm03).
3654.0	11	
3691.5	10	
3700.2	15	
3727.8	15	
3752.6	12	
3758.2?	15	
3775.3	11	
3806.3	13	
3814.6	15	
3827.3	14	
3871.1	12	
3889.8	13	
3905.6	12	
3915.7	12	
3924.4	13	
3937.1	12	
4510 [§]	12	$\sigma(\theta)$ distribution shown in 1979Sm03 but no conclusions drawn.
4730 [§]	12	3/2, 5/2 [@]
4960 [§]	12	3/2, 5/2 [@]

[†] From 1976Ma24, except as noted.[‡] From DWBA calculations for triton cluster transfers (1978Jo08).[§] From 1979Sm03.[#] From agreement with comparison of $\sigma(\theta)$ data with DWBA calculations (1979Sm03).[@] From table 5 of 1979Sm03, possibly based on $\sigma(\theta)$ shape.

$^{64}\text{Ni}(\text{p}, \alpha \gamma)$ 1970Co21

1970Co21: E(p)=10 MeV. Measured E γ , I γ , E α , $\alpha \gamma$ coin, semi, enriched target.

 ^{61}Co Levels

E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$
0.0	7/2-	1325? [§]	(1/2) [§]	1952 3	1/2-, 3/2-
1025 3	3/2-	1619 3	7/2-	2232 3	
1205 3	3/2-, 5/2-	1647 3	3/2, 5/2	2302? [§]	
1285 3		1891 3	3/2 to 9/2		

[†] From table 4 of 1970Co21, unless otherwise stated.

[‡] As listed in 1970Co21 from their experiment and previous data.

[§] from 1969Co05.

 $\gamma(^{61}\text{Co})$

E(level)	E $\gamma^{\dagger}$	I γ	E(level)	E $\gamma^{\dagger}$	I γ	E(level)	E $\gamma^{\dagger}$	I γ
1025	1025	100	1647	622	12 4	2232	947	16 5
1205	1205	100		1647	88 4		1027 [‡] #	<66 [‡]
1285	1285	100	1891	244	8 3		1207 [‡] #	<66 [‡]
1325?	300 [#]			606	42 8		2232	18 7
1619	332	45 8		1891	50 8	2302?	1277 [#]	
	1619	55 8	1952	747	100			
1647	322 [#]			1952 [§] #	<20			

[†] From level-energy differences.

[‡] According to 1970Co21, 2232-keV level decays to the 1025-keV level or to the 1205-keV level, or to both. The total intensity of these two possible branches is 66 9.

[§] This γ is not listed in Adopted dataset since it is not confirmed in any other study, and even in this dataset, only an upper limit of intensity is given.

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

 $^{238}\text{U}(^{70}\text{Zn}, \text{X}\gamma)$ 2012Re11

Multinucleon transfer reactions.

2012Re11 (also 2012Re16): ^{70}Zn beam at E=460 MeV delivered by the LNL-Legnaro Tandem-ALPI accelerator complex.

Target=400 $\mu\text{g}/\text{cm}^2$ ^{238}U . Gamma rays detected in coincidence with nuclei by the CLARA-PRISMA setup: a large-acceptance magnetic spectrometer and 22 Compton-suppressed Ge clover detectors. Measured E γ , I γ , (^{61}Co) γ coin. Deduced levels, configurations. Comparison with large-scale shell-model calculations.

 ^{61}Co Levels

E(level) [†]	J $\pi^{\ddagger}$
0.0	7/2-
1286.4 9	(9/2)-
1663.5 5	(11/2-)
2372.9 9	(13/2-)
3125.1 14	(15/2-)
3471.4 16	(13/2-)
3657.8 17	(15/2-)
4093.9 19	(17/2-)

[†] From E γ data.

[‡] From ^{61}Co Adopted Levels.

²³⁸U(⁷⁰Zn,Xγ)

2012Re11 (continued)

γ(⁶¹Co)

Eγ	E(level)	Iγ
^x 168.7 12		18 6
186.4 5	3657.8	18 4
436.1 9	4093.9	20 7
709.4 7	2372.9	45 9
752.2 11	3125.1	42 15
1286.4 9	1286.4	100 15
1663.5 5	1663.5	84 16
1807.8 15	3471.4	40 10

^x γ ray not placed in level scheme.

Adopted Levels, Gammas

Q(β^-)=-2237.5 10; S(n)=7820.11 5; S(p)=9860.57 22; Q(α)=-6465.06 26 2012Wa38.
 S(2n)=19207.84 7, S(2p)=18135.1 3 (2012Wa38).
 isotopic identification of ^{61}Ni by mass spectrograph method by Aston: Nature 134, 178 (1934).
 1976Ch34: $^{60}\text{Ni}(t,d)$, E=2.5-4.75 MeV. Measured $\sigma(E(t),E(d),\theta)$, semi. Deduced rms radii of g.s., 68-keV and 284-keV states, DWBA.
 1985Wo01: $^{64}\text{Ni}(^{18}\text{O},^{21}\text{O})$, E=150 MeV. Measured $\sigma(E(^{21}\text{O}))$.
 2012VoZZ: $^{56}\text{Fe}(^6\text{Li},p)$, E=15 MeV; measured $\sigma(\theta)$, deduced level density.
 Hyperfine structures, NMR: 2003Bb02, 1997Ba98, 1990Ku08, 1988Le02.

 ^{61}Ni Levels**Cross Reference (XREF) Flags**

A ^{61}Co β^- Decay (1.649 h)
 B ^{61}Cu ε Decay (3.339 h)
 C $^{58}\text{Fe}(\alpha,n\gamma)$, (HI,xn γ)
 D $^{59}\text{Co}(^3\text{He},p)$
 E $^{59}\text{Ni}(t,p)$
 F $^{60}\text{Ni}(n,\gamma)$, (pol n, γ) E=thermal
 G $^{60}\text{Ni}(n,\gamma)$ E=0.01-90 keV
 H $^{60}\text{Ni}(n,\gamma)$, (n,n): Resonances

I $^{60}\text{Ni}(d,p)$, (pol d,p)
 J $^{60}\text{Ni}(\alpha,^3\text{He})$
 K $^{60}\text{Ni}(^{14}\text{C},^{13}\text{C})$, ($^{13}\text{C},^{12}\text{C}$)
 L $^{61}\text{Ni}(\gamma,\gamma')$
 M $^{61}\text{Ni}(n,n'\gamma)$
 N $^{61}\text{Ni}(p,p')$
 O $^{61}\text{Ni}(p,p'\gamma)$
 P $^{61}\text{Ni}(d,d')$

Q $^{61}\text{Ni}(^3\text{He},^3\text{He}')$
 R Coulomb Excitation
 S $^{62}\text{Ni}(p,d)$, (pol p,d)
 T $^{62}\text{Ni}(d,t)$, (pol d,t)
 U $^{62}\text{Ni}(^3\text{He},\alpha)$
 V $^{63}\text{Cu}(d,\alpha)$
 W $^{64}\text{Zn}(n,\alpha)$

E(level) [†]	J π	XREF	T _{1/2} [#]	Comments
0.0	3/2-	ABCDEFGH IJKLMNOPQRSTUWV	stable	μ =-0.75002 4 (1964Dr02,2014StZZ). Q =+0.162 15 (1968Ch10,2013StZZ,2014StZZ). Evaluated rms charge radius=3.8225 fm 19 (2013An02). μ : NMR (1964Dr02), recalculated in 1976Fu06. Q : Atomic beam, includes polarization correction (1968Ch10). See also 2008Py02 evaluation. $J\pi$: spin from electron paramagnetic resonance (1958Wo52). $L(d,p)=L(p,d)=1$; $L+1/2$ from A_y in (pol d,p) and (pol p,d).
67.418 7	5/2-	ABCDEFGH IJKLMNOP RSTUVW	5.34 ns 16	μ =+0.480 6 (1971Go31,2014StZZ). Q =-0.20 3 (1971Go31,2013StZZ,2014StZZ). μ,Q : Mossbauer effect (1971Go31). Other: Q =-0.08 7 (1976Ob01). $J\pi$: $L(d,p)=L(p,d)=L(d,t)=3$; $L-1/2$ from $A_y(\theta)$ in (pol d,p), (pol p,d). $T_{1/2}$: from $\beta^*\gamma(t)$ in ^{61}Cu ε decay. Other: 5.1 ns 3 (Coulomb excitation).
282.956 7	1/2-	BCDEFG IJK MNOP RSTUVw	23 ps 3	$J\pi$: $L(d,p)=L(p,d)=L(d,t)=1$; $L-1/2$ from $A_y(\theta)$ in (pol d,p), (pol p,d). $T_{1/2}$: weighted average of 22 ps 4 ($\beta^*\gamma(t)$ in ^{61}Cu ε decay) and 24 ps 4 ($^{58}\text{Fe}(\alpha,n\gamma)$).
656.019 7	1/2-	BCDEF IJK MNOPQRSTUWw	17 ps 4	$J\pi$: $L(d,p)=L(d,t)=1$; $L-1/2$ from $A_y(\theta)$ in (pol d,t), (pol p,d). See 2012PeZX who question assignment of 1/2- for 656 level based on branching ratio measurements and theory in ^{61}Cu decay. $T_{1/2}$: other: <21 ps from $\beta^*\gamma(t)$ in ^{61}Cu ε decay.
908.613 11	5/2-	BCdEF J MNO RSTUV	0.7 ps 4	$J\pi$: $L(d,p)=L(p,d)=3$; $L-1/2$ from (pol p,d).
917.5 7	(7/2)-	A d I P		$J\pi$: M1+E2 γ to 5/2-; (E2) γ to 3/2-; log ft=4.8 from 7/2-.

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Adopted Levels, Gammas (continued)
⁶¹Ni Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} [#]	Comments
1014.78 8	7/2-	BCDEF I MNOP RS UV	4.4 ps 6	J π : $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in ($\alpha, n\gamma$); L(p,d)=(3); L+1/2 from (pol p,d); L(t,p)=2 from 3/2- target. T _{1/2} : from ⁴⁸ Ca(¹⁸ O,5n γ) (1978Wa09). Others: 6 ps 2 in ⁵⁸ Fe($\alpha, n\gamma$), ⁵³ Cr(¹¹ B, ¹² C), >1.7 ps in Coulomb excitation.
1099.624 11	3/2-	BCDEF I K MNOP R TUV	0.16 ps 4	J π : L(d,p)=1; L+1/2 from A _y (θ) in (pol d,t); L(t,p)=0+2 from 3/2- target. T _{1/2} : from ⁶¹ Ni(n,n' γ). Others: 0.25 ps +47-11 in ⁵⁸ Fe($\alpha, n\gamma$), ⁵³ Cr(¹¹ B,p2n γ) and 0.18 ps 8 in ⁶⁰ Ni(n,n' γ).
1132.333 17	5/2-	BCDEF IJ MNOPQRSTUV	0.32 ps 3	J π : L(d,p)=L(p,d)=3; (L-1/2) from (pol p,d); $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in ($\alpha, n\gamma$). T _{1/2} : unweighted average of 0.29 ps 5 (⁵⁸ Fe($\alpha, n\gamma$)) and 0.35 ps 4 (Coul. ex.). Other: 0.14 ps 4 in ⁶¹ Ni(n,n' γ).
1185.243 10	3/2-	BCDEF IJ LMNOP RSTUV	0.12 ps 3	XREF: U(1170). J π : L(d,p)=L(p,d)=L(d,t)=1, L+1/2 from A _y (θ) in (pol d,p), (pol p,d), (pol d,t). T _{1/2} : from Coul. ex. Others: 0.14 ps +8-4 in ⁶¹ Ni(n,n' γ), 0.145 ps 35 in ⁶¹ Ni(γ, γ'), 0.104 ps 17 in ⁵⁸ Fe($\alpha, n\gamma$), ⁵³ Cr(¹¹ B,p2n γ).
1454.82 10	7/2-	CDEF IJ NOPQRSTUV	0.58 ps 25	J π : L(p,d)=L(d,t)=L($\alpha, ^3\text{He}$)=3; L+1/2 from (pol p,d).
1609.655 21	5/2-	BCDEF I NOP RSTUV	0.26 ps 4	J π : L(p,d)=3; L-1/2 from (pol p,d); L(t,p)=2+4 from 3/2- target.
1729.481 11	3/2-	BCDEF I K MNOP STUV	0.065 ps 11	J π : L(d,p)=L(d,t)=1; L+1/2 from (pol p,d); L(t,p)=0+2 from 3/2- target. T _{1/2} : other: 0.062 ps 14 in ⁶¹ Ni(n,n' γ).
1807.5 3	9/2-	CDE I MN P V	0.6 ps 5	J π : L(t,p)=4 from 3/2- target; $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in ($\alpha, n\gamma$).
1978 7				N V
1987.75 21	9/2-	CDE I MN P	0.51 ps 18	J π : L(t,p)=4 from 3/2- target; $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in ($\alpha, n\gamma$).
1998.07 7	5/2-	BCDEF I MN T V	0.045 ps 7	J π : L(d,t)=3; L(p,t)=2 from 3/2- target; $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in ($\alpha, n\gamma$). T _{1/2} : from ⁶¹ Ni(n,n' γ). Other: 0.042 ps 11 in ⁵⁸ Fe($\alpha, n\gamma$), ⁵³ Cr(¹¹ B,p2n γ).
2018.1 5	7/2-	CDE I M S	0.12 ps +8-3	J π : L(p,d)=3; L+1/2 from (pol p,d). T _{1/2} : from ⁶¹ Ni(n,n' γ). Other: 0.26 ps 16 in ($\alpha, n\gamma$).
2121.27 20	9/2+	BC E J MN S UV	0.40 ps +74-12	XREF: B(?)S(2124.5). J π : 9/2+ from $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in ($\alpha, n\gamma$); L=4 component of a doublet with L(d,p)=L(pol d,p)=1+4 and L(d,t)=(1+4). See 2123-keV level; L+1/2 for L=4 component from (pol d,p); L(t,p)=3+5 from 3/2- target.
2123.913 17	1/2-	BC F Mn	0.044 ps 15	J π : L=1 component of 2130-keV doublet with L(d,p)=L(pol d,p)=L(d,t)=1+4; L-1/2 from (pol d,p); log ft=5.0 from 3/2- parent. T _{1/2} : other: 0.045 ps 19 in ⁶¹ Ni(n,n' γ) and 0.051 ps 10 in ⁶⁰ Ni(n,n' γ).

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Adopted Levels, Gammas (continued)

 ^{61}Ni Levels (continued)

E(level) [†]	J π	XREF					T _{1/2} [#]	Comments
2128.87 21	11/2-	CD	I	K Mn P	T		>2 ps	J π : $\gamma(\theta)$ and linear polarization in ($\alpha, n\gamma$).
2409.7 3	9/2-	C			N	V	0.19 ps 4	J π : $\gamma(\theta)$ and linear polarization in ($\alpha, n\gamma$).
2415 6	(3/2-)	DE	I		P			E(level): from $^{59}\text{Ni}(t, p)$.
2465 6	7/2-	DE	I	MN P	STUV		0.236 ps +21-7	J π : L(t, p)=(0+2) from 3/2- target. J π : L(p, d)=3; L+1/2 from (pol p, d). T _{1/2} : from DSAM in $^{61}\text{Ni}(n, n'\gamma)$.
2530 4	5/2-, 7/2-	DE	I		P			J π : L(t, p)=2+4 from 3/2- target.
2593 5	7/2-	E	I		N	S UV		J π : L(p, d)=3; L+1/2 from (pol p, d).
2639.50 5	1/2-, 3/2-	DEF	I		N	S V		J π : L(d, p)=1.
2696 4	5/2+	E	I		N P	V		J π : L(d, p)=2; L+1/2 from (pol d, p).
2707.62 9	(3/2-, 5/2+)	F			N			J π : γ to 3/2-; γ from 7/2-; weak primary γ from 1/2+.
2734	(7/2-)			K		S		J π : L(p, d)=(3); L+1/2 from (pol p, d).
2764.99 7	3/2-	EF	I		N	V		J π : L(t, p)=0+2 from 3/2- target.
2786 6	5/2-, 7/2-	E	Ij		N	V		XREF: I(2804). J π : L(d, p)=3.
2800 7				j	N			
2853 6	5/2-, 7/2-	E			N	V		J π : L(t, p)=2+4 from 3/2- target.
2862.90 8	1/2-, 3/2-	F	I		N			XREF: I(2873). J π : L(d, p)=1.
2913 8	7/2-	DE	I			STUV		J π : L(p, d)=L($\alpha, ^3\text{He}$)=3; L+1/2 from (pol p, d).
3040 8	(1/2-, 3/2-)	D	I		N	S V		J π : L(d, p)=(1).
3062.14 5	1/2+	F	I					XREF: I(3073). J π : L(d, p)=0.
3099 7	(3/2-)				N	V		
3115 6	5/2-, 7/2-			I	N	T V		J π : L(d, p)=3.
3138 6	7/2-			I	N	S		J π : L(p, d)=3; L+1/2 from (pol p, d).
3144.943 24	(1/2-, 3/2)	F				V		J π : γ s to 1/2- and 5/2-; primary γ from 1/2+.
3175 8	(1/2-, 3/2-)			I	N	V		J π : L(d, p)=(1).
3231.61 4	1/2-, 3/2-	F	I					XREF: I(3241). J π : L(d, p)=1.
3247 6					N	V		
3259.2 5	(11/2-)	C			N	V	0.46 ps 8	J π : $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in ($\alpha, n\gamma$).
3275 7	(1/2-, 3/2-)			I	N	V		J π : L(d, p)=(1).
3286 7		D			N			
3295	7/2-					S		J π : L(p, d)=3; L+1/2 from (pol p, d).
3298 10	(1/2-, 3/2-)			I				J π : L(d, p)=(1) for 3298+3308, but 3308 is assigned 7/2- from (pol d, t).
3298.6 6	11/2+	C			M		0.60 ps +23-14	J π : $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in ($\alpha, n\gamma$).
3308 9	(7/2-)			I		TU		J π : L(d, t)=3, (L+1/2) from (pol d, t).
3346 7					N	V		
3382 6	1/2-, 3/2-	D	I		N			J π : L(d, p)=1.
3406 7					N			
3415.11 4	(1/2-, 3/2)	F			N			J π : gammas to 1/2- and 5/2-; primary γ from 1/2+.
3426.23 21	13/2-	C					>0.7 ps	J π : $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in ($\alpha, n\gamma$).
3427 10	(1/2-, 3/2-)			I	M	V		J π : L(d, p)=1.
3435.26 23	13/2+	C					1.0 ps 4	J π : $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in ($\alpha, n\gamma$).
3449 6	3/2+, 5/2+			I	N			T _{1/2} : other: <1.4 ps in $^{48}\text{Ca}(^{18}\text{O}, 5n\gamma)$.
3470 6		D		I	N			J π : L(d, p)=2.
3488 6	9/2+			IJ	N	S		J π : L(p, d)=4; L+1/2 from (pol p, d).
3506 6	3/2+, 5/2+			IJ	N			J π : L(d, p)=2.
3525.57 8	(1/2, 3/2)	D F	I		N	V		J π : γ s to 1/2- and 3/2-; primary γ from 1/2+.
3548 7					N			
3564 6				I	N			
3587 7					N			

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Adopted Levels, Gammas (continued)
⁶¹Ni Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} [#]	Comments
3610 6		I N		
3629 9	5/2 ⁻ , 7/2 ⁻	D I N T		J π : L(d,t)=3.
3644.3 8	(7/2 ⁺)	C I N		J π : $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in ($\alpha, n\gamma$).
3647 10	3/2 ⁺ , 5/2 ⁺	I		J π : L(d,p)=2.
3657 7	7/2 ⁻	N S		J π : L(p,d)=3; L+1/2 from (pol p,d).
3665.3 8	(9/2 ⁺)	C		J π : $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in ($\alpha, n\gamma$).
3668.97 4	(1/2 ⁻ , 3/2)	F		J π : gammas to 1/2 ⁻ and 5/2 ⁻ ; primary γ from 1/2 ⁺ .
3686 6	1/2 ⁻ , 3/2 ⁻	D I N		J π : L(d,p)=1.
3711.46 6	(1/2 ⁻ , 3/2)	F I N		J π : γ s to 1/2 ⁻ and 5/2 ⁻ ; primary γ from 1/2 ⁺ .
3728 6	1/2 ⁻ , 3/2 ⁻	I N		J π : L(d,p)=1.
3738.32 18	(1/2 ⁺)	D F I V		XREF: I(3753).
3768	7/2 ⁻	N S		J π : L(d,p)=(0).
3776.75 9	(1/2 ⁻ , 3/2 ⁻)	F I N		J π : L(p,d)=3; L+1/2 from (pol p,d).
3819 10	(1/2 ⁻ , 3/2 ⁻)	D I		XREF: I(3791).
3837 7		I N		J π : L(d,p)=(1); gammas to 1/2 ⁻ and 5/2 ⁻ ; primary γ from 1/2 ⁺ .
3857 6		I N		J π : L(d,p)=(1).
3869.97 7	(1/2, 3/2)	F I N		J π : gammas to 1/2 ⁻ and 3/2 ⁻ ; primary γ from 1/2 ⁺ .
3919 7		N		
3938 6	7/2 ⁻	D I N S		J π : L(p,d)=3; L+1/2 from (pol p,d).
3963 5		I N V		
3994 6		D I N		
4019.24 22	15/2 ⁺	C I	>1.4 ps	J π : $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in ($\alpha, n\gamma$).
4024 7	7/2 ⁻	N S		J π : L(p,d)=3; L+1/2 from (pol p,d).
4049 6	(1/2 ⁻ , 3/2 ⁻)	I N V		J π : L(d,p)=(1).
4080 6		D I N		
4103 7		I N		
4126 6	(1/2 ⁺)	I N		J π : L(d,p)=(0).
4143 7	7/2 ⁻	N S		J π : L(p,d)=3; L+1/2 from (pol p,d).
4165 6	3/2 ⁺ , 5/2 ⁺	I N		J π : L(d,p)=2.
4178.88 14	(3/2 ⁺)	D F I N		XREF: I(4189).
4204.2 4	(3/2 ⁺)	F I N V		J π : γ to 1/2 ⁺ ; primary γ from 1/2 ⁺ ; L(d,p)=2 for 4189+4200.
4215 10		I		J π : primary γ from 1/2 ⁺ ; see comment for 4178.8 level.
4231 6		I N		
4239.70 5	(3/2 ⁺)	F I		XREF: I(4252).
4259 7	5/2 ⁻ , 7/2 ⁻	N S		J π : γ s to 1/2 ⁻ and 5/2 ⁻ ; primary γ from 1/2 ⁺ ; L(d,p)=(2).
4267 7		N		J π : L(p,d)=3.
4288 6		I N V		
4306 8		I N		
4314 10	(1/2 ⁺)	I		J π : L(d,p)=(0) for 4314+4336.
4336 6	(1/2 ⁺)	I N		J π : see comment for 4314 level.
4354 6		I N		J π : L(d,p)=2 for a composite of 4360+4374+4386+4403 suggests 3/2 ⁺ , 5/2 ⁺ for one or more of these levels, but not for 4376 which is assigned 7/2 ⁻ here.
4376 6	7/2 ⁻	I N S		XREF: I(?).
4389 9		D I N		J π : L(p,d)=3; L+1/2 from (pol p,d).
4403 10		I		L(d,p)=2 for a composite probably does not include 4376 level.
4427 6		I N V		J π : see comment for 4354 level.

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Adopted Levels, Gammas (continued) ^{61}Ni Levels (continued)

E(level) [†]	J π	XREF			T _{1/2} [#]	Comments
4439.87 13	(1/2-, 3/2)	F	I	N		J π : γ s to 5/2- and 1/2+; primary γ from 1/2+; see also comment for 4476 level.
4455 7		D		N		
4476 6	(3/2+, 5/2+)		I	N		J π : L(d,p)=2 for a composite of 4448+4476+4501.
4487	7/2-			S		J π : L(p,d)=3; L+1/2 from (pol p,d).
4502 6	(3/2+, 5/2+)		I	N		J π : see comment for 4476 level.
4514.66 13	(1/2-, 3/2)	F		N		J π : γ to 5/2-; primary γ from 1/2+.
4522 10			I			
4544 6			I	N		
4568 6	(3/2+, 5/2+)		I	N		J π : L(d,p)=(2).
4578 8	3/2+, 5/2+		I	N		J π : L(d,p)=2.
4586	7/2-			S		J π : L(p,d)=3; L+1/2 from (pol p,d).
4601 6			I	N		
4624 6			I	N		
4641 6			I	N		
4652 9	7/2-	D	I		S V	J π : L(p,d)=3; L+1/2 from (pol p,d).
4667 6			I	N		
4685 6			I	N		
4701 7				N		
4720 7		F	I	N		XREF: F(4713?).
4736 10	7/2-		I		S	J π : L(p,d)=3; L+1/2 from (pol p,d).
4741 7				N		
4756 6	3/2+, 5/2+	D	I	N		J π : L(d,p)=2.
4793.10 16	7/2-		F	I	N S	J π : L(p,d)=3; L+1/2 from (pol p,d).
4818.6 6	(17/2+)	C	I	N	V <1.1 ps	J π : $\Delta J=1$ γ to 15/2+. T _{1/2} : from DSAM in $^{48}\text{Ca}(^{18}\text{O}, 5n\gamma)$.
4833 6		D	I	N		
4854 9	(1/2-, 3/2-)	D	I			J π : L(d,p)=(1).
4861 7				N		
4872 10	7/2-		I		S	J π : L(p,d)=3; L+1/2 from (pol p,d).
4881 7				N		
4883 10	(1/2+)		I			J π : L(d,p)=(0) for 4872+4883. 7/2- in (pol d,p) suggests L(d,p)=(0) corresponds to 4883 level.
4907 6	(1/2+)		I	N		J π : L(d,p)=0 for 4916+4954.
4930 7		d		N		
4951 6	7/2-	d	I	N	S U	J π : L(p,d)=3; L+1/2 from (pol p,d). L(d,p)=0 for 4916+4954 suggests that L=0 is for 4916 level.
4968 6	(3/2+, 5/2+)		I	N		J π : L(d,p)=2 for 4968+4980 doublet.
4989 6	(3/2+, 5/2+)		I	N		J π : see comment for 4968 group.
5008 7			I	N		
5024 7	(7/2-)		I	N	S	J π : L(p,d)=(3); L+1/2 from (pol p,d).
5036.21 9	(1/2-, 3/2-)	F	I	N		J π : L(d,p)=(1); Gammas to 1/2- and 5/2-.
5060 7	1/2+		I	N	V	J π : L(d,p)=0.
5079 10	7/2-			N	S	J π : L(p,d)=3; L+1/2 from (pol p,d).
5098 7	1/2-, 3/2-		I	N		J π : L(d,p)=1.
5116.57 17	1/2-, 3/2-	F	I	N		J π : L(d,p)=1.
5152 10				N		
5166 7	(1/2+)		I	N	S	J π : L(p,d)=(0).
5185 7	1/2+		I	N		J π : L(d,p)=0.
5208 8	3/2+, 5/2+		I	N		J π : L(d,p)=2.
5220 10				N		
5244 7	7/2-		I	N	S	J π : L(p,d)=3; L+1/2 from (pol p,d).
5267 7			I	N		
5280 10			I			
5295 10	(1/2-, 3/2-)		I	N		J π : L(d,p)=(1).
5309 10	1/2+		I			J π : L(d,p)=0.
5316.3 11	(15/2, 17/2, 19/2+)	C				J π : γ to 15/2+; yrast-type excitation in in-beam γ -ray study.

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Adopted Levels, Gammas (continued)
⁶¹Ni Levels (continued)

E(level) [†]	J π	XREF			Comments
5337 7		I	N	S	
5356 10	(1/2-, 3/2-)	I			J π : L(d,p)=(1).
5370 7		I	N		J π : see comment for 5406 level.
5390.82 14	(1/2, 3/2)	F I	N		J π : γ to 5/2-; primary γ from 1/2+. L(d,p)=(0) for a composite of 5366+5395+5405 levels suggests (1/2+) for one or more of these levels.
5406 7		I	N	S	J π : see comment for 5406 level.
5439 7	1/2-, 3/2-	I	N		J π : L(d,p)=1.
5460 7		I	N	S	
5487 7		I	N		
5508 7		I	N		
5528 7	3/2+, 5/2+	D I	N		J π : L(d,p)=2.
5550 10			N		
5574 10	1/2-, 3/2-	I	N		J π : L(d,p)=1.
5588 10	1/2+		N	S	J π : L(p,d)=0.
5601 10		I	N		
5622 7	3/2+, 5/2+	I			J π : L(d,p)=2.
5645 10	(1/2-, 3/2-)	I			J π : L(d,p)=(1).
5652	(3/2+)			S	J π : L(p,d)=(2); L-1/2 from (pol p,d).
5659 10	1/2-, 3/2-	I			J π : L(d,p)=1.
5703 10	1/2+	I		S	J π : L(p,d)=0.
5723 10	(3/2+, 5/2+)	I			J π : L(d,p)=2 for 5703+5723 probably correspond mainly to 5723 level.
5742 10	3/2+, 5/2+	I			J π : L(d,p)=2.
5761				S	
5796 10		I			
5804 10		I			
5821 10		I			
5842 10		I			
5859 10	(1/2+)	I			J π : L(d,p)=(0).
5883 10		I			
5894 10	(3/2+, 5/2+)	I			J π : L(d,p)=(2) for 5894+5914.
5914 10	(3/2+, 5/2+)	I			
5934 10	(3/2+, 5/2+)	I			J π : L(d,p)=2 for 5934+5957.
5955.48 17	3/2+	F I		S	J π : L(p,d)=2; L-1/2 from (pol p,d).
5987 10	1/2+	I			J π : L(d,p)=0.
6016 10	(3/2+, 5/2+)	I			J π : L(d,p)=(2).
6041 10		I			
6072 10		I			
6085 10	(3/2+, 5/2+)	I			J π : L(d,p)=(2).
6102 10	(3/2+, 5/2+)	I			J π : L(d,p)=2 for 6102+6135.
6135 10	(3/2+, 5/2+)	I			
6148 10		I			
6166 10		I			
6176 10		I			
6184 10		I			
6200				S	
6227 10		I			
6249 10	(3/2+, 5/2+)	I			J π : L(d,p)=(2).
6269 10		I			
6289 10	(1/2+)	I			J π : L(d,p)=(0).
6314 10		I			
6346 10	3/2+, 5/2+	I			J π : L(d,p)=2.
6371 10	3/2+, 5/2+	I			J π : L(d,p)=2.
6391 10		I			
6413 10		I			
6427 10	(3/2+, 5/2+)	I			J π : L(d,p)=2 for 6427+6444.
6444 10	(3/2+, 5/2+)	I			
6471 10		I			
6492 10		I			
6515 10	(1/2-, 3/2-)	I			J π : L(d,p)=(1) for 6515+6538.
6538 10	(1/2-, 3/2-)	I			
6556 10		I			

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Adopted Levels, Gammas (continued)
⁶¹Ni Levels (continued)

E(level) [†]	J π	XREF	Comments
6575.67 18	(3/2+)	F I	XREF: I(6571). J π : γ to 1/2-; primary γ from 1/2+; L(d,p)=(2) for 6571+6589.
6589 10	(3/2+, 5/2+)	I	J π : L(d,p)=(2) for 6571+6589.
6609 10	3/2+, 5/2+	I	J π : L(d,p)=2.
6615.8 3		F	
6630 10		I	
6661 10	(3/2+, 5/2+)	I	J π : L(d,p)=2 for 6661+6676.
6676 10	(3/2+, 5/2+)	I	J π : L(d,p)=2 for 6661+6676.
6706 10		I	
6732 10		I	
6748 10		I	
6767 10		I	
6776 10		I	
6803 10		I	
6818 10		I	
6838 10		I	
6849 10		I	
6878 10		I	
6908 10		I	
6923 10		I	
6928 10		I	
6939 10		I	
6971 10		I	
6993 10		I	
7008 10		I	
7036 10		I	
7051 10		I	
7099 50		I	
7137 50		I	
7185 50		I	
7206 50		I	
7232 50		I	
7276 50		I	
7312 50		I	
7374 50		I	
7437 50		I	
7469 50		I	
7509 50		I	
7557 50		I	
7604 50		I	
7620 50		I	
7698 50		I	
7722 50		I	
7747 50		I	
7811 50		I	
(7820.081 18)	1/2+ [§]	F	
7821.42 5		H	
7822.6 6	3/2-@	GH	
7825.56 5	3/2-@	H	
7826 50		I	
7832.12 5	1/2-@	H	
7832.5 7	1/2+@	GH	
7833.50 5	1/2-@	H	
7841.05 5	1/2-@	H	
7843.53 5	1/2-, 3/2-@	H	
7843.64 5		H	
7848.11 5	1/2-@	H	
7848.16 5	1/2-@	H	
7848.32 5	1/2+@	H	
7849.13 5	1/2-@	H	
7849.90 5	1/2-, 3/2-@	H	
7852.61 5	1/2-, 3/2-@	H	

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Adopted Levels, Gammas (continued)

 ^{61}Ni Levels (continued)

E(level) [†]	J π	XREF	E(level) [†]	J π	XREF
7852.98 5	1/2-, 3/2-@	H			
7859.03 5	1/2-, 3/2-@	H			
7862.15 5	1/2-, 3/2-@	H			
7862.42 5	1/2-@	H	7957.95 5		H
7862.54 5	1/2+@	H	7962.97 5	1/2-@	H
7865.50		I	7963.58 5		H
7866.90 5	1/2-@	H	7965.32 5	1/2-, 3/2-@	H
7866.96 5	1/2-, 3/2-@	H	7966.58 5		H
7866.99 5	1/2-@	H	7969.15 5	1/2-, 3/2-@	H
7868.53 10	1/2- $\frac{1}{2}$	G	7972.04 5	1/2-, 3/2-@	H
7869.13 5	1/2-@	H	7974.04 5	1/2+@	H
7870.24 5	1/2-@	H	7974.32 5	1/2-, 3/2-@	H
7870.89 5		H	7977.81 5	1/2-, 3/2-@	H
7871.94 5	1/2-@	H	7978.81 5		H
7875.52 5		H	7979.28 5	1/2+@	H
7876.10 5	1/2-@	H	7979.73 5	1/2-@	H
7883.97 5	1/2-@	H	7983.72 5		H
7884.13 5	1/2-@	H	7984.68 5	(3/2+, 5/2+)@	H
7884.28 5	1/2+@	H	7985.10 5	1/2-@	H
7884.66 5	1/2-, 3/2-@	H	7988.03 5		H
7890.36 5		H	7989.53 5	1/2-@	H
7892.17 5	1/2-, 3/2-@	H	7990.03 5	1/2-@	H
7897.50		I	7991.92 5	1/2-, 3/2-@	H
7897.11 5	1/2-@	H	7992.32 5	1/2-, 3/2-@	H
7898.91 5	1/2-, 3/2-@	H	7997.22 5	1/2-@	H
7900.80 5	1/2-, 3/2-@	H	8000.09 5	3/2-@	H
7903.77 5	1/2-, 3/2-@	H	8000.76 5	1/2-, 3/2-@	H
7904.93 5	1/2-, 3/2-@	H	8003.05 5	1/2+@	H
7905.58 5	1/2+@	H	8003.84 5	1/2-, 3/2-@	H
7906.62 5	1/2-, 3/2-@	H	8008.55 11	1/2-, 3/2-@	H
7908.45 5	1/2-@	H	8009.71 5	3/2-@	H
7910.32 5	1/2-, 3/2-@	H	8011.24 5	1/2-, 3/2-@	H
7912.41 5	1/2-, 3/2-@	H	8011.50 6		H
7914.11 5	1/2-@	H	8012.89 5		H
7915.64 5	1/2-, 3/2-@	H	8013.64 5		H
7916.58 5	1/2+@	H	8015.80 5	1/2+@	H
7917.96 5	1/2-, 3/2-@	H	8017.68 6	1/2+@	H
7920.59 5	1/2-@	H	8018.38 6	5/2+@	H
7926.26 5	1/2+@	H	8019.48 6	1/2-, 3/2-@	H
7926.86 5	3/2-@	H	8022.85 6	1/2-, 3/2-@	H
7929.85 5		H	8023.42 6	1/2-, 3/2-@	H
7930.34 5	1/2-, 3/2-@	H	8025.46 7	1/2-, 3/2-@	H
7930.61 5	1/2-, 3/2-@	H	8025.76 7		H
7931.65 5	1/2-, 3/2-@	H	8026.57 7		H
7932.20 5	1/2-@	H	8029.68 7		H
7938.63 5	1/2-@	H	8030.91 6	1/2-, 3/2-@	H
7938.76 5		H	8031.48 5	1/2-, 3/2-@	H
7939.08 5	1/2-, 3/2-@	H	8036.74 6	1/2-, 3/2-@	H
7941.81 5	1/2-, 3/2-@	H	8037.29 5	1/2-, 3/2-@	H
7942.20 5		H	8037.62 5		H
7945.45 5		H	8040.48 7		H
7945.78 5	1/2-, 3/2-@	H	8042.86 5	1/2-@	H
7947.86 5	1/2-, 3/2-@	H	8045.76 5	1/2-, 3/2-@	H
7951.55 5	1/2-, 3/2-@	H	8046.70 5	5/2+@	H
7952.50		I	8050.00 6	1/2-, 3/2-@	H
7953.51 5	1/2-@	H	8050.36 6	1/2-, 3/2-@	H
7954.00 5	1/2-, 3/2-@	H	8051.52 6	1/2-, 3/2-@	H
7954.27 5	1/2-, 3/2-@	H	8053.10 5	1/2-, 3/2-@	H
7955.19 5	1/2-, 3/2-@	H	8054.40 6	1/2-@	H
7955.42 5	1/2-, 3/2-@	H	8054.65 6	1/2-, 3/2-@	H
7957.00 5	1/2+@	H	8060.36 6	1/2-, 3/2-@	H
7957.48 5	1/2-, 3/2-@	H	8062.89 7	1/2-, 3/2-@	H
7957.83 5	1/2+@	H	8065.04 6	3/2-@	H

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Adopted Levels, Gammas (continued) ^{61}Ni Levels (continued)

E(level) [†]	J π	XREF			
			E(level) [†]	J π	XREF
8068.05 5	1/2+ [@]	H			
8068.57 7	1/2-, 3/2- [@]	H			
8069.25 7	3/2- [@]	H			
8070.19 7		H	8150.46 7	(1/2)- [@]	H
8070.53 7	1/2-, 3/2- [@]	H	8150.92 11	3/2+ [@]	H
8072.05 5	1/2+ [@]	H	8153.12 5	1/2+ [@]	H
8072.15 7	1/2-, 3/2- [@]	H	8153.74 11	1/2- [@]	H
8073.35 7	1/2-, 3/2- [@]	H	8155.87 11	1/2- [@]	H
8073.75 5	1/2+ [@]	H	8156.09 11	1/2- [@]	H
8074.55 7	1/2-, 3/2- [@]	H	8157.31 11	1/2- [@]	H
8075.84 11	1/2-, 3/2- [@]	H	8158.50 11		H
8076.86 7	1/2-, 3/2- [@]	H	8159.93 11	1/2- [@]	H
8078.38 7	1/2-, 3/2- [@]	H	8162.77 5		H
8079.08 7	1/2-, 3/2- [@]	H	8163.39 11	(1/2)- [@]	H
8081.50 7	1/2-, 3/2- [@]	H	8163.99 11	3/2+ [@]	H
8081.97 7	1/2- [@]	H	8164.50 7		H
8084.43 7	1/2- [@]	H	8166.79 9	3/2+ [@]	H
8084.81 7	1/2-, 3/2- [@]	H	8168.71 11	3/2+ [@]	H
8085.07 7	1/2-, 3/2- [@]	H	8169.90 11	3/2+ [@]	H
8089.35 7	1/2- [@]	H	8171.96 5	1/2+ [@]	H
8089.54 7		H	8173.07 11	1/2- [@]	H
8092.60 7	1/2- [@]	H	8173.76 11	3/2- [@]	H
8092.88 7		H	8175.36 11	1/2- [@]	H
8093.96 7	3/2- [@]	H	8180.10 11	1/2- [@]	H
8094.85 5	1/2+ [@]	H	8182.80 7		H
8095.86 7	3/2- [@]	H	8183.05 11	3/2+ [@]	H
8097.37 7	1/2-, 3/2- [@]	H	8183.84 11	1/2- [@]	H
8098.37 7	1/2-, 3/2- [@]	H	8184.72 5	3/2+ [@]	H
8098.78 7	3/2- [@]	H	8185.67 5	3/2+ [@]	H
8101.09 7	1/2- [@]	H	8187.04 7		H
8104.04 7	1/2-, 3/2- [@]	H	8187.66 11	1/2- [@]	H
8106.25 7	1/2-, 3/2- [@]	H	8188.72 11	1/2- [@]	H
8107.49 5	1/2+ [@]	H	8190.78 5	1/2+ [@]	H
8108.23 7	3/2- [@]	H	8190.80 11	1/2- [@]	H
8109.16 9		H	8191.85 7	1/2- [@]	H
8109.62 9	1/2-, 3/2- [@]	H	8192.52 11		H
8109.99 9	1/2-, 3/2- [@]	H	8193.58 11		H
8111.22 9	1/2- [@]	H	8193.76 11	3/2- [@]	H
8112.79 11	1/2- [@]	H	8195.28 11	1/2- [@]	H
8114.84 9	1/2- [@]	H	8195.65 11		H
8115.73 9	3/2+ [@]	H	8196.40 7		H
8117.51 7	3/2+ [@]	H	8197.31 7	1/2+ [@]	H
8121.66 11	1/2-, 3/2- [@]	H	8199.84 11		H
8122.65 7	3/2- [@]	H	8200.23 7		H
8123.22 7		H	8201.89 11	3/2+ [@]	H
8123.97 11	1/2-, 3/2- [@]	H	8202.32 11	1/2- [@]	H
8125.73 7		H	8202.93 7		H
8126.54 11	1/2-, 3/2- [@]	H	8203.06 7		H
8127.74 7		H	8206.94 11	3/2 [@]	H
8128.68 11		H	8208.60 11	1/2- [@]	H
8132.07 5	1/2+ [@]	H	8210.69 11	1/2- [@]	H
8132.09 11		H	8211.94 11	3/2+ [@]	H
8133.28 7		H	8212.77 11	1/2- [@]	H
8136.57 11	3/2- [@]	H	8214.58 11	1/2- [@]	H
8137.64 11	1/2-, 3/2- [@]	H	8215.81 11	1/2- [@]	H
8139.39 11	1/2- [@]	H	8216.64 11	3/2- [@]	H
8140.04 5	1/2+ [@]	H	8217.36 11	1/2- [@]	H
8141.12 11	1/2- [@]	H	8217.82 7		H
8142.31 11	3/2+ [@]	H	8219.23 7		H
8144.0 5	1/2-, 3/2- [@]	H	8220.81 11	1/2- [@]	H
8144.47 11	1/2- [@]	H	8221.68 11	1/2-, 3/2- [@]	H
8145.92 11	1/2- [@]	H	8223.61 11	3/2+ [@]	H
8148.99 11	3/2- [@]	H	8227.13 7	1/2+ [@]	H

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{61}Ni Levels (continued)

E(level) [†]	J π	XREF
8228.64 11	3/2+@	H
8228.94 11	3/2+@	H
8231.38 11		H
8232.12 11		H
8233.28 11	1/2-@	H
8235.61 7		H
8235.92 5	1/2+@	H
8237.30 7		H
8238.12 11	3/2+@	H
8239.74 11	1/2-@	H
8240.49 11	1/2-@	H
8242.85 11	1/2-@	H
8243.63 11	3/2+@	H
8244.40 11	1/2-@	H
8245.49 11	3/2+@	H
8248.81 21	3/2+@	H
8250.00 21	1/2-@	H
8250.94 5	1/2+@	H
8251.79 11	3/2+@	H
8252.27 7		H
8252.89 7		H
8253.54 7		H
8254.17 11	3/2+@	H
8254.92 7		H
8257.34 21	1/2+@	H
8258.42 7		H
8260.00 21	1/2-@	H
8260.86 7	1/2+@	H
8261.70 7		H
8262.19 7		H
8264.19 7	3/2-@	H
9550	7/2-	S

[†] From a least-squares fit to the $E\gamma$ data; reduced $\chi^2=1.0$. Other levels are from reaction data suitably averaged.

[‡] Probably corresponds to 7866.99, 1/2- and/or 7869.13, 1/2- excitations in neutron resonances; p-wave resonance 47.6 keV from 1978Be04.

[§] Thermal s-wave neutron capture in ^{60}Ni g.s.

[#] From $^{58}\text{Fe}(\alpha, n\gamma)$, except as noted.

[@] From s-wave, p-wave or d-wave assignment from R-matrix analysis in $^{60}\text{Ni}(n, \gamma), (n, n):$ resonances.

 $\gamma(^{61}\text{Ni})$

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. [‡]	$\delta^{\#}$	α	Comments
67.418	67.412& 10	100&	(M1+E2) §	0.0076@ 5	0.137	B(M1)(W.u.)=0.0118 4; B(E2)(W.u.)=0.27 4.
282.956	215.55& 18	0.18& 6	[E2]		0.0311	B(E2)(W.u.)=6.6 24.
	282.956& 10	100&	(M1+E2) §	0.044@ 4	0.00330	B(M1)(W.u.)=0.042 6; B(E2)(W.u.)=1.8 4.
656.019	373.050& 10	20.0& 5	[M1]			B(M1)(W.u.)=0.0038 9.
	588.605& 10	10.8& 2	[E2]			B(E2)(W.u.)=2.7 7.
	656.008& 10	100.0& 17	(M1+E2) §	1.6@ 9		B(M1)(W.u.)=0.0010 9; B(E2)(W.u.)=11 5.
908.613	625.605& 24	3.7& 4	[E2]			B(E2)(W.u.)=18 +24-6.
	841.211& 17	19.4& 6	M1+E2	+1.83 20		B(M1)(W.u.)=0.0019 +25-7; B(E2)(W.u.)=16 +21-6.
	908.631& 17	100& 2	M1+E2	-0.18 5		B(M1)(W.u.)=0.033 +44-12; B(E2)(W.u.)=2.3 +31-8.
917.5	850.0 10	22.0 20	M1+E2	+1.83 20		$E\gamma, I\gamma$: data for 850 γ and 917 γ are from β^- decay.
	917.5 10	100 7	(E2)			$\delta(\text{M3/E2})=-0.18 5$.
1014.78	357.9 ^{a c}	4.4 ^a	[M3]			This transition is highly suspect since implied M3 multipolarity is inconsistent with RUL for M3.
	947.1 1	100.0 13	M1+E2	+2.46 15		B(M1)(W.u.)=0.00061 11; B(E2)(W.u.)=7.4 11.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{61}\text{Ni})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	$\delta^{\#}$	Comments
1014.78	1015.14 15	33.3 13	E2		B(E2)(W.u.)=2.0 3.
1099.624	191.05 17	1.65 13			
	443.5& 1	1.2& 4			
	816.692& 13	100.0& 24	M1+E2	+0.23 7	B(M1)(W.u.)=0.12 4; B(E2)(W.u.)=18 12.
	1032.162& 27	13.7& 12			
	1099.560& 19	80& 2			
1132.333	117.5& 6	12& 6			
	1064.896& 20	54& 4	M1+E2	+0.14 12	B(M1)(W.u.)=0.0182 25; B(E2)(W.u.)=0.6 +10-6.
	1132.35& 3	100& 5	M1+E2	-0.47 9	B(M1)(W.u.)=0.023 4; B(E2)(W.u.)=7.3 25.
1185.243	276.69& 5	0.68& 6			
	529.169& 22	10.0& 2			
	902.294& 20	2.2& 1			
	1117.82& 4	0.86& 11			
	1185.234& 15	100.0& 19	(M1+E2) §	0.17@ 3	B(M1)(W.u.)=0.094 24; B(E2)(W.u.)=3.5 15.
1454.82	441.8 ^a	8.5 ^a			
	1387.4 3	33 4	M1+E2	+2.7 4	B(M1)(W.u.)=0.00040 21; B(E2)(W.u.)=2.7 13.
	1454.8 1	100 4	E2		B(E2)(W.u.)=7 +5-2.
1609.655	477.4 5	7.4 19			
	701.2 1	9.3 19			
	1542.204& 23	100& 9	M1+E2	-0.07 5	B(M1)(W.u.)=0.0115 22; B(E2)(W.u.)=0.04 +7-4.
	1609.62& 5	83& 8	M1+E2	-0.33 14	B(M1)(W.u.)=0.0076 16; B(E2)(W.u.)=0.6 5.
1729.481	545 ^c 5	11 1			E_{γ}, I_{γ} : from ε decay. Other: $I_{\gamma}=23$ in (p,p' γ). Evaluators treat this transition as uncertain since it is not reported in several other reactions.
	629.9& 2	11& 4			
	820.90 10	42 3			I_{γ} : from ε decay and (n, γ). Value of 12 in (α ,n γ) is discrepant.
	1073.465& 25	60& 6			
	1446.492& 19	84& 5			
	1662.000& 19	98& 5			
	1729.473& 18	100& 5			
1807.5	792.6 5	12.4 23	M1+E2	+0.97 18	B(M1)(W.u.)=0.004 +20-2; B(E2)(W.u.)=11 +55-5.
	1740.1 5	100.0 23	E2		B(E2)(W.u.)=4 +20-2.
1987.75	533.2 5	22.8 18	M1 (+E2)	+0.02 3	B(M1)(W.u.)=0.037 14; B(E2)(W.u.)=0.09 +29-9.
	972.5 5	21 4	M1+E2	-0.70 23	B(M1)(W.u.)=0.0038 18; B(E2)(W.u.)=3.5 21.
	1079.3 7	32 4	E2		B(E2)(W.u.)=10 4.
	1920.1 5	100 6	E2		B(E2)(W.u.)=1.7 7.
1998.07	982.5 3	16.2 15			
	1089.6 2	23.5 15			
	1342.3 4	18 4	[E2]		B(E2)(W.u.)=22 6.
	1930.6 8	7.4 15			
	1998.1 1	100 3	M1+E2	-0.27 6	B(M1)(W.u.)=0.035 6; B(E2)(W.u.)=1.1 5.
2018.1	1109.8 10	11			
	1950.6 5	100	M1 (+E2)	-0.02 +2-7	B(M1)(W.u.)=0.022 +6-15; B(E2)(W.u.)=0.004 +9-4.
2121.27	1106.5 2	100	E1		B(E1)(W.u.)=0.0008 +3-5.
2123.913	394.33 5	1.22 4			
	514.33 14	0.47 5			
	938.62 4	11.18 12			
	1024.27 7	0.84 4			
	1215.35 5	1.37 4			
	1840.94 5	3.28 8			
	2123.90 3	100.0 10			
2128.87	1114.1 2	100	E2		B(E2)(W.u.)<12.
2409.7	955.0 5	27 3	M1+E2	-0.10 5	B(M1)(W.u.)=0.022 6; B(E2)(W.u.)=0.4 +5-4.
	1277.5 5	19 3	E2		B(E2)(W.u.)=7.2 20.
	1394.6 5	15 3	M1+E2		B(E2)(W.u.)=1.8 7; B(M1)(W.u.)=0.0020 7.
					δ : -2.1 $\leq\delta\leq$ -0.3.
	2342.0 7	100 5	E2		B(E2)(W.u.)=1.8 4.
2639.50	2356.6 3	9.5 15			
	2639.44 6	100.0 23			
2707.62	2707.58 9	100			
2764.99	1154.9 3	26 4			
	1580.03 20	29 4			

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Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Ni})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\dagger}$	Mult. ‡	$\delta^{\#}$	Comments
2764.99	1633.08 20	44 6			
	1665 1	58 4			
	2108.99 18	70 6			
	2482.07 18	69 9			
	2764.69 16	100 6			
2862.90	1253.23 20	63 8			
	2207.0 3	95 15			
	2579.84 15	100 8			
	2795.3 4	52 9			
3062.14	1877.1 4	12.0 25			
	2406.05 6	100 3			
	2778.9 4	13.6 25			
	3062.16 10	54.0 25			
3144.943	1021.06 8	14.4 9			
	1146.69 16	10.5 11			
	1415.43 10	13.7 11			
	1536 1	9.3 12			
	1959.71 7	26.9 12			
	2012.47 22	12.3 18			
	2045.32 5	72.2 20			
	2488.84 12	17.6 11			
	2861.95 4	100.0 17			
	3077.5 3	9.1 11			
	3144.7 ^b 7	62.1 ^b 20			
3231.61	1107.71 9	20.4 18			
	1233.4 3	12.6 21			
	1502.0 1	23.1 18			
	1621.86 8	61 3			
	2099.27 7	100 3			
	2575.63 14	26.6 21			
	3164.49 24	25 3			
	3231.47 9	71 3			
3259.2	1271.6 5		M1+E2		δ : -2.7 $\leq\delta\leq$ -0.27.
	1451.5 7				
3298.6	1177.3 5	100	M1+E2	+0.63 8	B(M1)(W.u.)=0.016 +4-7; B(E2)(W.u.)=8.3 +25-36.
3415.11	650.1 4	3.9 12			
	1685.54 10	22.2 14			
	2229.84 20	19 4			
	2282.66 14	13.7 12			
	2315.35 16	16.1 14			
	2759.38 19	26.9 16			
	3132.05 8	100.0 25			
	3347.7 4	12.6 18			
	3415.04 6	99.0 22			
3426.23	1297.5 5	14.5 15	M1+E2	-2.6 4	E γ : alternative placement: 4515-->1100. B(M1)(W.u.)<0.00024; B(E2)(W.u.)<1.4.
	1438.43 14	100 4	E2		B(E2)(W.u.)<6.4.
	1618.9 5	30 3	E2		B(E2)(W.u.)<1.1.
3435.26	1314.0 2	100	E2		B(E2)(W.u.)=10 4.
3525.57	1795.61 24	27 4			
	2340.56 22	25 3			
	3242.59 11	100 5			
	3525.1 9	11 4			
3644.3	1523.0 7	100			
3665.3	1544.0 7	100			
3668.97	806.0 3	2.1 7			
	2483.6 7	3.5 15			
	3012.66 11	31.3 11			
	3385.92 5	100.0 14			
	3601.8 4	6.9 13			
3711.46	848.54 13	8.5 7			
	1587.77 23	7.1 9			
	2611.73 16	14.9 12			
	2802.7 4	5.9 12			

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Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Ni})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\dagger}$	Mult. ‡	$\delta^{\#}$	Comments
3711.46	3644.0 4	13.2 22			
	3711.42 11	100 4			
3738.32	3082.21 21	100			
3776.75	1778.83 12	91 6			
	2644.23 22	51 6			
	2676.5 5	25 7			
	3709.3 5	100 25			
3869.97	2684.58 25	13.4 21			
	3213.9 3	16.8 24			
	3869.83 12	100 6			
4019.24	584.0 2	39 4	M1+E2	+0.63 10	B(M1)(W.u.)<0.017; B(E2)(W.u.)<41.
	593.00 13	100 4	E1		B(E1)(W.u.)<0.0011.
4178.88	1116.46 25	40 6			
	4111.5 4	100 18			
4204.2	3104.6 8	100			
4239.70	2115.2 3	9.0 20			
	2510.0 3	9.8 13			E γ : alternative placement: 3526-->1015.
	3054.36 18	16.9 13			
	3106.8 4	24 3			
	3583.47 14	57 4			
	4171.7 6	8.3 22			
	4239.66 9	100 4			
4439.87	1377.3 4	11.5 25			E γ : alternative placement: 4240-->2863.
	3254.8 6	14 4			
	3531.51 20	100 9			
	4439.2 4	42 6			
4514.66	3328.6 6	42 10			
	3382.3 7	96 25			
	4514.6 4	100 14			
4793.10	2085.7 3	122 18			E γ : alternative placement: 5956-->3870.
	4793.2 7	100 26			
4818.6	799.4 5	100			
5036.21	3850.7 6	74 19			E γ : alternative placement: 6616-->2765.
	4753.0 6	100 21			
5116.57	2351.3 4	88 18			
	4833.2 9	100 38			
5316.3	1297 1	100			
5390.82	1721.5 5	36 10			
	5322.2 7	100 16			
5955.48	1750.9 6	36 10			
	4225.9 8	100 31			
	5955.3 8	69 20			
6575.67	6292.3 7	100			
6615.8	5515.4 7	100			
(7820.081)	1204.2 3	0.023 5			
	1244.39 18	0.05 1			
	1864.55 18	0.06 1			
	2429.15 14	0.09 1			
	2703.38 19	0.10 1			
	2783.80 9	0.19 1			
	3027.02 18	0.09 1	[E3]		E γ : this γ may be suspect due to implied high multipolarity.
	3305.30 14	0.13 1			
	3380.29 21	0.19 2			
	3580.26 6	0.070 3			
	3615.9 4	0.05 1			
	3640.99 18	0.16 1			
	3949.97 9	0.45 2			
	4043.33 14	0.22 1			
	4081.6 3	0.13 1			
	4108.52 8	0.85 2			
	4150.92 6	0.95 3			
	4294.44 15	0.16 1			

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Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Ni})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\dagger}$	Mult. ‡	Comments
(7820.081)	4404.82 5	1.31 3		
	4588.26 6	0.95 2		
	4675.05 5	1.64 2		
	4757.86 10	0.40 2		
	4957.1 4	0.18 2		
	5055.02 12	0.34 2		
	5112.1 5	0.07 1		
	5180.36 9	0.32 1		
	5695.86 4	12.70 24		
	6090.5 5	0.06 1		
	6634.40 5	2.39 3		
	6719.97 5	4.51 6		
	7163.9 5	0.11 2		
	7536.62 6	57.0 7		
	7819.56 6	100.0 12		
7822.6	7539	36		
	7755	100		
	7822	12		
7832.5	7549			$\Gamma_{\gamma}=0.29$ eV 5 (1978Be04).
	7832			$\Gamma_{\gamma}=10.51$ eV 8 (1978Be04).
7868.5	7868			$\Gamma_{\gamma}=0.28$ eV 7 (1978Be04).

$\dagger$ Values are from $^{58}\text{Fe}(\alpha, n\gamma)$ (also heavy-ion reactions in this dataset), Coulomb excitation, $^{60}\text{Ni}(n, \gamma)$, E=thermal, except as noted otherwise.

$\ddagger$ From $\gamma(\theta)$ and linear polarization data from $(\alpha, n\gamma)$, except as indicated otherwise.

$\S$ From $\Delta J\pi$ of initial and final levels.

From $\gamma(\theta)$ in $(\alpha, n\gamma)$, except as noted otherwise.

@ Calculated from B(E2) (see Coulomb excitation) and $T_{1/2}$.

& From ^{61}Cu ε decay.

a From $^{61}\text{Ni}(p, p'\gamma)$.

b From $^{61}\text{Ni}(n, \gamma)$ E=thermal.

c Placement of transition in the level scheme is uncertain.

 ^{61}Co β^- Decay (1.649 h) 1969Ki09

Parent ^{61}Co : E=0.0; $J\pi=7/2^-$; $T_{1/2}=1.649$ h 5; $Q(\text{g.s.})=1323.7$ 8; % β^- decay=100.

$^{61}\text{Co}-Q(\beta^-)$: From 2012Wa38.

1969Ki09: source produced in $^{61}\text{Ni}(n, p)$ reaction and separated by a chemical method. Measured E_{γ} , I_{γ} , β .

Source produced by $^{64}\text{Ni}(d, \alpha)$, $^{61}\text{Ni}(n, p)$, $^{59}\text{Co}(t, p)$ (see references in 1978LeZA compilation), and $^{58}\text{Fe}(\alpha, p)$ (1973Sc09).

Others: 1956Nu02, 1968Ka21, 1971VoZX, 1972GeZG.

From RADLIST code, deduced total decay energy is 1324 keV 5 agrees with 1324 keV 1 from $Q(\beta^-)$ value.

 ^{61}Ni Levels

E(level) †	$J\pi^{\ddagger}$
0.0	3/2-
67.412 10	5/2-
917.5 7	(7/2)-

$\dagger$ From least-squares fit to E_{γ} data.

$\ddagger$ From Adopted Levels.

 β^- radiations

Continued on next page (footnotes at end of table)

⁶¹Co β⁻ Decay (1.649 h) 1969Ki09 (continued)

β⁻ radiations (continued)

Eβ ⁻	E(level)	Iβ ^{-†‡}	Log ft	Comments
(406.2 11)	917.5	4.4 4	4.78 4	
(1256.3 8)	67.412	95.6 4	5.240 3	Measured Eβ=1220 40 (1956Nu02), 1220 5 (1969Ki09).

† β⁻ branches are obtained from I(γ+ce) imbalance at each level.

‡ Absolute intensity per 100 decays.

γ(⁶¹Ni)

Iγ normalization: Assumed no β⁻ feeding to g.s.

Eγ	E(level)	Iγ†§	Mult.‡	δ‡	α	Comments
67.412 10	67.412	96	(M1+E2)	0.0076 5	0.137	Eγ: from Adopted dataset. Eγ=67.5 5 (1972GeZG).
850.0 10	917.5	0.90 8	M1+E2	+1.83 20		
917.5 10	917.5	4.1 3	(E2)			

† Relative intensity normalized to Iγ(67.415γ)=96.

‡ From Adopted Gammas.

§ For absolute intensity per 100 decays, multiply by 0.882 4.

Decay Scheme

⁶¹Cu ε Decay (3.339 h) 1978Me10,1988Sa26

Parent ⁶¹Cu: E=0.0; Jπ=3/2-; T_{1/2}=3.339 h 8; Q(g.s.)=2237.5 10; %ε+%β⁺ decay=100.

⁶¹Cu-J,T_{1/2}: From ⁶¹Cu Adopted Levels.

⁶¹Cu-Q(ε): From 2012Wa38.

1978Me10: chemical separation. Measured Eγ, Iγ, by Ge(Li), Compton suppression.

1988Sa26: measured Eγ, Iγ by Ge(Li). Confirmed the presence of 215.6, 625.5, 947.3, 1014.4 and 701.1 γ rays. But presence of 190.8, 276.7, 443.5, 629.9, 820.9 and 1089 γ rays was not confirmed.

Source produced by ⁵⁹Co(α,2n) (1988Sa26,1967Be12,1967Bo01), ⁶⁰Ni(d,n) (1967Sc02), and ⁶³Cu(γ,2n) (1969Ri04).

Decay scheme is from γγ coin results of 1967Wa04 and energy sums.

Others: 1967Be12, 1967Bo01, 1967Sc02, 1967Wa04, 1969Ri04, 1971VoZX, 1977Wa03.

Pre-1960 studies of x ray, β and γ rays from ⁶¹Cu decay: 1938Al02, 1945Br02, 1948Co08, 1949Bo16, 1949Hu21, 1950Co05, 1950Ow03, 1950Bo34, 1953En06, 1956Nu02, 1957Ku57, 1958Bu07.

All data are from 1978Me10, except as noted.

From RADLIST code, deduced total decay energy is 2063 keV 81 as compared to 2238 keV 1 from Q(ε) value. It suggests that the decay scheme is reasonably complete.

^{61}Cu ϵ Decay (3.339 h) 1978Me10,1988Sa26 (continued) **^{61}Ni Levels**

E(level) [†]	J $\pi^{\ddagger}$	T _{1/2}	Comments
0.0	3/2-		
67.416 7	5/2-	5.34 ns 16	T _{1/2} : from $\beta^+\gamma(t)$, average of values from 1971AzZZ and 1975Ro25.
282.955 7	1/2-	22 ps 4	T _{1/2} : from $\beta^+\gamma(t)$ (1967Be12).
656.017 7	1/2-	<21 ps	T _{1/2} : from $\beta^+\gamma(t)$ (1967Be12).
			J π : see 2012PeZX who question assignment of 1/2- for 656 level based on branching ratio measurements and theory in ^{61}Cu decay.
908.620 11	5/2-		
1014.8 4	7/2-		
1099.619 11	3/2-		
1132.333 18	5/2-		
1185.239 11	3/2-		
1609.642 22	5/2-		
1729.473 11	3/2-		
1997.8 7	5/2-		
2120?			See also analysis of 1988Sa26.
2123.48 4	1/2-		

[†] From least-squares fit to E γ data. Reduced $\chi^2=1.8$ is below the critical χ^2 .

[‡] From Adopted Levels.

 β^+, ϵ Data

E ϵ	E(level)	I β^+ [‡]	I ϵ [‡]	Log ft	I($\epsilon+\beta^+$) ^{†‡}	Comments
(114.0 10)	2123.48		0.043 9	5.0 1		
(117.5 [§] 10)	2120?		<0.01	>5.7		
(239.7 13)	1997.8		0.0045 9	6.7 1		
(508.0 10)	1729.473		0.21 4	5.7 1		
(627.9 10)	1609.642		0.046 9	6.5 1		
(1052.3 10)	1185.239		4.3 8	5.0 1	4.3 8	
(1105.2 10)	1132.333		0.15 3	6.5 1	0.15 3	
(1137.9 10)	1099.619		0.60 11	5.9 1	0.60 11	
(1222.7 [§] 11)	1014.8	<9.0 $\times 10^{-5}$	<0.018	>7.5	<0.018	
(1328.9 10)	908.620	0.033 6	1.27 23	5.7 1	1.30 24	
(1581.5 10)	656.017	2.6 5	11.1 20	4.9 1	13.7 25	
(1954.5 10)	282.955	5.5 10	4.1 8	5.6 1	9.6 18	
(2170.1 10)	67.416	2.3 4	0.88 17	6.3 1	3.2 6	
(2237.5 10)	0.0	51 5	16 1	5.07 4	67 6	E ϵ : endpoint E(β^+)=1220 15 (1956Nu02). I β^+ : from measured β^+ spectrum (1956Nu02).

[†] From I($\gamma+\epsilon$) imbalance at each level except g.s.

[‡] Absolute intensity per 100 decays.

[§] Existence of this branch is questionable.

 $\gamma(^{61}\text{Ni})$

I γ normalization: Summed transition (I $\gamma+\epsilon$) intensity to g.s.=33 6, based on measured I β^+ (g.s.)=51% 5 (1956Nu02) and theoretical ϵ/β^+ value, which gives I ϵ (g.s.)=16% 1. This normalization implies an annihilation radiation intensity of 1008 100, in agreement with the measured intensities of 1090 50 (1967Sc02) and 860 40 (1967Bo01), all intensities relative to 100 for 282.956 γ .

E $\gamma^{\dagger}$	E(level)	I $\gamma^{\dagger\#}$	Mult. [§]	$\delta^{\S}$	α	Comments
67.412 10	67.416	34.7 11	(M1+E2)	0.0076 5	0.137	E γ : uncertainty=0.003 in 1978Me10.
117.5 [‡]	1132.333	0.09 5				
190.79 12	1099.619	0.040 8				
215.55 18	282.955	0.176 58	[E2]		0.0311	
276.688 53	1185.239	0.21 2				
282.956 10	282.955	100.0	(M1+E2)	0.044 4	0.00330	E γ : uncertainty=0.002 in 1978Me10.
373.050 10	656.017	17.6 4	[M1]		0.00171	E γ : uncertainty=0.005 in 1978Me10.
443.5 1	1099.619	0.03 1				
529.169 22	1185.239	3.1 1				

Continued on next page (footnotes at end of table)

^{61}Cu ϵ Decay (3.339 h) 1978Me10,1988Sa26 (continued) $\gamma(^{61}\text{Ni})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger$	Mult.§	$\delta^\S$	Comments
545@ 5	1729.473	0.048 3			E γ : reported by 1969Ri04 in coin with 656 γ .
588.605 10	656.017	9.57 17			E γ : uncertainty=0.009 in 1978Me10.
625.605 24	908.620	0.33 4			
629.90 25	1729.473	0.05 2			
656.008 10	656.017	88.3 15	(M1+E2)	1.6 9	E γ : uncertainty=0.004 in 1978Me10.
701.1@ 3	1609.642				I γ : not given in 1988Sa26. I γ =0.9 2 (1978Me10). Observed in $^{54}\text{Fe}(\alpha, n\gamma), ^{53}\text{Cr}(^{11}\text{B}, p2n\gamma)$.
816.692 13	1099.619	2.52 6	M1+E2	+0.23 7	
820.89 17	1729.473	0.18 2			
841.211 17	908.620	1.75 5	(M1+E2)	+1.83 20	
902.294 20	1185.239	0.68 4			
908.631 17	908.620	9.0 2	M1+E2	-0.18 5	
947.4 4	1014.8	0.08 4	M1+E2	+2.46 15	
1014.8	1014.8	0.086 30	E2		
1032.162 27	1099.619	0.35 3			
1064.896 20	1132.333	0.40 3	M1+E2	+0.14 12	
1073.465 25	1729.473	0.267 25			
1089.11	1997.8	0.005			
1099.560 19	1099.619	2.01 5			
1117.822 43	1185.239	0.265 34			
1132.351 32	1132.333	0.737 34	M1+E2	-0.47 9	
1185.234 15	1185.239	30.7 6	(M1+E2)	0.17 3	
1446.492 19	1729.473	0.37 2			
1542.204 23	1609.642	0.21 2	M1+E2	-0.07 5	
1609.625 48	1609.642	0.17 2	M1+E2	-0.33 14	
1662.000 19	1729.473	0.43 2			
1729.473 18	1729.473	0.44 2			
1840.7 2	2123.48	0.014 4			
1997.73 85	1997.8	0.032 1	M1+E2	-0.27 6	
2120@	2120?	<0.08			
2123.432 35	2123.48	0.34 2			E γ : unweighted averaged value of 2123.78 18 obtained from 2123.432 35, 2124.0 7 from ($\alpha, n\gamma$) and 2123.90 3 from (n, γ) is listed in Adopted dataset.

† From 1978Me10 unless otherwise stated. Uncertainties of five γ -ray energies quoted in 1978Me10 are unrealistically small.

Evaluators assign a minimum energy uncertainty of 0.010 keV, while uncertainty listed in 1978Me10 is given under comments.

‡ From 1988Sa26.

§ From Adopted Gammas.

$^\#$ For absolute intensity per 100 decays, multiply by 0.122 22.

@ Placement of transition in the level scheme is uncertain.

61Cu ε Decay (3.339 h) 1978Me10,1988Sa26 (continued)

Decay Scheme

Intensities: I(γ+ce) per 100 parent decays

3/2- 0.0 3.339 h
 $^{61}_{29}\text{Cu}_{32}$
 $\% \epsilon + \% \beta^+ = 100$
 $Q^+ = 2237.5^{10}$

58Fe(α,nγ), (HI,xnγ) 1977Wa03,1977Wa07,1978Wa09

Includes reactions: $^{60}\text{Ni}(\text{d},\text{p})$ from 1975Wi28 and 1968Na15; $^{53}\text{Cr}(\text{B},2\text{n}\gamma)$ from 1977Wa07 and $^{48}\text{Ca}(\text{O},5\text{n})$ from 1978Wa09.

1977Wa03: $E_\alpha = 6.5\text{--}13.0$ MeV. Measured excit. E_γ , I_γ , $\gamma\gamma$ -coin, $\gamma(\theta)$, linear polarization, DSA, semi, Compton suppression, enriched targets (71% and 87%).

1977Wa07: $E(\alpha) = 6.5\text{--}13.0$ MeV; $^{53}\text{Cr}(\text{B},2\text{n}\gamma)$, $E = 30$ MeV. Measured E_γ , I_γ , $\gamma\gamma$ -coin, $\gamma(\theta)$, linear polarization, lifetime by DSAM, enriched target.

1975Wi28: $E_\alpha = 8$ MeV; $^{60}\text{Ni}(\text{d},\text{p}\gamma)$, $E(\text{d}) = 6$ MeV. Measured E_γ , I_γ , $\text{n}\gamma$ -coin, $\gamma\gamma(\theta)$, 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: $E_\alpha = 9.0$ MeV. Measured lifetime by recoil distance method.

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

1968Na15: $^{60}\text{Ni}(\text{d},\text{p}\gamma)$, $E = 5.5$ MeV.

All data are from $^{58}\text{Fe}(\alpha,\text{n}\gamma)$ (1977Wa07, 1977Wa03), except as noted.

61Ni Levels

E(level) [†]	J^π [‡]	$T_{1/2}$ [§]	Comments
0.0	3/2-		
67.38 21	5/2-		
283.3 3	1/2-	24 ps ^a 4	
655.9 3	1/2-	17 ps ^a 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.
1099.6 4	3/2-	0.25 ps [@] +47-11	J^π : 7/2- (1977Wa03), 7/2- (1975Wi28).
1132.0 3	5/2-	0.29 ps [#] 5	J^π : 3/2- (1977Wa03).
1185.7 4	3/2-	0.104 ps [#] 17	J^π : 5/2- (1977Wa03), 5/2- (1975Wi28).
1454.5 3	7/2-	0.58 ps [#] 25	J^π : 3/2- (1975Wi28).
1609.3 3	5/2-	0.26 ps [#] 4	J^π : 7/2- (1977Wa03), (5/2-) (1975Wi28).
1729.3 3	3/2-	0.065 ps [#] 11	J^π : 5/2- (1977Wa03), 5/2- (1975Wi28).
1807.5 4	9/2-	0.6 ps [#] 5	J^π : (1/2-), 3/2- (1977Wa03), 3/2- (1975Wi28).
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 : 9/2- (1977Wa03).

Continued on next page (footnotes at end of table)

$^{58}\text{Fe}(\alpha, n\gamma)$, (HI, xn γ) 1977Wa03, 1977Wa07, 1978Wa09 (continued) **^{61}Ni Levels (continued)**

E(level) [†]	J π [‡]	T _{1/2} [§]	Comments
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 ps ^{&} 4	J π : 9/2- (1977Wa07).
3259.1 5	(11/2-)	0.46 ps ^{&} 8	J π : (11/2-) (1977Wa07).
3298.7 8	11/2+	0.60 ps ^{&} +23-14	J π : 11/2+ (1977Wa07).
3426.2 4	13/2-	>0.7 ps ^{&}	J π : 13/2- (1977Wa07).
3435.5 6	13/2+	1.0 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 ps ^{&}	J π : 15/2+ (1977Wa07).
4818.6 8	(17/2+)	<1.1 ps	E(level): seen both in $^{58}\text{Fe}(\alpha, n\gamma)$ and in $^{53}\text{Cr}(^{11}\text{B}, p2n\gamma)$. T _{1/2} : from DSAM (1978Wa09). E(level): from $^{53}\text{Cr}(^{11}\text{B}, p2n\gamma)$.
5316.2 12			

[†] From least-squares fit to E γ 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.[&] From 1977Wa07.^a Recoil-distance method (1977Wa15). $\gamma(^{61}\text{Ni})$

E(level)	E γ [†]	I γ [†]	Mult. [‡]	δ [§]	Comments
67.38	67.4 5	100			
283.3	283.4 5	100			
655.9	372.5 5	17 1			A ₂ =-0.01 1, A ₄ =0.00 1, POL=+0.04 6.
	588.4 5	8 1			A ₂ =-0.04 3, A ₄ =0.00 1, POL=+0.04 6.
	656.0 5	75 1			A ₂ =-0.01 1, A ₄ =0.00 1, POL=0.00 2.
908.3	625.0 7	6 1	E2		A ₂ =+0.21 3, A ₄ =-0.02 3.
	841.0 5	21 1	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	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	947.84 [@] 15	75 1	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	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	816.7 7	51 1	M1+E2	+0.23 7	A ₂ =-0.01 1, A ₄ =0.00 1, POL=-0.12 7.
	1032.1 5	7 1			A ₂ =-0.43 4, A ₄ =+0.03 5.
	1099.4 5	42 1			POL=+0.14 7.
1132.0	1064.6 5	37 1	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	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	529.8 5	8 3			
	902	<4			
	1119	<2			
	1185.5 7	92 3			δ >-0.27 (1975Wi28).
1454.5	1387.2 5	25 3	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	E2		A ₂ =+0.25 6, A ₄ =-0.15 1, POL=+0.50 6. δ : +0.72 +29 -23 (1975Wi28).
1609.3	477.4 5	4 1			A ₂ =+0.25 7, A ₄ =-0.10 8.
	701.1 7	5 1			A ₂ =+0.20 10, A ₄ =+0.10 10.

Continued on next page (footnotes at end of table)

⁵⁸Fe(α,ny), (HI,xny) 1977Wa03,1977Wa07,1978Wa09 (continued)

γ(⁶¹Ni) (continued)

E(level)	E _γ [†]	I _γ [†]	Mult. [‡]	δ [§]	Comments
1609.3	1541.7 5	54 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	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).
1729.3	820.7 7	3 [#]			
	1073.2 5	22 [#]			Pol=-0.3 1.
	1446.2 5	21 [#]			Pol=-0.1 1.
	1661.9 5	29 [#]			A ₂ =-0.01 1, A ₄ =+0.06 2, POL=-0.2 2.
	1729.3 5	25 [#]			Pol=-0.3 2.
1807.5	792.6 5	11 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	E2		A ₂ =+0.36 1, A ₄ =-0.10 1, POL=+0.53 5. δ(M3/E2)=+0.01 3.
1987.6	533.2 5	13 1	M1 (+E2)	+0.02 3	A ₂ =-0.18 1, A ₄ =-0.03 2, POL=-0.39 7.
	972.5 5	12 2	M1+E2	-0.70 23	A ₂ =-0.79 2, A ₄ =+0.06 3, POL=+0.03 12.
	1079.3 7	18 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	E2		A ₂ =+0.36 1, A ₄ =-0.10 1, POL=+0.39 10. δ(M3/E2)=+0.02 3.
1997.5	982.3 5	11 1			A ₂ =-0.40 6, A ₄ =+0.19 7.
	1089.4 5	16 1			A ₂ =+0.34 4, A ₄ =-0.14 4.
	1930.0 7	5 1			
	1997.3 7	68 2	M1+E2	-0.27 6	A ₂ =-0.43 1, A ₄ =+0.02, POL=-0.24 11.
2018.0	1109.8 10	10 [#]			
	1950.6 5	90 [#]	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	1106.5@ 2	100	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	2124.0 7	100			A ₂ =0.00 2, A ₄ =+0.03 2, POL=0.0 1.
2128.6	1114.0@ 2	100	E2		A ₂ =+0.32 1, A ₄ =-0.11 1, POL=+0.44 4. δ(M3/E2)=-0.02 2.
2409.5	955.0 5	17 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	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	M1+E2		δ: -2.1≤δ≤-0.3.
	2342.0 7	62 3	E2		A ₂ =-1.0 3, A ₄ =+0.1 2, POL=0.0 2. A ₂ =+0.33 2, A ₄ =-0.10 2, POL=+0.90 21. δ(E2/M3)=+0.02 4.
3259.1	1271.6 5		M1+E2		δ: -2.7≤δ≤-0.27. A ₂ =-0.61 4, A ₄ =+0.03 5, POL=0.0 3.
	1451.5 7				
3298.7	1177.3 5	100	M1+E2	+0.63 8	A ₂ =+0.44 1, A ₄ =+0.07 1, POL=-0.66 7.
3426.2	1297.5 5	10 1	M1+E2	-2.6 4	A ₂ =-0.72 5, A ₄ =+0.45 7, POL=+0.08 25.
	1438.43@ 14	69 3	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	E2		A ₂ =+0.29 2, A ₄ =-0.11 3, POL=+0.66 27. δ(M3/E2)=-0.04 3.
3435.5	1314.0@ 2	100	E2		A ₂ =+0.28 1, A ₄ =-0.11 1, POL=+0.58 8. δ(M3/E2)=-0.05 4.
3644.4	1523.0 7	100			
3665.4	1544.0 7	100			
4019.2	584.0@ 2	28 3	M1+E2	+0.63 10	A ₂ =+0.56 3, A ₄ =+0.10 4, POL=-0.50 23.
	593.00@ 13	72 3	E1		A ₂ =-0.33 1, A ₄ =+0.02 2, POL=+0.56 11. δ(M2/E1)=-0.04 3.
4818.6	799.4 5	100			A ₂ =-0.52 8, A ₄ =+0.03 10.
5316.2	1297 1	100			

[†] Level energies and relative branching from each level from 1977Wa03 and 1977Wa07.

[‡] From γ(0) 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.

$^{59}\text{Co}(^3\text{He},\text{p})$ 1968Co01

1968Co01: E=11.65 MeV. Measured $\sigma(\text{E}(\text{p}),\theta)$, 16 angles from 7.5° to 120° , magnetic spectrograph, FWHM=60 keV.
 $J\pi(^{59}\text{Co g.s.})=7/2^-$.

 ^{61}Ni Levels

E(level) [†]	L	dσ/dΩ (μb/sr) [‡]	E(level) [†]	L	dσ/dΩ (μb/sr) [‡]	E(level) [†]	L	dσ/dΩ (μb/sr) [‡]
0.0		9.6	2020 20	0	2.8	3690 20		5.3
65 20	0	10.6	2030 20		1.7	3740 20		19.8
290 20		4.5	2130 20		1.6	3807 20		6.3
660 20		2.6	2420 20		<0.9	3950 20	#	8.0
920 20	0	9.4	2480 20		1.4	4010 20		11.3
1020 20		3.1	2540 20		<0.7	4090 20		11.8
1100 20		1.7	2640 20		1.5	4180 20	#	30.8
1140 20		1.0	2920 20		5.2	4400 20		13.8
1190 20		1.7	3060 20		1.6	4470 20	#	53.4
1470 20		1.7	3290 20	#	19.1 [§]	4660 20		12.1
1610 20	0	4.7	3380 20	#	19.1 [§]	4760 20		21.4
1740 20		2.0	3480 20		21.8	4840 20		15.3
1810 20		<0.5	3540 20	#	31.1	4940 20	#	46.1
2000 20		1.5	3630 20		13.5	5540 20	#	(45.1)

[†] Above 2920 excitation energy, level energies given here corresponds to multiplets. According to 1968Co01, one-to-one matching of level energies in their study and those from previous studies is difficult to make.

[‡] Values are at 7° .

[§] Combined value for 3290+3380 levels.

L=0 component present in the observed group.

 $^{59}\text{Ni}(\text{t},\text{p})$ 1978Na14

1978Na14: E=17 MeV. Measured $\sigma(\text{E}(\text{p}),\theta)$, 12 angles from 10° to 65° , magnetic spectrometer, FWHM=10–15 keV, enriched target.
 $J\pi(^{59}\text{Ni})=3/2^-$.

 ^{61}Ni Levels

Cross sections listed in comments correspond to maximum values in the $\sigma(\theta)$ distribution.

E(level)	L [†]	Comments
0.0	0+2	dσ/dΩ=373 μb/sr.
70 10	2+4	dσ/dΩ=71 μb/sr.
280 10	2	dσ/dΩ=92 μb/sr.
660 10	2	dσ/dΩ=42 μb/sr.
910 10	4	dσ/dΩ=0.087 μb/sr.
1020 10	2	dσ/dΩ=54 μb/sr.
1100 10	0+2	dσ/dΩ=52 μb/sr.
1130 10	2	dσ/dΩ=57 μb/sr.
1190 10	2	dσ/dΩ=22.8 μb/sr.
1460 10	2+4	dσ/dΩ=7.5 μb/sr.
1610 10	2+4	dσ/dΩ=9.6 μb/sr.
1730 10	0+2	dσ/dΩ=1.02 μb/sr.
1810 10	4	dσ/dΩ=0.039 μb/sr.
1990 10	4	dσ/dΩ=2.4 μb/sr.
2000 10	2	dσ/dΩ=8.0 μb/sr.
2020 10	2	dσ/dΩ=14.3 μb/sr.
2110 10	3+5	dσ/dΩ=82 μb/sr.
2410 10	(0+2)	dσ/dΩ=5.7 μb/sr.
2470 10	2	dσ/dΩ=15.4 μb/sr.
2530 10	2+4	dσ/dΩ=8.0 μb/sr.
2590 10	4	dσ/dΩ=4.0 μb/sr.
2640 10	2	dσ/dΩ=5.9 μb/sr.
2700 10	1+3	dσ/dΩ=10.2 μb/sr.
2760 10	0+2	dσ/dΩ=20.5 μb/sr.
2790 10	2	dσ/dΩ=5.1 μb/sr.

Continued on next page (footnotes at end of table)

$^{59}\text{Ni}(t,p)$ 1978Na14 (continued) **^{61}Ni Levels (continued)**

E(level)	$L^\dagger$	Comments
2860 10	2+4	$d\sigma/d\Omega=20.5 \mu\text{b/sr.}$
2900 10	2+4	$d\sigma/d\Omega=1.8 \mu\text{b/sr.}$

† From DWBA analysis of $\sigma(\theta)$.

 $^{60}\text{Ni}(n,\gamma),(\text{pol } n,\gamma)$ E=thermal 2004Ra23,1993Ha05,1972Ko15

2004Ra23: E=THERMAL. Measured E_γ , I_γ , $\gamma\gamma$ with a coaxial intrinsic Ge detector positioned inside a NaI(Tl) annulus.

This Ge detector was operated either in the Compton-suppressed mode or in the pair-spectrometer mode.

1993Ha05,1993HaZV: measured E_γ , I_γ , Compton suppression and pair spectrometer, enriched target.

1972Ko15: measured E_γ , I_γ , CP(γ), semi, enriched target.

2007ChZX: PGNAA project, 36 secondary and 15 primary γ rays were reported in the measurements at Budapest .

1992Ku17: reanalysis of the data from 1991U101 with molecular dynamics simulations and an improved interatomic potential.

1991U101: measured lifetime by the γ -ray induced Doppler (GRID) method in thermal neutron capture.

Others: 1997Ve03, 1977Is01, 1970GaZQ, 1975Wi06, 1967Ba79, 1964Co13, 1964Za02.

All data are from 2004Ra23, unless otherwise indicated.

 ^{61}Ni Levels

E(level) †	$J\pi$	$T_{1/2}^\ddagger$	E(level) †	$J\pi$
0.0	3/2-		3415.14 4	1/2-, 3/2-
67.41 § 3	5/2-		3525.60 § 8	
282.973 21	1/2-a		3668.99 § 4	1/2-, 3/2-
656.039 § 22	1/2-		3711.49 6	1/2-, 3/2-
908.59 § 3	5/2-		3738.34 $^\#$ 18	(1/2+)
1015.32 § 9	7/2-		3776.80 9	(1/2-, 3/2-)
1099.684 § 22	3/2-a	0.18 ps 8	3869.99 7	
1132.41 3	5/2-		4178.90 14	
1185.301 § 22	3/2-a		4204.3 4	
1454.84 § 11	7/2-		4239.76 § 5	
1609.80 § 5	5/2-		4439.88 § 13	
1729.63 § 3	3/2-		4514.69 13	
1998.12 7	5/2-		4713.08? $^\@$ 8	
2123.949 § 19	1/2-a	51 fs 10	4793.12 16	
2639.51 5	1/2-, 3/2-		5036.24 $^\#$ 9	
2707.63 § 9	3/2-		5116.61 $^\#$ 17	1/2-, 3/2-
2765.03 § 7	3/2-		5390.85 14	
2862.94 9	1/2-, 3/2-		5955.52 § 17	
3062.16 5	1/2+		6575.70 18	
3144.98 § 3			6615.8 3	
3231.67 4	1/2-, 3/2-		(7820.113 $^\S\&$ 21)	1/2+

† From least-squares fit to E_γ data.

‡ From 1991U101 using the grid method.

§ Intensity imbalance [$I_\gamma(\text{in})-I_\gamma(\text{out})$] at this level is negative.

$^\#$ Intensity imbalance [$I_\gamma(\text{in})-I_\gamma(\text{out})$] at this level is positive.

$^\@$ E(level): from 1993Ha05, only 4714.2 7 γ observed in 2004Ra23 is unplaced.

$^\&$ E(level): 7020.113 in Table XVI of 2004Ra23 is a misprint. S(n)=7820.11 5 (2012Wa38).

a From 1972Ko15 measured circular polarization of γ -rays in $^{60}\text{Ni}(\text{pol } n,\gamma)$ reaction.

$^{60}\text{Ni}(\text{n},\gamma),(\text{pol n},\gamma)$ E=thermal 2004Ra23,1993Ha05,1972Ko15 (continued) $\gamma(^{61}\text{Ni})$

$I\gamma$ normalization: $\sigma=2.34$ b 5 (2004Ra23). The intensities listed by 2004Ra23 are in units of millibarns. To obtain intensities per 100 neutron captures, multiply by 0.0427.

$E\gamma$	E(level)	$I\gamma^{\dagger}g$	$E\gamma$	E(level)	$I\gamma^{\dagger}g$
67.42 20	67.41	32.9 6	1377.3 $\frac{1}{2}$ 4	4439.88	0.23 5
$\times$ 159.46 20		0.18 3	1387.6 4	1454.84	0.21 5
191.16 8	1099.684	0.64 5	1415.43 10	3144.98	0.90 7
215.51 9	282.973	0.38 3	$\times$ 1434.20 23		0.41 5
277.0 5	1185.301	0.37 6	1446.71 6	1729.63	2.08 7
282.99 5	282.973	812 27	1454.80 12	1454.84	0.87 6
$\times$ 355.85 14		0.29 3	$\times$ 1488.0 3		0.34 6
373.07 5	656.039	4.27 5	1502.01 10	3231.67	0.77 6
394.33 5	2123.949	1.77 6	1536 1	3144.98	0.61 8
477.6 5	1609.80	0.34 7	1542.42 7	1609.80	2.50 9
514.33 14	2123.949	0.69 8	1580.03 20	2765.03	0.46 6
529.27 3	1185.301	5.37 6	1587.77 23	3711.49	0.48 6
546.3 3	1454.84	0.14 4	$\times$ 1601.9 4		0.23 8
588.59 5	656.039	2.33 5	1610 1	1609.80	2.04 9
625.60 17	908.59	0.30 5	1621.86 8	3231.67	2.02 9
629.86 25	1729.63	0.20 4	1633.08 20	2765.03	0.70 9
650.1 4	3415.14	0.20 6	$\times$ 1645.0 3		0.35 6
$\times$ 651.14 25		0.50 11	1662 1	1729.63	2.13 7
656.02 4	656.039	20.39 22	1665 1	2765.03	0.92 6
701.22 11	1609.80	0.61 5	1685.54 10	3415.14	1.13 7
$\times$ 780.4 3		0.21 4	$\times$ 1716.46 25		0.63 8
806.0 3	3668.99	0.19 6	1721.5 5	5390.85	0.26 7
816.70 4	1099.684	38.7 4	1729.74 8	1729.63	2.03 9
820.90 10	1729.63	0.87 6	1750.9 6	5955.52	0.21 6
841.2 1	908.59	1.46 7	$\times$ 1760.2 4		0.35 6
848.54 13	3711.49	0.58 5	1778.83 12	3776.80	1.09 7
$\times$ 888.0 3		0.23 5	1795.61 24	3525.60	0.50 7
$\times$ 900.2 3		0.26 5	$\times$ 1819.7 6		0.25 7
902.27 7	1185.301	1.27 5	1840.94 5	2123.949	4.78 12
908.59 4	908.59	7.66 9	$\times$ 1843.87 17		1.15 9
938.62 4	2123.949	16.28 17	1864.55 18	(7820.113)	0.80 8
947.90 9	1015.32	0.82 6	1877.1 4	3062.16	0.39 8
$\times$ 977.12 18		0.30 5	1931.2 7	1998.12	0.23 6
$\times$ 980.81 25		0.24 5	$\times$ 1943.0 5		0.23 7
982.6 4	1998.12	0.14 5	1959.71 7	3144.98	1.77 8
$\times$ 998.0 4		0.14 5	1998.10 11	1998.12	1.44 10
1015.28 24	1015.32	0.29 6	2012.47 22	3144.98	0.81 12
1021.06 8	3144.98	0.95 6	2045.32 5	3144.98	4.76 13
1024.27 7	2123.949	1.22 6	2085.7 $\frac{1}{2}$ 3	4793.12	0.62 9
1032.25 4	1099.684	6.06 9	$\times$ 2088.26 25		0.79 10
$\times$ 1039.8 3		0.26 5	$\times$ 2093.10 21		0.81 9
1065.01 5	1132.41	3.29 6	2099.27 7	3231.67	3.34 10
1073.52 6	1729.63	1.85 6	2108.99 18	2765.03	1.12 10
1089.65 22	1998.12	0.37 6	$\times$ 2111.6 4		0.47 10
1099.67 4	1099.684	27.6 3	2115.2 3	4239.76	0.49 11
1107.71 9	3231.67	0.68 6	2123.90 3	2123.949	145.6 15
1116.46 25	4178.90	0.42 6	$\times$ 2126.9 3		1.19 16
1118 1	1185.301	0.69 8	2207.0 3	2862.94	0.86 14
1132.40 4	1132.41	5.89 9	2229.84 20	3415.14	0.96 22
1146.69 16	3144.98	0.69 7	2282.66 14	3415.14	0.70 6
1154.9 3	2765.03	0.41 6	$\times$ 2301.3 4		0.28 6
1185.29 4	1185.301	52.6 6	$\times$ 2306.3 5		0.24 6
$\times$ 1188.18 12		0.47 7	2315.35 16	3415.14	0.82 7
$\times$ 1195.3 4		0.24 6	2340.56 22	3525.60	0.46 6
1204.2 3	(7820.113)	0.28 5	$\times$ 2347.5 4		0.28 6
1215.35 5	2123.949	2.00 6	2351.3 4	5116.61	0.30 6
1233.4 3	3231.67	0.42 7	2356.6 3	2639.51	0.37 6
1244.39 18	(7820.113)	0.67 7	$\times$ 2387.21 14		0.94 7
1253.23 20	2862.94	0.57 7	2406.05 6	3062.16	3.24 9
$\times$ 1315.2 4		0.20 5	2429.15 14	(7820.113)	1.11 8
1342.3 4	1998.12	0.26 6	$\times$ 2432.2 4		0.39 7

Continued on next page (footnotes at end of table)

⁶⁰Ni(n,γ),(pol n,γ) E=thermal 2004Ra23,1993Ha05,1972Ko15 (continued)

γ(⁶¹Ni) (continued)

Eγ	E(level)	Iγ [†] g	Eγ	E(level)	Iγ [†] g
^x 2436.14 13		1.34 8	3382.3 7	4514.69	0.80 21
^x 2455.5 6		0.21 6	3385.92 5	3668.99	9.23 13
^x 2460.7 4		0.46 7	^x 3391.6 3		0.70 9
^x 2463.1 7		0.25 7	^x 3398.6 3		1.16 15
2482.07 18	2765.03	1.10 15	3415.04 ^g 6	3415.14	5.05 11
2483.6 7	3668.99	0.32 14	3525.1 9	3525.60	0.20 7
2488.84 12	3144.98	1.16 7	3531.51 20	4439.88	2.00 18
2510.0 [#] 3	4239.76	0.53 7	3580.18 7	(7820.113)	9.8 3
2575.63 14	3231.67	0.89 7	3583.47 14	4239.76	3.10 19
2579.84 15	2862.94	0.91 7	3601.8 4	3668.99	0.64 12
2611.73 16	3711.49	1.01 8	3615.9 4	(7820.113)	0.56 11
^x 2620.7 5		0.35 8	3640.99 18	(7820.113)	1.95 16
^x 2634.0 4		0.38 7	3644.0 4	3711.49	0.90 15
2639.44 6	2639.51	3.90 9	^x 3687.24 21		3.00 25
2644.23 22	3776.80	0.61 7	3709.3 5	3776.80	1.2 3
2676.5 5	3776.80	0.30 8	3711.42 11	3711.49	6.8 3
2684.58 25	3869.99	0.51 8	3850.7 ^a 6	5036.24	0.53 14
^x 2698.22 22		0.94 9	3869.83 12	3869.99	3.81 22
2703.38 19	(7820.113)	1.25 9	3949.97 9	(7820.113)	5.61 23
2707.58 9	2707.63	2.60 11	^x 3974.37 22		1.39 13
2759.38 19	3415.14	1.37 8	4043.33 14	(7820.113)	2.66 18
2764.69 16	2765.03	1.60 9	4081.6 3	(7820.113)	1.64 15
^x 2771.4 7		0.25 8	4108.52 8	(7820.113)	10.5 3
2778.9 4	3062.16	0.44 8	4111.5 4	4178.90	1.05 19
2783.80 9	(7820.113)	2.41 10	4150.92 6	(7820.113)	11.8 4
2795.3 [@] 4	2862.94	0.47 8	4171.7 6	4239.76	0.45 12
2802.7 4	3711.49	0.40 8	4225.9 8	5955.52	0.59 18
^x 2816.95 14		1.45 8	^x 4228.6 7		0.75 18
^x 2823.07 16		1.18 9	4239.66 9	4239.76	5.43 24
^x 2856.48 13		1.33 7	^x 4284.0 6		0.25 9
2861.95 4	3144.98	6.59 11	4294.44 15	(7820.113)	1.99 13
^x 2903.0 7		0.27 11	4404.82 5	(7820.113)	16.2 4
^x 2914.5 7		0.25 8	4439.2 4	4439.88	0.83 12
^x 2933.80 12		2.96 12	4514.6 4	4514.69	0.83 12
^x 2947.5 7		0.25 7	4588.26 6	(7820.113)	11.7 3
^x 2977.79 25		0.69 7	4675.05 5	(7820.113)	20.3 3
^x 3000.2 5		0.36 8	^x 4714.2 7		0.49 13
3012.66 11	3668.99	2.89 10	4753.0 6	5036.24	0.72 15
3027.02 18	(7820.113)	1.06 8	4757.86 10	(7820.113)	4.98 25
3054.36 18	4239.76	0.92 7	4793.2 7	4793.12	0.51 13
3062.16 10	3062.16	1.75 8	^x 4818.8 4		0.89 14
3077.5 3	3144.98	0.60 7	4833.2 9	5116.61	0.34 13
3082.21 21	3738.34	0.78 8	4957.1 4	(7820.113)	2.2 3
3104.6 8	4204.3	0.47 15	5055.02 12	(7820.113)	4.22 20
3106.8 4	4239.76	1.30 16	5112.1 5	(7820.113)	0.84 13
^x 3129.1 6		0.43 10	5180.36 9	(7820.113)	3.93 14
3132.05 8	3415.14	5.10 13	5322.2 7	5390.85	0.73 12
3144.7 7	3144.98	4.09 13	5515.4 7	6615.8	0.45 12
3164.49 24	3231.67	0.84 10	5695.86 ^b 4	(7820.113)	157 3
^x 3180.8 4		0.50 11	5955.3 8	5955.52	0.41 12
3213.9 3	3869.99	0.64 9	6090.5 5	(7820.113)	0.72 12
3231.47 9	3231.67	2.38 9	^x 6105.8 4		0.33 13
3242.59 11	3525.60	1.87 9	6292.3 7	6575.70	0.53 13
3254.8 6	4439.88	0.28 8	6634.40 ^c 5	(7820.113)	29.5 4
3305.30 14	(7820.113)	1.62 9	6719.97 ^d 5	(7820.113)	55.8 7
3328.6 6	4514.69	0.35 8	7163.9 5	(7820.113)	1.3 3
3347.7 4	3415.14	0.64 9	7536.62 ^e 6	(7820.113)	705 9
^x 3359.5 3		0.38 9	7819.56 ^f 6	(7820.113)	1236 15
^x 3369.1 4		0.53 8			
3380.29 21	(7820.113)	2.38 23			

[†] Absolute cross sections (2004Ra23) are in millibarns.

[‡] Alternative placement:4240 -->2863.

$^{60}\text{Ni}(\text{n},\gamma),(\text{pol n},\gamma)$ E=thermal 2004Ra23,1993Ha05,1972Ko15 (continued) $\gamma(^{61}\text{Ni})$ (continued)

- § Alternative placement:5956 -->3870.
 # Alternative placement:3526 -->1015.
 @ Alternative placement:4793 -->1998.
 & Alternative placement:4515 -->1100.
 a Alternative placement:6616 -->2765.
 b Circular polarization coefficient $R=+0.92$ 8 (1972Ko15).
 c Circular polarization coefficient $R=-1.0$ 4 (1972Ko15).
 d Circular polarization coefficient $R=-0.6$ 2 (1972Ko15).
 e Circular polarization coefficient $R=+1.05$ 3 (1972Ko15).
 f Circular polarization coefficient $R=-0.48$ 2 (1972Ko15).
 g For intensity per 100 neutron captures, multiply by 0.0427.
 x γ ray not placed in level scheme.

 $^{60}\text{Ni}(\text{n},\gamma)$ E=0.01-90 keV 1974Br39,1978Be04

1978Be04: E=7-70 keV, time of flight. Measured $E\gamma$, $I\gamma$, semi, natural target, 47.6 keV resonance.
 1974Br39: E=thermal-17 keV, time of flight. Measured $\sigma(E(\text{n}),E\gamma)$, semi, enriched target, 2.2 and 12 keV resonance.
 Others: 1968Al18 (E=10-90 keV), 1973Bi11 (E=5-60 keV).
 For giant resonance, see 1984So16.

 ^{61}Ni Levels

E(level) [†]	$J\pi^{\ddagger}$	Comments
0.0	3/2-	
67.0 14	5/2-	
283.0 10	1/2-	
7822.5 9	3/2-	E(level): p-wave res. 2.249 keV (2006MuZX).
7832.5 9	1/2+	E(level): s-wave resonance of E(n)=12.423 keV from (2006MuZX).
7868.5 10	1/2-	E(level): p-wave res. 47.6 keV from (1978Be04).

[†] From Adopted Levels for bound levels, deduced by E(n)+ S(n) for resonances.

[‡] From Adopted Levels.

 $\gamma(^{61}\text{Ni})$

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\ddagger}$	Comments
7822.5	7539	289	
	7755	814	
	7822	100	
7832.5	7549		Partial radiation $\Gamma_{\gamma}=0.29$ eV 5 (1978Be04).
	7832		Partial radiation $\Gamma_{\gamma}=10.51$ eV 8 (1978Be04).
7868.5	7868		Partial radiation $\Gamma_{\gamma}=0.28$ eV 7 (1978Be04).

[†] From level-energy differences.

[‡] Relative intensities normalized to 100 for the g.s. transition (1974Br39).

60Ni(n,γ),(n,n): Resonances 2006MuZX

Neutron resonance energies and parameters are from evaluation of 2006MuZX.

2010Gu19: E(n)=0.100–600 keV; measured E(n), I(n), σ, R-matrix analysis.

61Ni Levels

E(level) [†]	Jπ [‡]	L	$g\Gamma_n\Gamma_\gamma/\Gamma$ (eV) [§]	Comments
7816.01? 5	1/2+	0		E(level): fictitious level from negative value of resonance energy. E(n)(Lab)=-4.177, Γ_γ =(1.37) eV.
7821.42 5		[1]	0.00025 3	E(n)(Lab)=1.3263 10, $g\Gamma_n$ =0.00025 eV 3.
7822.33 5	3/2-	1		E(n)(Lab)=2.2487 10, $g\Gamma_n$ =0.0593 eV 6, Γ_γ =0.553. 50 eV.
7825.56 5	3/2-	1	0.038 3	E(n)(Lab)=5.5341 10, $g\Gamma_n$ =0.041 eV 3.
7832.12 5	1/2-	1	0.16 1	E(n)(Lab)=12.206 1.
7832.34 5	1/2+	0	2.29 17	E(n)(Lab)=12.423 1, $g\Gamma_n$ =2.35 keV 6, Γ_γ =2.29 eV 17.
7833.50 5	1/2-	1	0.280 2	E(n)(Lab)=13.606 1, $g\Gamma_n$ =1.1 eV 3.
7841.05 5	1/2-	1	0.019 2	E(n)(Lab)=21.286 2.
7843.53 5	[1/2]-	1	0.23 2	E(n)(Lab)=23.802 1, $g\Gamma_n$ =4.7 eV 2, Γ_γ =0.24 eV 2.
7843.64 5	[3/2+]	[2]	0.50 1	E(n)(Lab)=23.912 1, $g\Gamma_n$ =0.12 eV 4, Γ_γ =0.44 eV 2.
7848.11 5	1/2-	1	0.04 3	E(n)(Lab)=28.465 2.
7848.16 5	1/2-	1	0.097 6	E(n)(Lab)=28.515 2.
7848.32 5	1/2+	0	0.41 3	E(n)(Lab)=28.675 1, $g\Gamma_n$ =685 eV 15, Γ_γ =0.41 eV 3.
7849.13 5	1/2-	1	0.041 3	E(n)(Lab)=29.498 2.
7849.90 5	[3/2]-	1	0.38 1	E(n)(Lab)=30.279 1, $g\Gamma_n$ =0.8 eV 2, Γ_γ =0.36 eV 2.
7852.61 5	[1/2]-	1	0.49 2	E(n)(Lab)=33.039 2, $g\Gamma_n$ =8.0 eV 3, Γ_γ =0.52 eV 2.
7852.98 5	[1/2]-	1	0.29 2	E(n)(Lab)=33.414 2, $g\Gamma_n$ =9.8 eV 3, Γ_γ =0.30 eV 2.
7859.03 5	[3/2]-	1	0.52 2	E(n)(Lab)=39.560 1, $g\Gamma_n$ =2.3 eV 1, Γ_γ =0.34 eV 2.
7862.15 5	[1/2]-	1	0.31 1	E(n)(Lab)=42.735 1, $g\Gamma_n$ =1.4 eV 2, Γ_γ =0.40 eV 2.
7862.42 5	1/2-	1	0.39 2	E(n)(Lab)=43.007 2, $g\Gamma_n$ =2 eV.
7862.54 5	1/2+	0	0.18 2	E(n)(Lab)=43.133 1, $g\Gamma_n$ =101 eV 3, Γ_γ =0.18 eV 2.
7866.90 5	1/2-	1	0.08 1	E(n)(Lab)=47.567 5, $g\Gamma_n$ =0.1 eV.
7866.96 5	[3/2]-	1	0.92 2	E(n)(Lab)=47.630 3, $g\Gamma_n$ =1.7 eV 2, Γ_γ =1.00 eV 3.
7866.99 5	1/2-	1	0.92 2	E(n)(Lab)=47.658 5, $g\Gamma_n$ =0.6 eV 1, Γ_γ =0.6 eV.
7869.13 5	1/2-	1	0.32 2	E(n)(Lab)=49.835 1.
7870.24 5	1/2-	1	0.14 1	E(n)(Lab)=50.963 2.
7870.89 5	[3/2+]	[2]	0.48 1	E(n)(Lab)=51.628 1, $g\Gamma_n$ =0.85 eV 5, Γ_γ =0.55 eV 2.
7871.94 5	1/2-	1	0.10 1	E(n)(Lab)=52.696 3.
7875.52 5		[2]	0.29 1	E(n)(Lab)=56.331 1, $g\Gamma_n$ =0.60 eV 5, Γ_γ =0.56 eV 3.
7876.10 5	1/2-	1	0.45 1	E(n)(Lab)=56.919 1, $g\Gamma_n$ <0.62 eV.
7883.97 5	1/2-	1	0.05 2	E(n)(Lab)=64.92 1.
7884.13 5	1/2-	1	0.18 1	E(n)(Lab)=65.091 6, $g\Gamma_n$ =0.4 eV.
7884.28 5	1/2+	0	1.10 6	E(n)(Lab)=65.238 1, $g\Gamma_n$ =434 eV 8, Γ_γ =1.10 eV 6.
7884.66 5	[3/2]-	1	0.99 3	E(n)(Lab)=65.623 2, $g\Gamma_n$ <2.4 eV, Γ_γ =0.84 eV 4.
7890.36 5	[3/2+]	[2]	0.39 1	E(n)(Lab)=71.424 2, $g\Gamma_n$ <0.75 eV.
7892.17 5	[3/2]-	1	0.57 2	E(n)(Lab)=73.262 1, $g\Gamma_n$ =2.0 eV 1, Γ_γ =0.4 eV 2.
7897.11 5	1/2-	1		E(n)(Lab)=78.286 2, $g\Gamma_n$ <0.8 eV.
7898.91 5	[3/2]-	1	0.44 1	E(n)(Lab)=80.117 2, $g\Gamma_n$ <0.9 eV, Γ_γ =0.43 eV 3.
7900.80 5	[1/2]-	1	0.23 1	E(n)(Lab)=82.042 3, $g\Gamma_n$ =0.45 eV, Γ_γ =0.47 eV 4.
7903.77 5	[3/2]-	1	0.42 1	E(n)(Lab)=85.055 1, $g\Gamma_n$ <1 eV.
7904.93 5	[3/2]-	1	1.2 3	E(n)(Lab)=86.242 2, $g\Gamma_n$ =3.0 eV 2, Γ_γ =1.00 eV 4.
7905.58 5	1/2+	0	0.31 4	E(n)(Lab)=86.903 1, $g\Gamma_n$ =387 eV 11, Γ_γ =0.31 eV 4.
7906.62 5	[3/2]-	1	0.7 5	E(n)(Lab)=87.959 2, $g\Gamma_n$ =11.6 eV 3, Γ_γ =0.39 eV 3.
7908.45 5	1/2-	1	0.22 1	E(n)(Lab)=89.817 5.
7910.32 5	[1/2]-	1	0.35 2	E(n)(Lab)=91.722 5, $g\Gamma_n$ =6.7 eV 3, Γ_γ =0.37 eV 2.
7912.41 5	[3/2]-	1	0.57 2	E(n)(Lab)=93.845 5, $g\Gamma_n$ =3.2 eV 5, Γ_γ =0.35 eV 3.
7914.11 5	1/2-	1	0.16 1	E(n)(Lab)=95.573 5.
7915.64 5	[3/2]-	1	0.53 3	E(n)(Lab)=97.130 5, $g\Gamma_n$ =3.2 eV 2, Γ_γ =0.32 eV 2.
7916.58 5	1/2+	0	0.34 7	E(n)(Lab)=98.083 1, $g\Gamma_n$ =983 eV 19, Γ_γ =0.34 eV 7.
7917.96 5	[3/2]-	1	0.9 4	E(n)(Lab)=99.482 5, $g\Gamma_n$ =8.0 eV 6, Γ_γ =0.49 eV 3.
7920.59 5	1/2-	1	0.19 1	E(n)(Lab)=102.16 1.
7926.26 5	1/2+	0	0.72 6	E(n)(Lab)=107.93 1, $g\Gamma_n$ =634 eV 15, Γ_γ =0.72 eV 6.
7926.86 5	3/2-	1	0.8 3	E(n)(Lab)=108.54 1, $g\Gamma_n$ =3 eV 2, Γ_γ =0.55 eV.
7929.85 5	[3/2+]	[2]	1.42 3	E(n)(Lab)=111.58 1, $g\Gamma_n$ =5 eV 1, Γ_γ =0.99 eV 11.
7930.34 5	[1/2]-	1	0.38 3	E(n)(Lab)=112.08 1, $g\Gamma_n$ =2.5 eV 5, Γ_γ =0.45 eV 4.
7930.61 5	[1/2]-	1	0.47 4	E(n)(Lab)=112.35 1, $g\Gamma_n$ =3.5 eV 5, Γ_γ =0.54 eV 5.
7931.65 5	[3/2]-	1	0.75 5	E(n)(Lab)=113.41 1, $g\Gamma_n$ =3.0 eV 5, Γ_γ =0.50 eV 4.
7932.20 5	1/2-	1	0.028 4	E(n)(Lab)=113.97 2.

Continued on next page (footnotes at end of table)

⁶⁰Ni(n,γ),(n,n): Resonances 2006MuZX (continued)

⁶¹Ni Levels (continued)

E(level) [†]	Jπ [‡]	L	gΓ _n Γ _γ /Γ (eV) [§]	Comments
7938.63 5	1/2-	1	0.12 3	E(n)(Lab)=120.50 1.
7938.76 5	[3/2+]	[2]	0.76 10	E(n)(Lab)=120.64 1, gΓ _n =7.5 eV 3, Γ _γ =0.42 eV 6.
7939.08 5	[3/2]-	1	1.1 4	E(n)(Lab)=120.96 1, gΓ _n =2.6 eV 2, Γ _γ =0.88 eV 6.
7941.81 5	[3/2]-	1	0.68 5	E(n)(Lab)=123.74 0.1, gΓ _n =32.5 eV 10, Γ _γ =0.35 eV 3.
7942.20 5			0.061 15	E(n)(Lab)=124.13 1.
7945.45 5			0.022 5	E(n)(Lab)=127.44 1.
7945.78 5	[1/2]-	1	0.48 4	E(n)(Lab)=127.78 1, gΓ _n =68.4 eV 10, Γ _γ =0.48 eV 4.
7947.86 5	[3/2]-	1	0.78 2	E(n)(Lab)=129.89 1, gΓ _n <2.5 eV, Γ _γ =0.57 eV 10.
7951.55 5	[3/2]-	1	0.49 4	E(n)(Lab)=133.64 1, gΓ _n =22.9 eV 10, Γ _γ =0.50 eV 4.
7953.51 5	1/2-	1	0.13 2	E(n)(Lab)=135.63 2.
7954.00 5	[3/2]-	1	1.02 5	E(n)(Lab)=136.13 1, gΓ _n =17.5 eV 10, Γ _γ =0.54 eV 3.
7954.27 5	[3/2]-	1	1.59 3	E(n)(Lab)=136.41 1, gΓ _n =7.5 eV 6, Γ _γ =1.00 eV 2.
7955.19 5	1/2-, 3/2-	1	0.076 14	E(n)(Lab)=137.34 2.
7955.42 5	[1/2]-	1	0.45 3	E(n)(Lab)=137.58 1, gΓ _n =5.6 eV 3, Γ _γ =0.49 eV 3.
7957.00 5	1/2+	0	0.70 6	E(n)(Lab)=139.18 1, gΓ _n =31.6 eV 17, Γ _γ =0.72 eV 6.
7957.04 5	[3/2]-	1	1.05 5	E(n)(Lab)=139.67 2, gΓ _n =24.2 eV 10, Γ _γ =0.55 eV 3.
7957.83 5	1/2[-]	[1]	0.70 6	E(n)(Lab)=140.03 1, gΓ _n =33.6 eV 10, Γ _γ =0.72 eV 6.
7957.95 5			1.06 5	E(n)(Lab)=140.15 1.
7962.97 5	1/2-	1	0.045 8	E(n)(Lab)=145.25 1, gΓ _n =1 eV.
7963.58 5			0.97 4	E(n)(Lab)=145.87 1.
7965.32 5	1/2-, 3/2-	1	0.045 9	E(n)(Lab)=147.64 2.
7966.58 5	[3/2+]	[2]	0.97 4	E(n)(Lab)=148.92 1, gΓ _n =9.1 eV 6, Γ _γ =0.54 eV 2.
7969.15 5	[1/2]-	1	0.39 3	E(n)(Lab)=151.54 1, gΓ _n =15.6 eV 10, Γ _γ =0.40 eV 3.
7972.04 5	[1/2]-	1	0.50 4	E(n)(Lab)=154.48 1, gΓ _n =163 eV 4, Γ _γ =0.50 eV 4.
7974.04 5	1/2+	0	0.38 3	E(n)(Lab)=156.51 1, gΓ _n =472 eV 10, Γ _γ =0.38 eV 3.
7974.32 5	1/2-, 3/2-	1	0.02 1	E(n)(Lab)=156.80 2.
7977.81 5	[1/2]-	1	0.57 3	E(n)(Lab)=160.34 1, gΓ _n =21.9 eV 10, Γ _γ =0.59 eV 3.
7978.81 5			0.034 8	E(n)(Lab)=161.36 1.
7979.28 5	1/2+	0	0.6 3	E(n)(Lab)=161.84 1, gΓ _n =1.33 keV 3, Γ _γ =0.57 eV 3.
7979.73 5	1/2-	1	1.04 4	E(n)(Lab)=162.30 2.
7983.72 5	[3/2+]	[2]	0.98 5	E(n)(Lab)=166.35 1, gΓ _n <3 eV, Γ _γ =0.73 eV 5.
7984.68 5	[3/2+]	[2]	1.75 6	E(n)(Lab)=167.33 1, gΓ _n =7.4 eV 8, Γ _γ =1.15 eV 6.
7985.10 5	1/2-	1	0.36 2	E(n)(Lab)=167.76 2.
7988.03 5	[3/2+]	[2]	1.32 5	E(n)(Lab)=170.74 1, gΓ _n =4 eV 1, Γ _γ =0.99 eV 19.
7989.53 5	1/2-	1	0.15 3	E(n)(Lab)=172.26 2.
7990.03 5	1/2-	1	0.44 2	E(n)(Lab)=172.77 2.
7991.92 5	[1/2]-	1	0.25 3	E(n)(Lab)=174.69 2, gΓ _n =12.1 eV 5, Γ _γ =0.26 eV 3.
7992.32 5	[3/2]-	1	0.83 7	E(n)(Lab)=175.10 2, gΓ _n =4 eV 1, Γ _γ =0.52 eV 4.
7997.22 5	1/2-	1	0.52 3	E(n)(Lab)=180.08 2.
8000.09 5	3/2-	1	0.92 6	E(n)(Lab)=183.00 2, gΓ _n =77.3 eV 16, Γ _γ =0.47 eV 3.
8000.76 5	[1/2]-	1	0.72 4	E(n)(Lab)=183.68 2, gΓ _n =12.9 eV 5, Γ _γ =0.76 eV 4.
8003.05 5	1/2+	0	0.50 18	E(n)(Lab)=186.01 1, gΓ _n =5.38 keV 14, Γ _γ =0.50 eV 18.
8003.84 5	1/2-, 3/2-	1	0.86 5	E(n)(Lab)=186.81 1, gΓ _n <2 eV.
8008.55 11	1/2-, 3/2-	1	0.032 9	E(n)(Lab)=191.6 1.
8009.71 5	3/2-	1	0.66 4	E(n)(Lab)=192.78 2, gΓ _n =63.3 eV 16, Γ _γ =0.33 eV 2.
8011.24 5	[3/2]-	1	0.97 6	E(n)(Lab)=194.34 1, gΓ _n =18.7 eV 12, Γ _γ =0.51 eV 3.
8011.50 6			0.49 4	E(n)(Lab)=194.60 3.
8012.89 5			0.13 2	E(n)(Lab)=196.01 1.
8013.64 5			1.16 5	E(n)(Lab)=196.78 1, gΓ _n <5 eV.
8015.80 5	1/2+	0	0.69 14	E(n)(Lab)=198.97 1, gΓ _n =3.03 keV 8, Γ _γ =0.83 eV 14.
8017.68 6	1/2+	0	0.43 5	E(n)(Lab)=200.88 3, gΓ _n =23.8 eV 12, Γ _γ =0.44 eV 5.
8018.38 6	5/2+	2	1.47 12	E(n)(Lab)=201.60 3, gΓ _n =156 eV 2, Γ _γ =0.50 eV 4.
8019.48 6	[1/2]-	1	0.35 3	E(n)(Lab)=202.72 3, gΓ _n =3 eV, Γ _γ =0.40 eV 3.
8022.85 6	[1/2]-	1	0.48 5	E(n)(Lab)=206.14 3, gΓ _n =34.2 eV 10, Γ _γ =0.49 eV 5.
8023.42 6	[1/2]-	1	0.48 4	E(n)(Lab)=206.72 3, gΓ _n =142 eV 4, Γ _γ =0.48 eV 4.
8025.46 7	1/2-, 3/2-	1	0.034 9	E(n)(Lab)=208.80 5.
8025.76 7			0.16 2	E(n)(Lab)=209.10 5.
8026.57 7			0.12 2	E(n)(Lab)=209.92 5.
8029.68 7			0.12 2	E(n)(Lab)=213.09 5.
8030.91 6	[3/2]-	1	0.77 6	E(n)(Lab)=214.34 3, gΓ _n =126 eV 6, Γ _γ =0.39 eV 3.
8031.48 5	[3/2]-	1	0.99 6	E(n)(Lab)=214.92 2, gΓ _n =4 eV 1, Γ _γ =0.66 eV 10.
8036.74 6	[1/2]-	1	0.35 4	E(n)(Lab)=220.27 3, gΓ _n =76.3 eV 20, Γ _γ =0.35 eV 4.
8037.29 5	[3/2]-	1	1.37 12	E(n)(Lab)=220.82 2, gΓ _n =32 eV 1, Γ _γ =0.72 eV 6.

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⁶⁰Ni(n,γ),(n,n): Resonances 2006MuZX (continued)

⁶¹Ni Levels (continued)

E(level) [†]	Jπ [‡]	L	gΓ _n Γ _γ /Γ (eV) [§]	Comments
8037.62 5			0.62 6	E(n)(Lab)=221.16 2, gΓ _n =80 eV 4, Γ _γ =0.31 eV 3.
8040.48 7			0.087 19	E(n)(Lab)=224.07 5.
8042.86 5	1/2-	1	0.50 4	E(n)(Lab)=226.49 2, gΓ _n <2 eV.
8045.76 5	[3/2]-	1	2.30 16	E(n)(Lab)=229.44 2, gΓ _n =17.6 eV 16, Γ _γ =1.32 eV 8.
8046.70 5	5/2+	2	2.3 5	E(n)(Lab)=230.39 2, gΓ _n =107.4 eV 20, Γ _γ =0.77 eV 16.
8050.00 6	[3/2]-	1	0.74 6	E(n)(Lab)=233.75 3, gΓ _n =15.0 eV 7, Γ _γ =0.39 eV 3.
8050.36 6	[3/2]-	1	0.79 7	E(n)(Lab)=234.11 3, gΓ _n =9 eV 2, Γ _γ =0.43 eV 4.
8051.52 6	1/2-, 3/2-	1	0.58 3	E(n)(Lab)=235.29 3, gΓ _n <2 eV.
8053.10 5	[3/2]-	1	1.48 11	E(n)(Lab)=236.90 2, gΓ _n =12 eV 2, Γ _γ =0.84 eV 6.
8054.40 6	1/2-	1	1.10 5	E(n)(Lab)=238.22 3, gΓ _n <2 eV.
8054.65 6	[1/2]-	1	0.44 5	E(n)(Lab)=238.48 3, gΓ _n =17 eV 2, Γ _γ =0.45 eV 5.
8060.36 6	[3/2]-	1	0.62 4	E(n)(Lab)=244.28 3, gΓ _n =2.5 eV, Γ _γ =0.41 eV 2.
8062.89 7	1/2, 3/2-	1	0.15 2	E(n)(Lab)=246.86 5.
8065.04 6	3/2-	1	1.89 14	E(n)(Lab)=249.04 3, gΓ _n =84 eV 6, Γ _γ =0.97 eV 7.
8068.05 5	1/2+	0	0.95 9	E(n)(Lab)=252.10 1, gΓ _n =0.57 keV 3, Γ _γ =0.95 eV 9.
8068.57 7	[3/2]-	1	0.71 6	E(n)(Lab)=252.63 5, gΓ _n =5 eV 1, Γ _γ =0.41 eV 3.
8069.25 7	3/2-	1	0.76 8	E(n)(Lab)=253.32 5, gΓ _n =264 eV 3, Γ _γ =0.38 eV 4.
8070.19 7			0.05 1	E(n)(Lab)=254.28 5.
8070.53 7	[1/2]-	1	0.27 4	E(n)(Lab)=254.62 5, gΓ _n =36 eV 4, Γ _γ =0.27 eV 4.
8072.05 5	1/2+	0	1.13 20	E(n)(Lab)=256.17 1, gΓ _n =887 eV 17, Γ _γ =1.13 eV 20.
8072.15 7	[3/2]-	1	1.1 8	E(n)(Lab)=256.27 5, gΓ _n =11 eV 1, Γ _γ =0.61 eV 8.
8073.35 7	[1/2]-	1	0.17 4	E(n)(Lab)=257.49 5, gΓ _n =23 eV 3, Γ _γ =0.17 eV 4.
8073.75 5	1/2+	0	0.59 9	E(n)(Lab)=257.90 1, gΓ _n =1.84 keV 5, Γ _γ =0.59 eV 9.
8074.55 7	[3/2]-	1	0.73 9	E(n)(Lab)=258.71 5, gΓ _n =13 eV 1, Γ _γ =0.39 eV 5.
8075.84 11	1/2-, 3/2-	1	0.14 2	E(n)(Lab)=260.02 10.
8076.86 7	[1/2]-	1	0.55 5	E(n)(Lab)=261.06 5, gΓ _n =51 eV 2, Γ _γ =0.56 eV 5.
8078.38 7	[1/2]-	1	0.33 4	E(n)(Lab)=262.61 5, gΓ _n <6 eV, Γ _γ =0.35 eV 4.
8079.08 7	[3/2]-	1	1.21 11	E(n)(Lab)=263.32 5, gΓ _n =44 eV 4, Γ _γ =0.62 eV 6.
8081.50 7	1/2-, 3/2-	1	0.083 14	E(n)(Lab)=265.78 5.
8081.97 7	1/2-	1	0.64 6	E(n)(Lab)=266.26 5, gΓ _n =58 eV 2, Γ _γ =0.65 eV 6.
8084.43 7	1/2-	1	0.44 4	E(n)(Lab)=268.76 5, gΓ _n =1.5 eV, Γ _γ =0.62 eV 8.
8084.81 7	[3/2]-	1	0.85 7	E(n)(Lab)=269.14 5, gΓ _n =59 eV 6, Γ _γ =0.43 eV 4.
8085.07 7	[3/2]-	1	0.79 9	E(n)(Lab)=269.41 5, gΓ _n =28 eV 3, Γ _γ =0.41 eV 5.
8089.35 7	1/2-	1	0.15 5	E(n)(Lab)=273.76 5.
8089.54 7			0.10 3	E(n)(Lab)=273.95 5.
8092.60 7	1/2-	1	0.64 2	E(n)(Lab)=277.07 5, gΓ _n =1.2 eV.
8092.88 7	[3/2+]	[2]	1.78 15	E(n)(Lab)=277.35 5, gΓ _n =44 eV 4, Γ _γ =0.99 eV 8.
8093.96 7	3/2-	1	0.72 12	E(n)(Lab)=278.45 5, gΓ _n =367 eV 11, Γ _γ =0.36 eV 6.
8094.85 5	1/2+	0	0.39 4	E(n)(Lab)=279.35 1, gΓ _n =250 eV 25, Γ _γ =0.39 eV 4.
8095.86 7	3/2-	1	0.94 10	E(n)(Lab)=280.38 5, gΓ _n =145 eV 8, Γ _γ =0.47 eV 5.
8097.37 7	[1/2]-	1	0.28 4	E(n)(Lab)=281.92 5, gΓ _n =15 eV 5, Γ _γ =0.29 eV 4.
8098.37 7	[3/2]-	1	1.85 19	E(n)(Lab)=282.93 5, gΓ _n =175 eV 12, Γ _γ =0.94 eV 10.
8098.78 7	3/2-	1	1.38 16	E(n)(Lab)=283.35 5, gΓ _n =108 eV 18, Γ _γ =0.70 eV 8.
8101.09 7	1/2-	1	0.30 3	E(n)(Lab)=285.70 5.
8104.04 7	[1/2]-	1	0.5 3	E(n)(Lab)=288.70 5, gΓ _n =1.7 eV, Γ _γ =0.79 eV 47.
8106.25 7	[1/2]-	1	1.02 5	E(n)(Lab)=290.95 5, gΓ _n =37 eV 3, Γ _γ =0.50 eV 3.
8107.49 5	1/2+	0	0.47 4	E(n)(Lab)=292.21 1, gΓ _n =144 eV 4, Γ _γ =0.47 eV 4.
8108.23 7	3/2-	1	1.20 6	E(n)(Lab)=292.96 5, gΓ _n =148 eV 3, Γ _γ =0.61 eV 3.
8109.16 9			0.20 3	E(n)(Lab)=293.90 7.
8109.62 9	[1/2]-	1	0.62 7	E(n)(Lab)=294.37 7, gΓ _n =15 eV 2, Γ _γ =0.65 eV 8.
8109.99 9	[1/2]-	1	0.20 7	E(n)(Lab)=294.75 7, gΓ _n =9 eV 1, Γ _γ =0.21 eV 7.
8111.22 9	1/2-	1	0.64 4	E(n)(Lab)=296.00 7, gΓ _n =144 eV 4, Γ _γ =0.64 eV 4.
8112.79 11	1/2-	1	0.31 3	E(n)(Lab)=297.6 1, gΓ _n =138 eV 4, Γ _γ =0.31 eV 3.
8114.84 9	1/2-	1	0.21 2	E(n)(Lab)=299.68 7, gΓ _n =2 eV.
8115.73 9	3/2+	2	1.33 7	E(n)(Lab)=300.59 7, gΓ _n =60 eV 3, Γ _γ =0.65 eV 4.
8117.51 7	3/2+	2	1.59 7	E(n)(Lab)=302.40 5, gΓ _n =17.4 eV 20, Γ _γ =0.88 eV 4.
8121.66 11	[3/2]-	1	1.03 8	E(n)(Lab)=306.62 10, gΓ _n =429 eV 13, Γ _γ =0.52 eV 4.
8122.65 7	3/2-	1	2.24 10	E(n)(Lab)=307.62 5, gΓ _n =200 eV 10, Γ _γ =1.13 eV 5.
8123.22 7			0.48 5	E(n)(Lab)=308.20 5.
8123.97 11	[3/2]-	1	0.74 4	E(n)(Lab)=308.96 10, gΓ _n =3 eV, Γ _γ =0.49 eV 2.
8125.73 7			0.16 3	E(n)(Lab)=310.75 5.
8126.54 11	[1/2]-	1	0.46 4	E(n)(Lab)=311.58 10, gΓ _n =12.7 eV 20, Γ _γ =0.48 eV 4.
8127.74 7			0.27 3	E(n)(Lab)=312.80 5.

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60Ni(n,γ),(n,n): Resonances 2006MuZX (continued)**61Ni Levels (continued)**

E(level) [†]	Jπ [‡]	L	gΓ _n Γ _γ /Γ (eV) [§]	Comments
8128.68 11	[3/2+]	[2]	1.54 6	E(n)(Lab)=313.75 10, gΓ _n =10 eV 2, Γ _γ =0.91 eV 3.
8132.07 5	1/2+	0	1.2 4	E(n)(Lab)=317.20 1, gΓ _n =2.87 keV 8, Γ _γ =1.2 eV 4.
8132.09 11	[5/2+]	[2]	2.16 9	E(n)(Lab)=317.22 10, gΓ _n <12 eV, Γ _γ =0.89 eV 3.
8133.28 7			0.29 3	E(n)(Lab)=318.43 5.
8136.57 11	3/2-	1	0.99 7	E(n)(Lab)=321.78 10, gΓ _n =20 eV 5, Γ _γ =0.52 eV 4.
8137.64 11	[1/2]-	1	0.52 7	E(n)(Lab)=322.86 10, gΓ _n =5.2 eV 5, Γ _γ =0.58 eV 8.
8139.39 11	1/2-	1	0.14 4	E(n)(Lab)=324.64 10.
8140.04 5	1/2+	0	2.9 6	E(n)(Lab)=325.30 1, gΓ _n =7.27 keV 19, Γ _γ =2.9 eV 6.
8141.12 11	1/2-	1	0.57 6	E(n)(Lab)=326.4 1, gΓ _n =3 eV.
8142.31 11	3/2+	2	2.71 10	E(n)(Lab)=327.61 10, gΓ _n =16 eV 2, Γ _γ =1.63 eV 5.
8144.0 5	[1/2]-	1	0.66 8	E(n)(Lab)=329.31 50, gΓ _n =40 eV 4, Γ _γ =0.67 eV 8.
8144.47 11	1/2-	1	0.69 7	E(n)(Lab)=329.81 10, gΓ _n =2.2 eV.
8145.92 11	1/2-	1	0.57 4	E(n)(Lab)=331.28 10, gΓ _n =1.3 eV.
8148.99 11	3/2-	1	1.15 8	E(n)(Lab)=334.41 10, gΓ _n =230 eV, Γ _γ =0.58 eV 8.
8150.46 7	(1/2)-	1	0.08 8	E(n)(Lab)=335.90 5, gΓ _n =27 eV 3, Γ _γ =0.80 eV 8.
8150.92 11	3/2+	2	1.09 16	E(n)(Lab)=336.37 10, gΓ _n =162 eV 3, Γ _γ =1.12 eV 5.
8153.12 5	1/2+	0	1.8 4	E(n)(Lab)=338.60 1, gΓ _n =3.56 keV 9, Γ _γ =2.5 eV 6.
8153.74 11	1/2-	1	0.41 2	E(n)(Lab)=339.23 10, gΓ _n =2.3 eV 7, Γ _γ =(0.5) eV.
8155.87 11	1/2-	1	0.47 7	E(n)(Lab)=341.4 1, gΓ _n =110 eV 10, Γ _γ =0.2 eV 3.
8156.09 11	1/2-	1	0.64 7	E(n)(Lab)=341.62 10, gΓ _n =105 eV 3, Γ _γ =0.65 eV 7.
8157.31 11	1/2-	1	1.01 12	E(n)(Lab)=342.87 10, gΓ _n =210 eV 4, Γ _γ =1.01 eV 12.
8158.50 11	[3/2+]	[2]	1.41 8	E(n)(Lab)=344.08 10, gΓ _n =4 eV, Γ _γ =1.09 eV 10.
8159.93 11	1/2-	1	0.96 7	E(n)(Lab)=345.53 10, gΓ _n =2 eV, Γ _γ =1.86 eV 25.
8162.77 5	(5/2+)	[2]	4.08 20	E(n)(Lab)=348.42 1, gΓ _n =94 eV 3, Γ _γ =1.42 eV 7.
8163.39 11	(1/2)-	1	1.10 19	E(n)(Lab)=349.05 10, gΓ _n =27 eV 1, Γ _γ =1.12 eV 20.
8163.99 11	3/2+	2	1.56 23	E(n)(Lab)=349.66 10, gΓ _n =20 eV 5, Γ _γ =1.61 eV 25.
8164.50 7			0.4 3	E(n)(Lab)=350.18 5, gΓ _n =1.2 eV 4, Γ _γ =(0.5) eV.
8166.79 9	3/2+	2	1.37 9	E(n)(Lab)=352.50 7, gΓ _n =9 eV 3, Γ _γ =0.81 eV 6.
8168.71 11	3/2+	2	1.27 16	E(n)(Lab)=354.46 10, gΓ _n =493 eV 4, Γ _γ =0.64 eV 8.
8169.90 11	3/2+	2	1.33 9	E(n)(Lab)=355.67 10, gΓ _n =30 eV 10, Γ _γ =0.71 eV 5.
8171.96 5	1/2+	0	1.17 20	E(n)(Lab)=357.76 1, gΓ _n =1.56 keV 6, Γ _γ =1.17 eV 20.
8173.07 11	1/2-	1	1.74 14	E(n)(Lab)=358.89 10, gΓ _n =10 eV, Γ _γ =1.81 eV 15.
8173.76 11	3/2-	1	0.95 18	E(n)(Lab)=359.59 10, gΓ _n =1.256 keV 7, Γ _γ =0.5 eV 9.
8175.36 11	1/2-	1	0.61 7	E(n)(Lab)=361.22 10, gΓ _n =7 eV, Γ _γ =0.67 eV 8.
8180.10 11	1/2-	1	1.66 15	E(n)(Lab)=366.04 10, gΓ _n =60 eV 5, Γ _γ =1.69 eV 16.
8182.80 7			0.40 2	E(n)(Lab)=368.78 5, gΓ _n =2.0 eV 6, Γ _γ =(0.5) eV.
8183.05 11	3/2+	2	3.7 2	E(n)(Lab)=369.04 10, gΓ _n =15 eV 2, Γ _γ =2.5 eV 2. E(level): E(n)=366.04 is a repeated entry in 2006MuZX. Evaluators assume it as 369.04 10.
8183.84 11	1/2-	1	0.91 11	E(n)(Lab)=369.84 10, gΓ _n <7 eV, Γ _γ =1.05 eV 15.
8184.72 5	3/2+	2	1.62 14	E(n)(Lab)=370.74 1, gΓ _n =56 eV 15, Γ _γ =0.83 eV 8.
8185.67 5	3/2+	2	2.21 11	E(n)(Lab)=371.70 1, gΓ _n =6.5 eV, Γ _γ =2.83 eV 18.
8187.04 7	[1/2]		0.20 4	E(n)(Lab)=373.10 5, gΓ _n =0.33 eV 10, Γ _γ =(0.5) eV.
8187.66 11	1/2-	1	0.17 11	E(n)(Lab)=373.73 10, gΓ _n =30 eV 5, Γ _γ =0.18 eV 11.
8188.72 11	1/2-	1	0.36 3	E(n)(Lab)=374.8 1, gΓ _n =1.3 eV 4, Γ _γ =(0.5) eV.
8190.78 5	1/2+	0	2.0 9	E(n)(Lab)=376.90 1, gΓ _n =3.82 keV 5, Γ _γ =2.0 eV 9.
8190.80 11	1/2-	1	1.12 8	E(n)(Lab)=376.92 10, gΓ _n =7 eV, Γ _γ =1.34 eV 12.
8191.85 7	1/2-	1	0.61 9	E(n)(Lab)=377.99 5, gΓ _n =4.5 eV, Γ _γ =0.70 eV 12.
8192.52 11	[1/2]		0.30 5	E(n)(Lab)=378.67 10, gΓ _n =0.7 eV 3, Γ _γ =(0.5) eV.
8193.58 11		[1]		E(n)(Lab)=379.75 10, gΓ _n =7 eV 4.
8193.76 11	3/2-	1	1.93 14	E(n)(Lab)=379.93 10, gΓ _n =281.0 eV 17.
8195.28 11	1/2-	1	2.15 14	E(n)(Lab)=381.47 10, gΓ _n =30 eV 2, Γ _γ =2.25 eV 15.
8195.65 11	[1/2]		1.16 11	E(n)(Lab)=381.85 10, gΓ _n =5.0 eV 21.
8196.40 7			0.59 10	E(n)(Lab)=382.61 5, gΓ _n =2 eV, Γ _γ =0.83 eV 20.
8197.31 7	1/2+	0	1.19 12	E(n)(Lab)=383.54 5, gΓ _n =375 eV 9, Γ _γ =1.19 eV 12.
8199.84 11	[3/2]		0.37 6	E(n)(Lab)=386.11 10, gΓ _n =0.59 eV 16, Γ _γ =1 eV.
8200.23 7	[1/2]		0.45 4	E(n)(Lab)=386.51 5, gΓ _n =0.4 eV 34, Γ _γ =0.5 eV.
8201.89 11	3/2+	2	0.78 13	E(n)(Lab)=388.2 1, gΓ _n =260 eV 5, Γ _γ =0.37 eV 6.
8202.32 11	1/2-	1	2.82 13	E(n)(Lab)=388.63 10, gΓ _n =160 eV 5, Γ _γ =2.88 eV 13.
8202.93 7				E(n)(Lab)=389.25 5.
8203.06 7				E(n)(Lab)=389.38 5.
8206.94 11	3/2[-]	[1]	0.94 16	E(n)(Lab)=393.33 10, gΓ _n =365 eV 10, Γ _γ =0.47 eV 8.
8208.60 11	1/2-	1	0.21 4	E(n)(Lab)=395.02 10.

Continued on next page (footnotes at end of table)

⁶⁰Ni(n,γ),(n,n): Resonances 2006MuZX (continued)

⁶¹Ni Levels (continued)

E(level) [†]	Jπ [‡]	L	gΓ _n Γ _γ /Γ (eV) [§]	Comments
8210.69 11	1/2-	1	0.56 5	E(n)(Lab)=397.14 10.
8211.94 11	3/2+	2	0.40 14	E(n)(Lab)=398.41 10, gΓ _n =460 eV 9, Γ _γ =0.20 eV 7.
8212.77 11	1/2-	1	0.95 8	E(n)(Lab)=399.26 10, gΓ _n =37 eV 4.
8214.58 11	1/2-	1	0.69 6	E(n)(Lab)=401.1 1, gΓ _n =3 eV.
8215.81 11	1/2-	1	1.23 7	E(n)(Lab)=402.35 10, gΓ _n =5.4 eV.
8216.64 11	3/2-	1	1.72 10	E(n)(Lab)=403.19 10, gΓ _n =425 eV 25, Γ _γ =0.86 eV 5.
8217.36 11	1/2-	1	0.67 8	E(n)(Lab)=403.93 10, gΓ _n =4 eV.
8217.82 7			0.36 5	E(n)(Lab)=404.39 5.
8219.23 7			0.16 4	E(n)(Lab)=405.83 5.
8220.81 11	1/2-	1	0.3 5	E(n)(Lab)=407.43 10, gΓ _n =30 eV 6, Γ _γ =0.27 eV 5.
8221.68 11	[3/2]-	1	1.42 8	E(n)(Lab)=408.32 10, gΓ _n =20 eV 5, Γ _γ =0.76 eV 4.
8223.61 11	3/2+	2	1.12 16	E(n)(Lab)=410.28 10, gΓ _n =190 eV 20, Γ _γ =0.56 eV 8.
8227.13 7	1/2+	0	0.82 7	E(n)(Lab)=413.86 5, gΓ _n =344 eV 9, Γ _γ =0.82 eV 7.
8228.64 11	3/2+	2	1.5 3	E(n)(Lab)=415.4 1, gΓ _n =400 eV 12, Γ _γ =0.75 eV 15.
8228.94 11	3/2+	2	2.2 3	E(n)(Lab)=415.7 1, gΓ _n =34 eV 6, Γ _γ =1.18 eV 15.
8231.38 11			0.35 4	E(n)(Lab)=418.18 10.
8232.12 11			0.41 6	E(n)(Lab)=418.93 10, gΓ _n =68 eV 6, Γ _γ =0.41 eV 6.
8233.28 11	1/2-	1	1.52 9	E(n)(Lab)=420.11 10, gΓ _n =20 eV 5, Γ _γ =0.78 eV 5.
8235.61 7			0.36 7	E(n)(Lab)=422.48 5, gΓ _n =83 eV 8, Γ _γ =0.36 eV 7.
8235.92 5	1/2+	0	0.63 20	E(n)(Lab)=422.80 1, gΓ _n =1.81 eV 6, Γ _γ =0.63 eV 2.
8237.30 7			0.20 4	E(n)(Lab)=424.20 5.
8238.12 11	3/2+	2	1.76 11	E(n)(Lab)=425.04 10, gΓ _n =74 eV 5, Γ _γ =0.90 eV 6.
8239.74 11	1/2-	1	1.07 6	E(n)(Lab)=426.68 10, gΓ _n =5 eV, Γ _γ =0.68 eV 6.
8240.49 11	1/2-	1	0.63 6	E(n)(Lab)=427.45 10, gΓ _n =10 eV, Γ _γ =0.68 eV 6.
8242.85 11	1/2-	1	0.7 2	E(n)(Lab)=429.84 10, gΓ _n =580 eV 20, Γ _γ =0.7 eV 2.
8243.63 11	3/2+	2	0.99 8	E(n)(Lab)=430.64 10, gΓ _n =27 eV 2, Γ _γ =0.51 eV 8.
8244.40 11	1/2-	1	0.22 9	E(n)(Lab)=431.42 10, gΓ _n =240 eV 10, Γ _γ =0.22 eV 9.
8245.49 11	3/2+	2	1.60 12	E(n)(Lab)=432.53 10, gΓ _n =180 eV 8, Γ _γ =0.81 eV 6.
8248.81 21	3/2+	2	0.79 16	E(n)(Lab)=435.9 2, gΓ _n =48 eV 3, Γ _γ =0.40 eV 8.
8250.00 21	1/2-	1	0.59 5	E(n)(Lab)=437.12 20, gΓ _n =3 eV.
8250.94 5	1/2+	0	0.87 20	E(n)(Lab)=438.07 1, gΓ _n =1.16 keV 6, Γ _γ =0.87 eV 20.
8251.79 11	3/2+	2	1.81 11	E(n)(Lab)=438.94 10, gΓ _n =26 eV 3, Γ _γ =0.97 eV 6.
8252.27 7			0.98 21	E(n)(Lab)=439.42 5, gΓ _n =32 eV 3.
8252.89 7			0.76 15	E(n)(Lab)=440.05 5, gΓ _n =38 eV 3.
8253.54 7			1.22 19	E(n)(Lab)=440.71 5.
8254.17 11	3/2+	2	1.2 3	E(n)(Lab)=441.36 10, gΓ _n =150 eV 2, Γ _γ =0.61 eV 16.
8254.92 7			0.68 13	E(n)(Lab)=442.12 5, gΓ _n =1.0 eV 3, Γ _γ =(1) eV.
8257.34 21	1/2+	0	2.51 12	E(n)(Lab)=444.58 20, gΓ _n =163 eV 14, Γ _γ =0.26 eV 12.
8258.42 7			0.30 4	E(n)(Lab)=445.68 5, gΓ _n =0.70 eV 22, Γ _γ =(0.5) eV.
8260.00 21	1/2-	1	0.45 4	E(n)(Lab)=447.28 20, gΓ _n =1 eV.
8260.86 7	1/2+	0	0.11 17	E(n)(Lab)=448.16 5, gΓ _n =2.63 keV 10.
8261.70 7			0.98 10	E(n)(Lab)=449.01 5, gΓ _n =32 eV 4.
8262.19 7			0.68 13	E(n)(Lab)=449.51 5, gΓ _n =1.0 eV 3.
8264.19 7	3/2-	1	1.4 5	E(n)(Lab)=451.54 5, gΓ _n =131 eV 8.

[†] Deduced by the evaluators from S(n)+E(n)(c.m.), where S(n)=7820.11 5 for ⁶¹Ni (2012Wa38). E(n)(c.m.)=E(n)(lab)[mass of ⁶⁰Ni/(mass of ⁶⁰Ni+mass of neutron)].

[‡] Values in square brackets are assumed assignments.

[§] g=statistical weight factor, (2J+1)/2 in this case, where J=spin of resonant state.

⁶⁰Ni(d,p),(pol d,p) 1967Co27,2013Sc06,1973Ay03

1967Co27: (d,p): E=7.5 MeV. Measured $\sigma(E(p),\theta)$, 23 angles (c.m.) from $\approx 7^\circ$ to 172° , magnetic spectrograph, enriched target, FWHM=10 keV.

2013Sc06, 2013ScZZ: (d,p), E(d)=10 MeV beam from WNSL-Yale tandem accelerator facility. Measured proton spectra, $\sigma(\theta)$, and spectroscopic factors C^2S for 19 proton groups using a split-pole Enge spectrograph. FWHM ≈ 33 keV. Target=204 $\mu\text{g}/\text{cm}^2$ thick 99.7% enriched. Deduced levels, J, π . DWBA analysis. Comparison with shell-model calculations.

The main purpose of the neutron adding and neutron removal reaction studies by 2013Sc06 was to obtain occupancies of neutron orbitals, proton vacancies, and energy centroids of neutron, neutron-holes, proton-single particle excitations in ⁶⁰Ni and ⁶²Ni, and thereby investigate closure of $0f_{7/2}$ shell. Some data details of this study are supplied in 2013ScZZ.

Others:

1964Fu04: (d,p): E=12 MeV. Measured $\sigma(E(p),\theta)$, 7 angles from 5° to 50° , magnetic spectrograph, enriched target, FWHM=10 keV.

1973Ay03: (pol d,p): E=10 MeV. Measured vector analyzing power, $\theta(\text{c.m.})=2.5^\circ-70^\circ$, semi detector and magnetic spectrograph, enriched target.

For gross structure of γ -spectrum as a function of E(p) in (d,p γ), see 1968Na15.

1975Ba28 (E=3.0-4.5 MeV, $\theta(\text{c.m.})=10^\circ-135^\circ$, Levels at 4762, 4907 keV), L-values and S factors.

1977St07 (E=2.8 MeV, 23 angles from 50° to 160° , FWHM ≈ 30 keV), 22 groups up to 5.3 MeV, $\sigma(\theta)$, L-values and S-factor.

Other: 1962Co02 ($\theta=9^\circ, 15^\circ, 25^\circ, 40^\circ$),.

1991We07: E(d)=2.7, 3.0, 3.3 MeV, FWHM=22 keV; measured $\sigma(\theta)$, DWBA analysis. Deduced density of valence neutron distributions and density differences between isotopes.

d σ /d Ω in mb/sr (2013ScZZ)

Level	15°	35°
0	5.29	0.93
67	0.39	0.77
283	4.18	0.55
656	0.13	0.022
909	0.046	0.075
1100	0.44	0.11
1132	0.080	0.10
1185	0.97	0.22
1455	0.067	0.072
1729	0.11	0.029
2122	0.59	0.91
2124	0.94	0.19
2640	0.42	0.099
2697	1.09	0.79
2765	0.29	0.13
2801	0.055	0.091
2905		
3062	0.61	0.42
3487	0.076	0.15
3506	2.39	1.91

Level energies are quoted by 2013Sc06 from 1999-NDS (1999Bh04); values are nearly the same in Adopted Levels here

The uncertainties in cross sections are $\approx 4\%$ for $\sigma > 1$ mb/sr, $\approx 7\%$ for $0.1 < \sigma < 1.0$ mb/sr, and $\approx 18\%$ for $\sigma < 0.1$ mb/sr at their respective maxima. The uncertainties arising from possible contaminants or previously unidentified states for very weak transitions could be ≈ 0.02 mb/sr.

Most data listed here are from 1967Co27.

⁶¹Ni Levels

E(level) [†]	J π [‡]	L [§]	(2J+1)C ² S [#]	Comments
0 5	3/2-	1	1.49	(2J+1)C ² S: 1.76 (2013Sc06,2013ScZZ). (d σ /d Ω) _{max} =3.60 mb/sr.
68 5	5/2-	3	3.04	(d σ /d Ω) _{max} =0.650 mb/sr.
284 5	1/2-	1	1.23	(2J+1)C ² S: 1.32 (2013Sc06,2013ScZZ). (d σ /d Ω) _{max} =3.20 mb/sr.

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$^{60}\text{Ni}(\text{d,p}),(\text{pol d,p})$ 1967Co27,2013Sc06,1973Ay03 (continued) **^{61}Ni Levels (continued)**

E(level) [†]	$J\pi^{\ddagger}$	$L^{\S}$	(2J+1)C ² S [#]	Comments
661 5		1	0.053	(2J+1)C ² S: 0.04 for $J\pi=1/2-$ (2013Sc06,2013ScZZ). ($d\sigma/d\Omega$) _{max} =0.151 mb/sr.
916 10		(3)	0.345	($d\sigma/d\Omega$) _{max} =0.080 mb/sr.
1020 10		&		($d\sigma/d\Omega$) _{max} =0.029 mb/sr.
1106 10		1	0.108	(2J+1)C ² S: 0.12 for $J\pi=3/2-$ (2013Sc06,2013ScZZ). ($d\sigma/d\Omega$) _{max} =0.345 mb/sr.
1139 10		3	0.400	($d\sigma/d\Omega$) _{max} =0.098 mb/sr.
1192 10	3/2-	1	0.255	(2J+1)C ² S: 0.26 (2013Sc06,2013ScZZ). ($d\sigma/d\Omega$) _{max} =0.825 mb/sr.
1462 10		3&	0.16	($d\sigma/d\Omega$) _{max} =0.105 mb/sr.
1618 10		&		($d\sigma/d\Omega$) _{max} =0.03 mb/sr.
1737 10		1	0.044	(2J+1)C ² S: 0.027 for $J\pi=3/2-$ (2013Sc06,2013ScZZ). ($d\sigma/d\Omega$) _{max} =0.159 mb/sr.
1814 10		&		($d\sigma/d\Omega$) _{max} =0.017 mb/sr.
1996 10		&		($d\sigma/d\Omega$) _{max} =0.021 mb/sr.
2009 10		&		($d\sigma/d\Omega$) _{max} =0.035 mb/sr.
2025 10		&		($d\sigma/d\Omega$) _{max} =0.025 mb/sr.
2130 10	9/2+ and 1/2-	4+1	8.45, 0.392	(2J+1)C ² S: 0.21 for $L=1, 1/2-$ (2013Sc06,2013ScZZ). ($d\sigma/d\Omega$) _{max} =0.035 mb/sr.
2417 10		&		($d\sigma/d\Omega$) _{max} =0.058 mb/sr.
2474 10		&		($d\sigma/d\Omega$) _{max} =0.022 mb/sr.
2536 10		&		($d\sigma/d\Omega$) _{max} =0.031 mb/sr.
2602 10		1	0.087	(2J+1)C ² S: 0.09 (2013Sc06,2013ScZZ). ($d\sigma/d\Omega$) _{max} =0.369 mb/sr.
2707 10	5/2+	2	0.521	($d\sigma/d\Omega$) _{max} =1.21 mb/sr.
2773 10		1	0.054	(2J+1)C ² S: 0.06 for $J\pi=3/2-$ (2013Sc06,2013ScZZ). ($d\sigma/d\Omega$) _{max} =0.233 mb/sr.
2804 10		3	0.291	($d\sigma/d\Omega$) _{max} =0.090 mb/sr.
2873 10		1	0.032	($d\sigma/d\Omega$) _{max} =0.141 mb/sr.
2910 10				L: (1) in 1967Co27 is not confirmed in (α , ³ He) measurement by 2013Sc06, where L=3 is obtained. Thus (2J+1)C ² S=0.014 in 1967Co27 is not adopted. ($d\sigma/d\Omega$) _{max} =0.062 mb/sr.
3051 10		(1)	0.017	($d\sigma/d\Omega$) _{max} =0.077 mb/sr.
3073 10		0	0.067	($d\sigma/d\Omega$) _{max} =1.80 mb/sr.
3116 10		3	0.135	($d\sigma/d\Omega$) _{max} =0.045 mb/sr.
3141 10		&		($d\sigma/d\Omega$) _{max} =0.021 mb/sr.
3164 10		(1)	0.007	($d\sigma/d\Omega$) _{max} =0.031 mb/sr.
3241 10		1	0.011	($d\sigma/d\Omega$) _{max} =0.052 mb/sr.
3268 10		(1)	0.013	($d\sigma/d\Omega$) _{max} =0.062 mb/sr.
3298 10		(1) ^a	0.038 ^a	
3308 10		(1) ^a	0.038 ^a	
3370 10		1	0.022	($d\sigma/d\Omega$) _{max} =0.105 mb/sr.
3427 10		1	0.045	($d\sigma/d\Omega$) _{max} =0.217 mb/sr.
3448 10		2	0.050	($d\sigma/d\Omega$) _{max} =0.132 mb/sr.
3473 10		&		($d\sigma/d\Omega$) _{max} =0.031 mb/sr.
3492 10		4	2.120	($d\sigma/d\Omega$) _{max} =0.305 mb/sr.
3507 10		2	0.840	($d\sigma/d\Omega$) _{max} =2.280 mb/sr.
3537 10		&		($d\sigma/d\Omega$) _{max} =0.045 mb/sr.
3573 10		&		($d\sigma/d\Omega$) _{max} =0.039 mb/sr.
3608 10		&		($d\sigma/d\Omega$) _{max} =0.049 mb/sr.
3628 10		&		($d\sigma/d\Omega$) _{max} =0.050 mb/sr.
3647 10		2	0.196	($d\sigma/d\Omega$) _{max} =0.53 mb/sr.
3683 10		1	0.054	($d\sigma/d\Omega$) _{max} =0.271 mb/sr.
3708 10		&		($d\sigma/d\Omega$) _{max} =0.55 mb/sr.
3725 10		1	0.033	($d\sigma/d\Omega$) _{max} =0.149 mb/sr.
3753 10		(0)	0.131	($d\sigma/d\Omega$) _{max} =(1.5) mb/sr.
3791 10		(1)	0.019	($d\sigma/d\Omega$) _{max} =0.096 mb/sr.
3819 10		(1)	0.009	($d\sigma/d\Omega$) _{max} =0.045 mb/sr.
3860 10		&		($d\sigma/d\Omega$) _{max} =0.042 mb/sr.
3879 10		&		($d\sigma/d\Omega$) _{max} =0.145 mb/sr.
3942 10		&		($d\sigma/d\Omega$) _{max} =0.087 mb/sr.
3954 10		&		($d\sigma/d\Omega$) _{max} =0.080 mb/sr.
3984 10		&		($d\sigma/d\Omega$) _{max} =0.030 mb/sr.

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$^{60}\text{Ni}(\text{d,p}),(\text{pol d,p})$ 1967Co27,2013Sc06,1973Ay03 (continued) **^{61}Ni Levels (continued)**

E(level) [†]	L [§]	(2J+1)C ² S [#]	Comments
4018 10	&		(dσ/dΩ) _{max} =0.034 mb/sr.
4044 10	(1)	0.012	(dσ/dΩ) _{max} =0.105 mb/sr.
4082 10	&		(dσ/dΩ) _{max} =0.036 mb/sr.
4093 10	&		(dσ/dΩ) _{max} =0.036 mb/sr.
4131 10	(0)	0.005	(dσ/dΩ) _{max} =0.076 mb/sr.
4163 10	2	0.08	(dσ/dΩ) _{max} =0.281 mb/sr.
4189 10	2 ^b	0.018 ^b	
4200 10	2 ^b	0.018 ^b	
4215 10	&		(dσ/dΩ) _{max} =0.045 mb/sr.
4226 10	&		(dσ/dΩ) _{max} =0.121 mb/sr.
4252 10	(2)	0.067	(dσ/dΩ) _{max} =0.289 mb/sr.
4287 10	&		
4295 10	&		
4314 10	(0) ^c	0.02 ^c	
4336 10	(0) ^c	0.02 ^c	
4360 10	d	d	
4374 10	d	d	
4386 10	d	d	
4403 10	d	d	
4425 10	&		
4448 10	e	e	
4476 10	2 ^e	0.19 ^e	
4501 10	e	e	
4522 10	&		(dσ/dΩ) _{max} =0.130 mb/sr.
4551 10	&		(dσ/dΩ) _{max} =0.038 mb/sr.
4569 10	(2)	0.030	(dσ/dΩ) _{max} =0.096 mb/sr.
4589 10	2	0.032	(dσ/dΩ) _{max} =0.100 mb/sr.
4605 10	&		(dσ/dΩ) _{max} =0.039 mb/sr.
4623 10	&		
4635 10	&		
4650 10	&		(dσ/dΩ) _{max} =0.035 mb/sr.
4665 10	&		
4694 10	&		
4716 10			
4736 10			
4762 10	2	0.958	Other: L=2 and (2J+1)S=0.715 (1975Ba28). (dσ/dΩ) _{max} =2.69 mb/sr.
4795 10	&		(dσ/dΩ) _{max} =0.042 mb/sr.
4818 10	&		(dσ/dΩ) _{max} =0.130 mb/sr.
4837 10	&		(dσ/dΩ) _{max} =0.045 mb/sr.
4857 10	(1)	0.015	(dσ/dΩ) _{max} =0.080 mb/sr.
4872 10	(0) ^f	0.052 ^f	
4883 10	(0) ^f	0.052 ^f	
4916 10	0 ^g	0.40 ^g	
4954 10	0 ^g	0.40 ^g	
4968 10	2 ^h	0.098 ^h	
4980 10	2 ^h	0.098 ^h	
5005 10	&		(dσ/dΩ) _{max} =0.080 mb/sr.
5020 10	&		(dσ/dΩ) _{max} =0.034 mb/sr.
5034 10	(1)	0.021	(dσ/dΩ) _{max} =0.115 mb/sr.
5064 10	0	0.163	(dσ/dΩ) _{max} =(4.51) mb/sr.
5097 10	1	0.054	(dσ/dΩ) _{max} =0.280 mb/sr.
5121 10	1	0.108	(dσ/dΩ) _{max} =0.590 mb/sr.
5168 10	&		(dσ/dΩ) _{max} =0.086 mb/sr.
5187 10	0	0.102	(dσ/dΩ) _{max} =2.98 mb/sr.
5216 10	2	0.053	(dσ/dΩ) _{max} =0.170 mb/sr.
5241 10	&		
5263 10	&		
5280 10	&		(dσ/dΩ) _{max} =0.157 mb/sr.
5295 10	(1)	0.033	(dσ/dΩ) _{max} =0.190 mb/sr.
5309 10	0	0.053	(dσ/dΩ) _{max} =1.192 mb/sr.
5336 10	&		(dσ/dΩ) _{max} =0.025 mb/sr.
5356 10	(1)	0.024	(dσ/dΩ) _{max} =0.140 mb/sr.

Continued on next page (footnotes at end of table)

$^{60}\text{Ni}(\text{d,p}),(\text{pol d,p})$ 1967Co27,2013Sc06,1973Ay03 (continued) **^{61}Ni Levels (continued)**

E(level) [†]	L [§]	(2J+1)C ² S [#]	Comments
5366 10	i	i	
5395 10	i	i	
5405 10	i	i	
5440 10	1	0.070	(dσ/dΩ) _{max} =0.390 mb/sr.
5466 10	&		(dσ/dΩ) _{max} =0.067 mb/sr.
5487 10	&		(dσ/dΩ) _{max} =0.047 mb/sr.
5512 10	&		(dσ/dΩ) _{max} =0.160 mb/sr.
5534 10	2	0.071	(dσ/dΩ) _{max} =0.278 mb/sr.
5574 10	1	0.090	(dσ/dΩ) _{max} =0.510 mb/sr.
5601 10	&		(dσ/dΩ) _{max} =0.574 mb/sr.
5620 10	2	0.072	(dσ/dΩ) _{max} =0.276 mb/sr.
5645 10	(1)	0.052	(dσ/dΩ) _{max} =0.284 mb/sr.
5659 10	1	0.049	(dσ/dΩ) _{max} =0.30 mb/sr.
5703 10	2 ^j	0.521 ^j	
5723 10	2 ^j	0.521 ^j	
5742 10	2	0.325	(dσ/dΩ) _{max} =1.318 mb/sr.
5796 10	&		
5804 10	&		
5821 10	&		(dσ/dΩ) _{max} =0.179 mb/sr.
5842 10	&		(dσ/dΩ) _{max} =0.099 mb/sr.
5859 10	(0)	0.034	(dσ/dΩ) _{max} =0.280 mb/sr.
5883 10	&		(dσ/dΩ) _{max} =0.162 mb/sr.
5894 10	(2) ^k	0.028 ^k	
5914 10	(2) ^k	0.028 ^k	
5934 10	2 ^l	0.098 ^l	
5957 10	2 ^l	0.098 ^l	
5987 10	0	0.071	(dσ/dΩ) _{max} =1.09 mb/sr.
6016 10	(2)	0.037	(dσ/dΩ) _{max} =0.130 mb/sr.
6041 10	&		(dσ/dΩ) _{max} =0.192 mb/sr.
6072 10	&		(dσ/dΩ) _{max} LE 0.035 mb/sr.
6085 10	(2)	0.038	(dσ/dΩ) _{max} =0.150 mb/sr.
6102 10	2 ^m	0.192 ^m	
6135 10	2 ^m	0.192 ^m	
6148 10	&		(dσ/dΩ) _{max} =0.040 mb/sr.
6166 10	&		(dσ/dΩ) _{max} =0.030 mb/sr.
6176 10	&		
6184 10	&		
6227 10	&		(dσ/dΩ) _{max} =0.090 mb/sr.
6249 10	(2)	0.071	(dσ/dΩ) _{max} =0.275 mb/sr.
6269 10	&		(dσ/dΩ) _{max} =0.144 mb/sr.
6289 10	(0)	0.015	(dσ/dΩ) _{max} =(0.138) mb/sr.
6314 10	&		(dσ/dΩ) _{max} =0.185 mb/sr.
6346 10	2	0.115	(dσ/dΩ) _{max} =0.492 mb/sr.
6371 10	2	0.053	(dσ/dΩ) _{max} =0.231 mb/sr.
6391 10	&		(dσ/dΩ) _{max} =0.060 mb/sr.
6413 10			(dσ/dΩ) _{max} =(0.120) mb/sr.
6427 10	2 ⁿ	0.213 ⁿ	
6444 10	2 ⁿ	0.213 ⁿ	
6471 10	&		(dσ/dΩ) _{max} =0.173 mb/sr.
6492 10	&		(dσ/dΩ) _{max} =0.165 mb/sr.
6515 10	(1) ^o	0.045 ^o	
6538 10	(1) ^o	0.045 ^o	
6556 10	&		(dσ/dΩ) _{max} =0.115 mb/sr.
6571 10	(2) ^p	0.094 ^p	
6589 10	(2) ^p	0.094 ^p	
6609 10	2	0.029	(dσ/dΩ) _{max} =0.140 mb/sr.
6630 10			
6661 10	2 ^q	0.091 ^q	
6676 10	2 ^q	0.091 ^q	
6706 10			
6732 10			
6748 10			
6767 10			

Continued on next page (footnotes at end of table)

$^{60}\text{Ni}(\text{d,p}),(\text{pol d,p})$ 1967Co27,2013Sc06,1973Ay03 (continued) **^{61}Ni Levels (continued)**

<u>E(level)[†]</u>	<u>E(level)[†]</u>	<u>E(level)[†]</u>
6776 10	7036 10	7557 [@] 50
6803 10	7051 10	7604 [@] 50
6818 10	7099 [@] 50	7620 [@] 50
6838 10	7137 [@] 50	7698 [@] 50
6849 10	7185 [@] 50	7722 [@] 50
6878 10	7206 [@] 50	7747 [@] 50
6908 10	7232 [@] 50	7811 [@] 50
6923 10	7276 [@] 50	7826 [@] 50
6928 10	7312 [@] 50	7865 [@] 50
6939 10	7374 [@] 50	7897 [@] 50
6971 10	7437 [@] 50	7952 [@] 50
6993 10	7469 [@] 50	
7008 10	7509 [@] 50	

[†] From 1967Co27.[‡] From $\sigma(\theta)$ and $A_y(q)$ in (pol d,p) (1973Ay03).[§] From DWBA analysis of $\sigma(\theta)$ (1967Co27).

From 1967Co27 unless otherwise stated.

[@] From 1964Fu04.[&] Corresponding angular distribution showed a nonstripping pattern.^a Combined for 3298+3308 levels.^b Combined for 4189+4200 levels.^c combined for 4314+4336 levels.^d L=2, (2J+1)S=0.284, combined for 4360+4374+4386+4403 levels.^e L=2, (2J+1)S=0.19, combined for 4448+4476+4501 levels.^f Combined for 4872+4883 levels.^g Combined for 4916+4954 levels.^h Combined for 4968+4980 levels.ⁱ L=(0), (2J+1)S=0.071, combined for 5366+5395+5405 levels.^j Combined for 5703+5723 levels.^k Combined for 5894+5914 levels.^l Combined for 5934+5957 levels.^m Combined for 6102+6135 levels.ⁿ Combined for 6427+6444 levels.^o Combined for 6515+6538 levels.^p Combined for 6571+6589 levels.^q Combined for 6661+6676 levels.

⁶⁰Ni(α ,³He) 2013Sc06,2013ScZZ

2013Sc06, 2013ScZZ: E(α)=38 MeV from WNSL–Yale tandem accelerator facility. Measured ³He spectra, $\sigma(\theta)$, spectroscopic factors C²S using a split-pole Enge spectrograph. FWHM =50 keV. Target=204 $\mu\text{g}/\text{cm}^2$ thick 99.7% enriched. Deduced levels, J, π . DWBA analysis. Comparison with shell-model calculations.

The main purpose of the neutron adding and neutron removal reaction studies by 2013Sc06 was to obtain occupancies of neutron orbitals, proton vacancies, and energy centroids of neutron, neutron-holes, proton-single particle excitations in ⁶⁰Ni and ⁶²Ni, and thereby investigate closure of 0f_{7/2} shell. Some data details of this study are supplied in 2013ScZZ.

Other:

1961Sa09: E=43 MeV. Measured E(³He), magnetic spectrometer, $\theta=22^\circ$. Three groups at 0, 1700 and 2700 are reported; the 1700– and 2700-keV peaks cannot be easily assigned to those observed in spectral figure 2 in 2013Sc06.

There are either calibration issues or contribution from impurities.

The uncertainties in $d\sigma/d\Omega$ are estimated to be $\approx 4\%$ for $\sigma > 1$ mb/sr, $\approx 7\%$ for $0.1 < \sigma < 1.0$ mb/sr, and $\approx 18\%$ for $\sigma < 0.1$ mb/sr at their respective maxima. The uncertainties arising from possible contaminants or previously unidentified states for very weak transitions could be ≈ 0.02 mb/sr.

⁶¹Ni Levels

E(level) [†]	L	C ² S	Comments
0.0			$d\sigma/d\Omega(7^\circ)=0.22$ mb/sr.
67	3	3.33	$d\sigma/d\Omega(7^\circ)=2.01$ mb/sr.
283			$d\sigma/d\Omega(7^\circ)=0.044$ mb/sr.
656			$d\sigma/d\Omega(7^\circ)=0.013$ mb/sr.
909	3	0.44	C ² S: for $J\pi=5/2^-$. $d\sigma/d\Omega(7^\circ)=0.18$ mb/sr.
1132	3	0.40	C ² S: for $J\pi=5/2^-$. $d\sigma/d\Omega(7^\circ)=0.14$ mb/sr.
1185			$d\sigma/d\Omega(7^\circ)=0.038$ mb/sr.
1455	3	0.16	C ² S: for $J\pi=7/2^-$. $d\sigma/d\Omega(7^\circ)=0.049$ mb/sr.
2122	4	3.57	E(level): 1.7-MeV peak in 1961Sa09 may correspond to the strongly populated 2122 level. C ² S: for $J\pi=9/2^+$. $d\sigma/d\Omega(7^\circ)=3.53$ mb/sr.
2801	3	0.09	C ² S: for $J\pi=5/2^-, 7/2^-$. $d\sigma/d\Omega(7^\circ)<0.018$ mb/sr.
2905	3	0.08	C ² S: for $J\pi=7/2^-$.
3487	4	0.32	E(level): 2.7-MeV peak in 1961Sa09 may correspond to the strongly populated 2122 level. $d\sigma/d\Omega(7^\circ)=0.32$ mb/sr.
3506			$d\sigma/d\Omega(7^\circ)=0.32$ mb/sr.

[†] 2013Sc06 quote values from 1999–NDS of A=61 (1999Bh04). Values are nearly the same in Adopted Levels here.

⁶⁰Ni(¹⁴C,¹³C),(¹³C,¹²C) 1985Vi01

1985Vi01: (¹⁴C,¹³C), E=64 MeV. Measured $\sigma(E(^{13}\text{C}),\theta)$, Q3D spectrometer with 50-cm long gridded ionization counter, FWHM=250-keV. DWBA analysis. Deduced spectroscopic factors.

1983Os08: (¹³C,¹²C), E=60.83 MeV, analyzed data for 284 level using DWBA (1976Mo02).

1976Mo02: analyzed data of Bond et al. Bulletin of APS 19, 502 (1974).

⁶¹Ni Levels

E(level)	L [†]	Comments
0.0	2+1	E(level): unresolved group: 0+67.
67		
283	1+0	$J\pi=1/2^-$ from DWBA analysis (1976Mo02), L=0 (1983Os08).
656		
1100		E(level): unresolved group: 909+1015+1100+1132+1186.
1720		E(level): unresolved group: 1459+1610+1730+1808+1991.
2140		E(level): unresolved group: 2009+2019+2114+2123+2410.
2730		E(level): unresolved group: 2594+2640+2699+2765+2795+2863.

[†] From DWBA analysis of $\sigma(\theta)$.

$^{61}\text{Ni}(\gamma, \gamma')$ 1989Gr24, 1981Ca10

1989Gr24: E=67.4 keV. Measured Mossbauer spectra. Deduced magnetic hyperfine field.

1981Ca10: E=0.5–1.65 MeV bremsstrahlung. Measured $\gamma(\theta)$, self-absorption, absolute γ -transition strength. Deduced $T_{1/2}$. **^{61}Ni Levels**

E(level) [†]	J π [†]	$T_{1/2}$	Comments
0.0	3/2 ⁻		
67.4	5/2 ⁻		
1185.7	3/2 ⁻	0.145 ps 35	$T_{1/2}$: from $g[\Gamma_0^2/\Gamma]\omega(\theta)=0.0019$ eV 5 with $\Gamma_0/\Gamma=0.77$ 8 and $\delta(1185\gamma)=0.14$ taken from Adopted Gammas.

[†] From Adopted Levels. **$\gamma(^{61}\text{Ni})$**

E γ	E(level)
67.4 [†]	67.4
1118.3 [§]	1185.7
1185.7 [‡] 6	1185.7

[†] From 1989Gr24.[‡] From 1981Ca10.[§] From Adopted Gammas. **$^{61}\text{Ni}(\text{n}, \text{n}'\gamma)$ 1989Ko54**1989Ko54: E=1–6 MeV. Measured $\gamma(\theta)$, δ , $T_{1/2}$, B(E2), B(M1), Ge(Li)–NaI(Tl) detector. **^{61}Ni Levels**

E(level) [†]	J π [‡]	$T_{1/2}$ [§]	E(level) [†]	J π [‡]	$T_{1/2}$ [§]	E(level) [†]	J π [‡]	$T_{1/2}$ [§]
0.0	3/2 ⁻		1132	5/2 ⁻	0.14 ps 4	2121	9/2 ⁺	
67	5/2 ⁻		1185	3/2 ⁻	0.14 ps +8-4	2124	1/2 ⁻	0.045 ps 19
282	1/2 ⁻		1729	3/2 ⁻	0.062 ps 14	2129	11/2 ⁻	
656	1/2 ⁻		1808	9/2 ⁻		2462	7/2 ⁻	0.236 ps +21-7
908	5/2 ⁻		1987	9/2 ⁻		3298	11/2 ⁺	
1015	7/2 ⁻		1998	5/2 ⁻	0.045 ps 7	3435	13/2 ⁺	
1099	3/2 ⁻	0.16 ps 4	2018	7/2 ⁻	0.12 ps +8-3			

[†] From 1989Ko54, except as noted.[‡] From Adopted Levels.[§] From Doppler shift attenuation method (DSAM). **$\gamma(^{61}\text{Ni})$**

E γ	E(level)	E γ	E(level)	E γ	E(level)
67	67	841	908	1079	1987
282	282	908	908	1114	2129
588	656	948	1015	1177	3298
626	908	972	1987	1314	3435
816	1099	1015	1015	1741	1808

$^{61}\text{Ni}(\text{p},\text{p}') \quad 1967\text{Te02}$

1967Te02: $E(\text{p})=11-11.5$ MeV. Measured $\sigma(E(\text{p}'))$, magnetic spectrograph, FWHM=11 keV, enriched target (92%).

1967Co27: Report 20 groups up to 2.6 MeV.

Others: 1968An22, 1970An32.

For deformation parameters, see 1970An32.

$J\pi(^{61}\text{Ni g.s.})=3/2^-$.

 ^{61}Ni Levels

<u>E(level)</u>	<u>E(level)</u>	<u>E(level)</u>
0.0	3527 7	4624 7
65 7	3548 7	4644 7
280 7	3560 7	4668 7
654 7	3587 7	4681 7
906 7	3611 7	4701 7
1014 7	3621 7	4722 7
1099 7	3639 7	4741 7
1134 7	3657 7	4752 7
1184 7	3687 7	4790 7
1452 7	3710 7	4817 7
1606 7	3730 7	4831 7
1724 7	3758 7	4861 7
1807 7	3782 7	4881 7
1978 7	3837 7	4903 7
1991 7	3855 7	4930 7
2010 7	3872 7	4949 7
2114 7	3919 7	4968 7
2123 7	3934 7	4993 7
2402 7	3969 7	5010 10
2462 7	3997 7	5027 10
2523 7	4024 7	5038 10
2590 7	4051 7	5056 10
2638 7	4077 7	5079 10
2691 7	4108 7	5098 10
2709 7	4123 7	5119 10
2757 7	4143 7	5152 10
2784 7	4166 7	5164 10
2800 7	4181 7	5183 10
2849 7	4196 7	5200 10
2887 7	4234 7	5220 10
3034 7	4259 7	5247 10
3053 7	4267 7	5270 10
3099 7	4288 7	5295 10
3113 7	4312 7	5338 10
3136 7	4336 7	5374 10
3180 7	4351 7	5387 10
3250 7	4377 7	5408 10
3259 7	4400 7	5438 10
3275 7	4428 7	5453 10
3286 7	4443 7	5486 10
3346 7	4453 7	5503 10
3388 7	4477 7	5519 10
3406 7	4502 7	5550 10
3423 7	4520 7	5574 10
3449 7	4540 7	5588 10
3468 7	4568 7	5601 10
3486 7	4573 7	5623 10
3506 7	4599 7	

$^{61}\text{Ni}(\text{p},\text{p}'\gamma)$ 1975SeZB

1975SeZB: E(p)=6.0 MeV. Measured $E\gamma$, $I\gamma$, semi, Compton suppression, enriched target (24.7% and 85.4%).
Other: 1974BrYF.

 ^{61}Ni Levels

<u>E(level)[†]</u>	<u>$J\pi^{\ddagger}$</u>	<u>E(level)[†]</u>	<u>$J\pi^{\ddagger}$</u>	<u>E(level)[†]</u>	<u>$J\pi^{\ddagger}$</u>
0.0	3/2-	908.9 8	5/2-	1185.2 7	3/2-
67.1 5	5/2-	1014.3 6	7/2-	1456.3 7	7/2-
283.3 7	1/2-	1099.4 7	3/2-	1609.9 8	5/2-
656.1 5	1/2-	1131.7 8	5/2-	1729.9 6	3/2-

[†] From level scheme and $E\gamma$ data using least-squares fit, assuming 1 keV uncertainty in $E\gamma$ values.

[‡] From Adopted Levels.

 $\gamma(^{61}\text{Ni})$

<u>$E\gamma$</u>	<u>E(level)</u>	<u>$I\gamma$</u>	<u>Mult.</u>	<u>Comments</u>
67.11	67.1	258		
283.7	283.3	100		
357.9 [†]	1014.3	2	[M3]	$E\gamma$: this γ , implied as M3 from $\Delta J\pi$ is not confirmed in any other γ -ray study where this level is populated. Evaluators consider it questionable.
372.9	656.1	7.2		
441.8	1456.3	6		
529.4	1185.2	5.1		
545	1729.9	3.5		
588.6	656.1	6.6		
656.0	656.1	57.5		
816.3	1099.4	20		
842.0	908.9	14		
908.7	908.9	61		
947.7	1014.3	45		
1014	1014.3	32		
1032	1099.4	4.3		
1064.5	1131.7	13		
1073.5	1729.9	9		
1099.4	1099.4	18.6		
1131.8	1131.7	42.5		
1185.2	1185.2	51		
1389	1456.3	19		
1456.6	1456.3	71		
1542.8	1609.9	16		
1609.9	1609.9	16		
1662.8	1729.9	12		
1729.9	1729.9	15		

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

 $^{61}\text{Ni}(\text{d},\text{d}')$ 1967Co27

1967Co27: E=7.5 MeV. Measured $\sigma(E(\text{d}'),0)$, 20 angles (c.m.) between $\approx 30^\circ$ and 172.5° , magnetic spectrograph $\Delta E=5-10$ keV, enriched target (74%).

$J\pi(^{61}\text{Ni g.s.})=3/2-$.

Other: 1962Jo05.

 ^{61}Ni Levels

<u>E(level)</u>	<u>$L^{\dagger}$</u>
0.0	
68 5	
284 5	

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$^{61}\text{Ni}(\text{d},\text{d}')$ 1967Co27 (continued) **^{61}Ni Levels (continued)**

E(level)	$L^\dagger$	E(level)	$L^\dagger$	E(level)
661 5	2	1462 10	2	2417 10
916 5	2	1618 10	(2)	2474 10
1020 10	2	1737 10		2536 10
1106 10		1814 10		2707 10
1139 10	2	1996 10		
1192 10	2	2130 10		

† From comparison with angular distribution of (d,d') to the first 2+ state in ^{60}Ni .

 $^{61}\text{Ni}(^3\text{He},^3\text{He}')$ 1968Ru01

1968Ru01: E=25 MeV. Measured $\sigma(\text{E}(^3\text{He}'),\theta)$, 34 angles between 7.5° and 90° , semi.

For $^{61}\text{Ni}(^3\text{He},^3\text{He})$, see 1981Bu26.

For deformation parameters, see 1968Ru01.

$J\pi(^{61}\text{Ni g.s.})=3/2^-$.

 ^{61}Ni Levels

E(level)	$L^\dagger$
0.0	
660	2
1130	2
1460	2

† From DWBA analysis of $\sigma(\theta)$.

Coulomb Excitation 1974An20,1977Pa06,1986TaZV

1977Pa06: (p,p'), E(p)=3.0–4.5 MeV, (α,α'), E α =4.5–5.5 MeV. Measured E_γ , I_γ , $\gamma(\theta)$, semi, natural target.

1974An20: (α,α'), E α =3.5,6.8 MeV, ($^{12}\text{C},^{12}\text{C}'$), E=26 MeV. Measured E_γ , I_γ , semi, enriched target (85%).

1986TaZV: (p,p'), E(p)=2.0–4.6 MeV. Measured 67, 283, 656, 908, and 1015-keV levels by Ge(Li) with FWHM=2 keV.

Others: 2011TrZZ, 1974An17, 1974Le34, 1969Sh12, 1969Ga25, 1962Ri09.

 ^{61}Ni Levels

B(E2) from unweighted average of values from 1974An20 and 1977Pa06; the two are not in very good agreement with each other.

E(level) †	$J\pi^\ddagger$	$T_{1/2}$	Comments
0.0	3/2-		
67.1 3	5/2-	5.1 ns 3	$T_{1/2}$: from $\gamma(t)$ measurements of 67 γ (1969Sh12). B(E2) $\uparrow$ =0.00069 7. B(E2) $\uparrow$: $\alpha(K)_{\text{exp}}=0.13$ for 67 γ has been used.
283.0 4	1/2-		B(E2) $\uparrow$ =0.0013 1.
655.8 4	1/2-		B(E2) $\uparrow$ =0.0074 10.
909.0 4	5/2-		B(E2) $\uparrow$ =0.0039 26.
1014.7 4	7/2-	>1.7 ps §	B(E2) $\uparrow$ =0.0088 10.
1099.5 4	3/2-		B(E2) $\uparrow$ =0.0026 13.
1132.3 4	5/2-	0.35 ps § 4	B(E2) $\uparrow$ =0.0128 30.
1185.6 5	3/2-	0.12 ps § 3	B(E2) $\uparrow$ =0.0048 10.
1457.9 8	7/2-		
1610.2 11	5/2-		

† From least-squares fit to E_γ data.

‡ From Adopted Levels.

§ From Doppler shift attenuation (1974Le34).

Coulomb Excitation 1974An20,1977Pa06,1986TaZV (continued)

$\gamma(^{61}\text{Ni})$					
E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\ddagger}$	Mult.§	$\delta^{\#}$	Comments
67.1	67.3 5	100	(M1+E2)	0.0076 5	
283.0	283.0 5	100			
655.8	373.0 5	16.6			
	588.4 5	8.0			
	655.8 5	75.4			
909.0	842.4 5	35.7			
	908.5 5	64.3			
1014.7	947.7 5	68.0			
	1014.8 5	32.0			
1099.5	816.3 5				
	1032.4 5				
	1099.6 5				
1132.3	1065.0 5	36.7			
	1132.4 5	63.3	(M1+E2)	0.43 7	
1185.6	1185.6 5		(M1+E2)	0.17 3	δ : with $I_{\gamma}=86$.
1457.9	444	51 1			
	1390	49 1			
1610.2	1543	≈ 100			

† From 1974An20, except for the decay of 1458- and 1610-keV levels, which are from 1977Pa06.

‡ Relative branching ratios from 1974An20, except for decay of 1458- and 1610-keV levels, which are from 1977Pa06.

§ From $J\pi$ difference.

$^{\#}$ From $B(E2)$ and $T_{1/2}$. For suggested δ from $\gamma(\theta)$ (inconsistent with other measurements), see 1977Pa06.

 $^{62}\text{Ni}(p,d),(\text{pol } p,d)$ 1996Ma11,2013Sc06,1976Ko06

1996Ma11: (pol p,d): $E(p)=65$ MeV, FWHM ≈ 40 keV. Measured $\sigma(E(d),\theta)$, and analyzing powers, DWBA analysis.

2013Sc06, 2013ScZZ: (p,d), $E(p)=28$ MeV from WNSL-Yale tandem accelerator facility. Measured deuteron spectra, $\sigma(\theta)$, spectroscopic factors C^2S using a split-pole Enge spectrograph. FWHM ≈ 48 keV. Target=219 $\mu\text{g}/\text{cm}^2$ thick 96.5% enriched. Deduced levels, J, π . DWBA analysis. Comparison with shell-model calculations.

The main purpose of the neutron adding and neutron removal reaction studies by 2013Sc06 was to obtain occupancies of neutron orbitals, proton vacancies, and energy centroids of neutron, neutron-holes, proton-single particle excitations in ^{60}Ni and ^{62}Ni , and thereby investigate closure of $0f_{7/2}$ shell. Some data details of this study are supplied in 2013ScZZ.

1976Ko06: (p,d): $E(p)=40$ MeV. Measured $\sigma(E(d),\theta)$, 14 angles between 4° and 54° , magnetic spectrograph, FWHM=45 keV, enriched target.

Others: 1979Ik04, 1974Ko32, 1965Sh06 (12 levels up to 9550 keV).

All data are from 1996Ma11, except as noted.

 $d\sigma/d\Omega$ in mb/sr (2013ScZZ)

Level	10°	25°
	(p, d)	(p, d)
0	14.3	1.19
67	0.78	1.4
283	3.92	0.27
656	0.53	0.059
909	0.001	0.011
1015	0.001	0.025
1100	0.66	0.052
1132	0.001	0.076
1185	1.49	0.16
1455	0.16	0.37
1610	0.073	0.052
1729	0.35	0.029
2122	0.001	0.091
2124	0.22	0.091
2469	0.068	0.12
2593	0.001	0.019
2640	0.05	0.019

Continued on next page (footnotes at end of table)

$^{62}\text{Ni}(\text{p,d}),(\text{pol p,d})$ 1996Ma11,2013Sc06,1976Ko06 (continued)

2905 0.17 0.38
 3308 0.17 0.43

Level energies in 2013Sc06 are from 1999-NDS for A=61 (1999Bh04);
 these values are nearly the same as in Adopted Levels here

The uncertainties in cross sections are $\approx 4\%$ for $\sigma > 1$ mb/sr, $\approx 7\%$ for $0.1 < \sigma < 1.0$ mb/sr, and $\approx 18\%$ for $\sigma < 0.1$ mb/sr at their respective maxima. The uncertainties arising from possible contaminants or previously unidentified states for very weak transitions could be ≈ 0.02 mb/sr.

 ^{61}Ni Levels

E(level) [†]	$J\pi^{\ddagger}$	$L^{\S}$	$C^2S^{\P}$	Comments
0.0	3/2-	1 [#]	2.0	C^2S : 1.92 (2013Sc06,2013ScZZ), 1.8 (1976Ko06).
68	5/2-	3 [#]	2.97	C^2S : 2.51 (1976Ko06).
286	1/2-	1 [#]	0.60	C^2S : 0.55 (2013Sc06,2013ScZZ), 0.46 (1976Ko06).
658	1/2-	1 [#]	0.10	C^2S : 0.08 (2013Sc06,2013ScZZ), 0.09 (1976Ko06).
912	5/2-	3 [#]	0.081	C^2S : 0.09 (1976Ko06).
1018	(7/2-)	(3)	(0.026)	
1123	(5/2-)	3+1	0.38	L=1+3 and J=1/2-,3/2-,5/2- for a doublet 1101+1132 keV from (1976Ko06). C^2S : for L=3, 5/2-. Others: 0.11 for L=1, 3/2- component (2013Sc06,2013ScZZ); 0.11 for L=1, 0.18 for L=3 (1976Ko06).
1191	3/2-	1 [#]	0.27	C^2S : 0.24 (2013Sc06,2013ScZZ), 0.25 (1976Ko06).
1458	7/2-	3 [#]	0.32	C^2S : 0.49 (1976Ko06).
1614	5/2-	3 [#]	0.15	C^2S : 0.13 (1976Ko06).
1731	3/2-	1 [#]	0.056	C^2S : 0.06 (2013Sc06,2013ScZZ), 0.06 (1976Ko06).
2015	7/2-	3 [#]	0.092	C^2S : 0.09 (1976Ko06).
2125	9/2+	4+1	0.22	L=4+1 and J=(1/2-,9/2+) for a 2120 group quoted in 1976Ko06. C^2S : for L=4, 9/2+. Others: 0.04 for L=1, 1/2- component (2013Sc06, 2013ScZZ); 0.25, 0.021 (1976Ko06).
2476	7/2-	3 [#]	0.13	C^2S : 0.23 (1976Ko06).
2609	7/2-	3	0.061	
2640		1	0.011	E(level),L, C^2S : from 2013Sc06, 2013ScZZ.
2734	(7/2-)	(3)	(0.033)	
2902	7/2-	3 [#]	0.57	C^2S : 0.8 (1976Ko06).
3053@				L=0 and J=1/2+ for a 3068 keV level from 1976Ko06. C^2S : 0.03 (1976Ko06).
3140	7/2-	3	0.086	
3295	7/2-	3 [#]	0.72	C^2S : 0.98 (1976Ko06).
3483	9/2+	4	0.12	
3652	7/2-	3	0.083	
3768	7/2-	3	0.071	
3932	7/2-	3	0.084	C^2S : 0.12 (1976Ko06).
4025	7/2-	3	0.078	
4144	7/2-	3	0.20	
4258	7/2-	3	0.038	
4378	7/2-	3	0.067	
4487	7/2-	3	0.11	
4586	7/2-	3 [#]	0.14	C^2S : 0.18 (1976Ko06).
4655	7/2-	3	0.058	
4729	7/2-	3	0.061	
4791	7/2-	3	0.075	
4880	7/2-	3	0.23	
4956	7/2-	3 [#]	0.24	C^2S : 0.33 (1976Ko06).
5031	(7/2-)	(3)	(0.041)	
5079	7/2-	3	0.059	
5174	(1/2+)	(0)	(0.048)	
5232	7/2-	3	0.057	
5333@				
5407@				
5460@				
5596	1/2+	0 [#]	0.22	C^2S : 0.16 (1976Ko06).
5652	(3/2+)	(2)	(0.20)	
5706	1/2+	0 [#]	0.14	C^2S : 0.12 (1976Ko06).

Continued on next page (footnotes at end of table)

$^{62}\text{Ni}(\text{p,d}),(\text{pol p,d})$ 1996Ma11,2013Sc06,1976Ko06 (continued) **^{61}Ni Levels (continued)**

E(level) [†]	$J\pi^{\ddagger}$	L [§]	C ² S [§]	Comments
5761@				
5954	3/2+	2	0.20	
6200@				
9550	7/2-	3	0.37	E(level): identified as IAS of ^{61}Co g.s. (1996Ma11,1965Sh06). L: same value in 1965Sh06.

[†] Uncertainties not given by authors.[‡] From $\sigma(\theta)$ and $A_y(\theta)$ in (pol p,d).[§] Extracted from DWBA analysis of angular distributions (1996Ma11). Values from 1976Ko06 for about 20 levels are in general agreement with those from 1996Ma11. Neutron orbitals : $2p_{3/2}$ for L=1,L+1/2, $2p_{1/2}$ for L=1,L-1/2, $1f_{7/2}$ for L=3,L+1/2, $1f_{5/2}$ for L=3, L-1/2 : $3s_{1/2}^{-1}$ for L=0, $2d_{3/2}^{-1}$ for L=2, $1g_{9/2}^{-1}$ for L=4.

L value is the same in 1976Ko06.

@ $\sigma(\theta)$ and $A_y(\theta)$ inconclusive for $J\pi$ determination. **$^{62}\text{Ni}(\text{d,t}),(\text{pol d,t})$ 1965Fu06,1976Hu06**1965Fu06: (d,t): E=15 MeV. Measured $\sigma(E(t),\theta)$, $\theta=20^\circ, 25^\circ, 30^\circ, 35^\circ, 45^\circ$, $\Delta E-E$ telescope, FWHM=70 keV, enriched target, thickness of (0.5-3.1 mg/cm²), DWBA analysis $\sigma(\theta)$ data.1976Hu06: (pol d,t): E=15 MeV. Measured analyzing power $A_y(\theta)$, 19 angles (c.m.) between $\approx 10^\circ$ and 90° , $\Delta E-E$ Si(Li) telescope, FWHM =50 keV, enriched target thickness of 0.2 mg/cm². The data were compared with DWBA analyses. **^{61}Ni Levels**

E(level) [†]	$J\pi^{\ddagger}$	L [§]	C ² S [§]	Comments
0.0	3/2-@	1	2.77	$(d\sigma/d\Omega)_{\text{max}}=3.48$ mb/sr.
6530	5/2-@	3	2.59	$(d\sigma/d\Omega)_{\text{max}}=0.78$ mb/sr.
29010	1/2-	1	0.88	$(d\sigma/d\Omega)_{\text{max}}=0.94$ mb/sr.
65420	1/2-	1	0.18	$(d\sigma/d\Omega)_{\text{max}}=0.16$ mb/sr.
111020	3/2-@	1	0.26	$(d\sigma/d\Omega)_{\text{max}}=0.17$ mb/sr.
113210				E(level): from figure 6 in 1976Hu06.
117020	3/2-@	1	0.34	$(d\sigma/d\Omega)_{\text{max}}=0.22$ mb/sr.
				E(level): 1186 from 1976Hu06.
145020	(7/2-)#	3	1.05	$(d\sigma/d\Omega)_{\text{max}}=0.16$ mb/sr.
161030				$(d\sigma/d\Omega)_{\text{max}}=0.068$ mb/sr.
173030		1	0.08	C ² S: for L-1/2.
				$(d\sigma/d\Omega)_{\text{max}}=0.036$ mb/sr.
200030		3	=0.25	C ² S: for L+1/2.
				$(d\sigma/d\Omega)_{\text{max}}=0.027$ mb/sr.
214030		(1+4)	=0.08,0.72	C ² S: for 1/2 for L=1 and 9/2 for L=4.
				$(d\sigma/d\Omega)_{\text{max}}=0.023$ mb/sr.
249030		(1+4)		L,E(level): from figure 8 in 1965Fu06.
				$(d\sigma/d\Omega)_{\text{max}}=0.048$ mb/sr.
292020	(7/2-)#	(3)	1.58	$(d\sigma/d\Omega)_{\text{max}}=0.11$ mb/sr.
313020				$(d\sigma/d\Omega)_{\text{max}}=0.049$ mb/sr.
331030	7/2-#	3	2.08	$(d\sigma/d\Omega)_{\text{max}}=0.12$ mb/sr.
363030		3	=0.76	C ² S: for L+1/2.
				$(d\sigma/d\Omega)_{\text{max}}=0.034$ mb/sr.

[†] Level energies with uncertainty of 10 keV assigned for groups with $\sigma>0.5$, 20 keV for $\sigma=0.1-0.5$ and 30 keV for $\sigma<0.1$ and doublets from 1965Fu06.[‡] Spin and parity from $\sigma(\theta)$ DWBA analysis and angular distributions of vector analyzing power $A_y(\theta)$ (1976Hu06), unless otherwise stated.[§] From comparison with DWBA calculations in 1965Fu06.# From comparison of $A_y(\theta)$ distributions with empirical curves, based on L=3, L+1/2 states in ^{57}Ni and ^{59}Ni (1976Hu06).@ $A_y(\theta)$ analyzed for composites of (g.s.+65) keV and (1110+1186) keV (including 1132) in 1976Hu06.

⁶²Ni(³He,α) 2013Sc06,1968Ru02

2013Sc06, 2013ScZZ: E(³He)=25 MeV from WNSL-Yale tandem accelerator facility. Measured α spectra, σ(θ), spectroscopic factors C²S using a split-pole Enge spectrograph. FWHM ≈75 keV. Target=219 μg/cm² thick 96.5% enriched. Deduced levels, J, π. DWBA analysis. Comparison with shell-model calculations.
The main purpose of the neutron adding and neutron removal reaction studies by 2013Sc06 was to obtain occupancies of neutron orbitals, proton vacancies, and energy centroids of neutron, neutron-holes, proton-single particle excitations in ⁶⁰Ni and ⁶²Ni, and thereby investigate closure of 0f_{7/2} shell. Some data details of this study are supplied in 2013ScZZ.
1968Ru02: E=25 MeV. Measured σ(Eα,θ), 34 angles between 7.5° and 90°, semi, FWHM=140 keV.
Other: 1969Ar20.

dσ/dΩ in mb/sr (2013ScZZ)

Level	5° (³ He,α)
0	1.04
67	2.53
283	0.36
656	0.074
909	0.056
1015	0.012
1100	0.12
1132	0.24
1185	0.25
1455	0.73
1610	0.16
1729	0.055
2122	0.51
2469	0.21
2593	0.042
2905	1.11
3308	1.52

The uncertainties are estimated to be ≈4% for σ>1 mb/sr, ≈7% for 0.1<σ<1.0 mb/sr, and ≈18% for σ<0.1 mb/sr at their respective maxima. The uncertainties arising from possible contaminants or previously unidentified states for very weak transitions could be ≈0.02 mb/sr.

⁶¹Ni Levels

E(level) [†]	L [‡]	S [‡]	Comments
0.0			
67	3	2.07	S: for Jπ=5/2-. L=(1+3), S=3.03 for L=3, 5/2- (1968Ru02).
283			
656			
909	3	0.04	S: for Jπ=5/2-.
1015	3	0.009	S: for Jπ=7/2-.
1100			
1132	3	0.18	S: for Jπ=5/2-. 1968Ru02 report 1150 group with L(1+3), S=0.59 for L=3, 5/2-.
1185			
1455	3	0.54	S: for Jπ=7/2-. Other: S=0.47 for L=3, 7/2- (1968Ru02).
1610	3	0.11	S: for Jπ=5/2-.
1729			
2122	4	0.34	S: for Jπ=9/2+. Other: S=0.27 for L=(4), 9/2+ (1968Ru02).
2469	3	0.15	S: for Jπ=7/2-. Other: S=0.23 for L=3 (1968Ru02).
2593	3	0.03	S: for Jπ=7/2-.
2905	3	0.80	S: for Jπ=7/2-. Other: S=0.60 for L=3, 7/2- (1968Ru02).
3308	3	1.11	S: for Jπ=7/2-. Other: S=0.91 for L=3, 7/2- (1968Ru02).
4940 40	(3)	(0.69)	E(level),L,S: from 1968Ru02 only; level not reported in 2013Sc06.

[†] 2013Sc06 quote values from 1999-NDS for A=61 (1999Bh04). These values are nearly the same as in Adopted Levels here.

[‡] From 2013Sc06, 2013ScZZ, except for the 4940 group reported only in 1968Ru02.

⁶³Cu(d,α) 1969Da09,1967Hj01

1969Da09: E=10.5–12.5 MeV. Measured $\sigma(E, E\alpha, \theta)$, $\theta=50^\circ$, 70° , semi, FWHM=60 keV, measured $E\alpha$, magnetic spectrograph, FWHM=11 keV, the authors proposed only an α -particle spectral Fig. 2 up to 3550 keV.
 1967Hj01: E=15 MeV. Measured $\sigma(E\alpha, \theta)$, 15 angles between 20° and 90° , magnetic spectrograph, FWHM=50 keV, enriched target.
 $J\pi(^{63}\text{Cu g.s.})=3/2^-$.

⁶¹Ni Levels

E(level) [†]	L [‡]	S [§]	Comments
0.0	(0+2)	4.16	
68	4	1.98	
283	(0+2)	1.16	
656	(0+2)	0.47	
910			
1017			
1101			
1133	(0+2)	1.77	L,S: for 1100+1132 levels.
1186	(0+2)	1.19	
1455	(4)	1.46	
1610?			
1730			
1809			
1984	(4)	1.89	L,S: for 1988+2018 levels. doublet 1984 and 1997.
2015			
2116	(4)	1.10	doublet 2116 and 2124.
2407			
2466	(4)	1.64	L,S: for 2407+2464 levels.
2527			
2594			
2641			
2696			
2762?			
2791			doublet 2791 and 2801.
2857			
2895	4	2.57	
3040			
3060			
3105	(2)	0.60	L,S: for 3106+3125+3145 levels.
3125			
3145			
3189?			
3236?			
3256 [‡]	4	8.61	L,S: for 3260+3288 levels. doublet 3256 and 3265. doublet 3282 and 3293.
3282			
3354?			
3430			
3530			
3748 [‡] 50			
3960 [‡] 50			
4050 [‡] 50			
4201 [‡] 50			
4291 [‡] 50			
4430 [‡] 50			
4657 [‡] 50			
4824 [‡] 50			
5074 [‡] 50			

[†] The level energies from Fig. 2 in 1969Da09, except as noted.

[‡] From 1967Hj01.

[§] Spectroscopic coefficient from comparison to DWBA calculations with theoretical admixture of L values (1967Hj01).

 $^{64}\text{Zn}(\text{n},\alpha)$ 1984Em01

1984Em01: E=thermal. Measured $\sigma(\text{E}\alpha)$. Deduced ^{61}Ni levels.

 ^{61}Ni Levels

E(level)[†]

0.0

67

484

[†] ΔE not given by authors.

Adopted Levels, Gammas

Q(β^-)=-5635 16; S(n)=11710.6 19; S(p)=4800.3 10; Q(α)=-5063.8 11 2012Wa38.

S(2n)=21768.7 11, S(2p)=14332.7 10 (2012Wa38).

⁶¹Cu produced and identified by 1937Th01 (deuteron bombardment of Ni by 5 MeV deuterons followed by chemical separation), and 1937Ri01 (E=9 MeV alpha bombardment of Ni, chemical separation).

2010Vi07: measured spin, magnetic dipole moment and electric quadrupole moment, hyperfine structure study at ISOLDE-CERN using collinear and in-source laser spectroscopy.

⁶¹Cu Levels

Cross Reference (XREF) Flags

A ⁶¹Zn ϵ Decay (89.1 s)
 B ²⁸Si(³⁶Ar,3p γ)
 C ⁴⁰Ca(²⁴Mg,3p γ)
 D ⁴⁰Ca(²⁸Si, α 3p γ)
 E ⁵⁸Ni(α ,p)
 F ⁵⁸Ni(α ,p γ)

G ⁵⁸Ni(¹⁶O,¹³N)
 H ⁵⁹Co(³He,n γ)
 I ⁶⁰Ni(p, γ): Resonances
 J ⁶⁰Ni(p,p),(p,p'): Resonances
 K ⁶⁰Ni(d,n)
 L ⁶⁰Ni(³He,d)

M ⁶⁰Ni(α ,t)
 N ⁶¹Ni(p,n): Resonances
 O ⁶¹Ni(p,n),(p,n γ)
 P ⁶³Cu(p,t)
 Q ⁶⁴Zn(p, α)

E(level) [†]	J $\pi^{\ddagger}$	XREF	T _{1/2} [#]	Comments
0.0@	3/2-	ABCDEFGHI KLM OPQ	3.339 h 8	% ϵ +% β^+ =100. μ =+2.1083 5 (2011Vi03,2014StZZ). Q =-0.221 10 (2011Vi03,2013StZZ,2014StZZ). $J\pi$: atomic beam (1958Re10,1957Ni09); hyperfine structure (2011Vi03, 2010Vi07). Parity from L(³ He,d)=1. Dominant configuration= $\pi p_{3/2}$ from comparison of measured g factor with predictions from shell-model calculations (2010Vi07). μ , Q : from 2011Vi03 (also 2010Vi07), hyperfine structure using collinear laser spectroscopy. Value of Q =-0.211 10 in 2011Vi03 and -0.21 2 in 2010Vi07 re-evaluated by 2013StZZ. Other μ : +2.14 4 (atomic beam, 1966Do01). T _{1/2} : weighted average of 3.32 h 3 (1954Be84), 3.27 h 10 (1956Ru45), 3.408 h 10 (1969Ri04, uncertainty increased to 0.030 in averaging procedure), 3.26 h 5 (1972Du09), 3.34 h 1 (1972Cr02), 3.39 h 4 (1973Ne02) 3.24 h 16 (1982Ma41), 3.333 5 (1982Gr10, uncertainty is statistical, increased to 0.010 in averaging procedure), 3.36 h 6 (2006Ab30). Others: 3.4 h 1 (1937Ri01,1937Th01,1950Ku05,1950Bo34), 3.33 h (1948Co08).
475.05 6	1/2-	A EFGHI KLM OPQ	0.66 ps 9	$J\pi$: L(³ He,d)=L(d,n)=1, J not 3/2 from $\gamma(0)$ in (α ,p γ).
970.07& 5	5/2-	ABCDEFGHI KLM OPQ	0.69 ps 13	$J\pi$: L(³ He,d)=L(d,n)=3, log ft=7.1 from 3/2- in ⁶¹ Zn ϵ decay.
1310.49@ 7	7/2-	ABCDEFGHI LM OPQ	0.53 ps 7	XREF: G(1330). $J\pi$: $\gamma(0)$ in (α ,p γ); $\gamma(\text{lin pol})$ in (²⁴ Mg,3p γ).
1394.29 6	5/2-	AB DEF HI KLM OPQ	0.85 ps 14	$J\pi$: L(³ He,d)=L(d,n)=3, $\gamma(0)$ in (α ,p γ).
1660.42 7	3/2-	A EF HI O Q	0.182 ps 19	$J\pi$: log ft=5.30 from 3/2-; $\gamma(0)$ in (α ,p γ).
1701	7/2-	G L		
1732.58 5	7/2-	ABCDEF HI O Q	>1.4 ps	$J\pi$: $\gamma(0)$ in (α ,p γ), π from M1+E2 from 1942,7/2-.
1904.20 13	5/2-	A F HI L O Q	180 fs 19	$J\pi$: L(³ He,d)=3; log ft=6.8 from 3/2-.
1919 3		E		
1932.52 9	3/2-	A EFGHI KLM O Q	87 fs 10	XREF: G(1940). $J\pi$: L(³ He,d)=L(d,n)=1, $\gamma(0)$ in (α ,p γ).
1942.56 11	7/2-	BCD F HI O Q	1.2 ps +11-4	$J\pi$: $\gamma(0)$ in (α ,p γ), 1942 γ to 3/2- is E2.
2088.89 9	(1/2)-	A EFG I L O Q	40 fs 4	$J\pi$: L(³ He,d)=1; $\gamma(0)$ in (α ,p γ). T _{1/2} : from (α ,p γ). Other: 28.4 fs 35 in ⁶¹ Ni(p,n γ).
2203.41 11	5/2-	EF I LM O Q	173 fs 20	$J\pi$: L(³ He,d)=3; E2 γ to 1/2-.
2295.22 9	9/2-	B DEF I O Q	1.8 ps 6	$J\pi$: $\gamma(0)$ in (α ,p γ), 1325 γ to 5/2- is E2.
2336.39& 8	9/2-	BCDEF I K O Q	430 fs 50	$J\pi$: $\Delta J=2$, E2 γ to 5/2-. (5/2-) proposed for a 2335 5 group in (α ,p) is in disagreement, if same level as 2336.4.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)
⁶¹Cu Levels (continued)

E(level) [†]	Jπ [‡]	XREF	T _{1/2} [#]	Comments
2358.13 10	3/2-	A EF I L O Q	197 fs 24	E(level): possibly doublet (1973Sa19). Jπ: L(³ He,d)=1, γ(θ) in (α,pγ).
2399.35 13	7/2-	EF G I L O Q	121 fs 14	Jπ: L(³ He,d)=3, γ(θ) in (α,pγ).
2472.49 10	3/2-	A EF I L O Q	75 fs 8	Jπ: L(³ He,d)=1, γ(θ) in (α,pγ).
2583.77 22	3/2, 5/2	F I O Q	102 fs 12	XREF: O(2575).
2584.6 5	3/2, 5/2	EF Q	98 fs 12	Jπ: γ(θ) in (α,pγ).
2611.99 8	9/2-	BCDEF I Q	280 fs 40	Jπ: γ(θ) in (α,pγ), 879γ to 7/2- is M1+E2.
2627.12 [@] 9	11/2-	BCDEF I	>350 fs	
2684.03 18	3/2-	A EF I L Q	85 fs 12	Jπ: L(³ He,d)=1, γ(θ) in (α,pγ).
2706 15	9/2+	G Q		
2720.34 ^a 9	9/2+	BCDEF I LM Q	>2.8 ps	Jπ: L(³ He,d)=L(α,p)=4,; γ(θ) in (α,pγ); σ(θ) in (α,p).
2728.21 15	7/2-	F I	0.23 ps 3	Jπ: γ(θ) in (α,pγ), 1758γ to 5/2- is M1+E2.
2792.56 10	5/2-	A EF I KL Q	116 fs +20-40	Jπ: L(³ He,d)=3; log ft=5.21 from 3/2-.
2840.53 13	1/2-, 3/2-	A EF I LM Q		Jπ: L(³ He,d)=L(d,n)=1.
2857.1 3	(3/2)-	A EF I L Q		Jπ: L(³ He,d)=1; 3/2- supported in (α,p) from σ(θ) and DWBA.
2924.2 4	(5/2, 7/2)-	EF Q	0.27 ps 4	Jπ: 1192γ to 7/2- is M1(+E2); σ(θ) and DWBA in (α,p); possible 297γ to 11/2- disfavors 5/2.
2932.56 14	3/2-	A F I L	65 fs 13	Jπ: L(³ He,d)=1; γ(θ) in (α,pγ).
3001.67 17	5/2	EF I Q	0.17 ps 6	Jπ: γ(θ) of primary-γ in ⁶⁰ Ni(p,γ).
3015.73 11	11/2-	BCDEF I Q	0.29 ps 4	
3019.3 10	3/2-	A F I LM	69 fs 11	Jπ: L(³ He,d)=1, γ(θ) in (α,pγ).
3042.0? 7	3/2-	I K Q		
3065.57 21	3/2-	EF I L Q	40 fs 6	Jπ: L(³ He,d)=L(d,n)=1, γ(θ) in (α,pγ).
3092.1 5	3/2-	A EF I LM Q	33 fs 5	Jπ: L(³ He,d)=1, γ(θ) in (α,pγ).
3198.58 23		EF K Q		
3249 15		Q		
3260.42 8	11/2-	BCDEFG I Q	0.35 ps 5	Jπ: ΔJ=2, E2 γ to 7/2-; ΔJ=1, (M1+E2) γ to 9/2-.
3277.1 4		E I L Q		Jπ: L(³ He,d)=(4) suggests (7/2+, 9/2+), but γ to 3/2- and γ from a 6627, 1/2- level requiring high multipolarities disfavors such an assignment. It is possible there are two separate levels near this energy, one with a high spin of 7/2 or 9/2 and the other of low spin of 1/2, 3/2.
3323.1 5	(3/2)	EF Q		Jπ: σ(θ) and DWBA in (α,p).
3358.2 6		I Q		
3364 6		E		
3372.9 4	(9/2)	F		Jπ: γ(θ) in (α,pγ).
3411.7 7	(5/2)+	E G I LM Q		Jπ: L(³ He,d)=2; 5/2+ from σ(θ) and DWBA in (α,p).
3430.3 6		I Q		
3437.1 11		E I		
3454.4 4	3/2+, 5/2+	EF K Q		Jπ: L(d,n)=2.
3521.2 15	1/2-, 3/2-, 5/2-	A EF I Q		Jπ: log ft=5.5 from 3/2-.
3548.78 12	(11/2-)	BC EF Q		
3578 6	3/2+, 5/2+	E LM Q		Jπ: L(³ He,d)=2.
3591 2	(5/2+)	E I		Jπ: σ(θ) and DWBA in (α,p).
3612.6 10		E I		
3647 5	(5/2, 7/2)	E		Jπ: σ(θ) and DWBA in (α,p).
3653.3 11		D		
3660 6		E		
3686 7		E		
3706.1 6		E I		Jπ: σ(θ) and DWBA in (α,p) suggest (11/2-); but gamma rays from 3/2 resonances at 6362, 6372 and 6393 suggest a maximum spin of 7/2.
3730.1 5		I		
3739.5 5	(11/2)	FG		Jπ: γ(θ) in (α,pγ).
3748 7		E		
3780.6 ^{&} 3	13/2-	BC		

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Adopted Levels, Gammas (continued)

61Cu Levels (continued)

E(level) [†]	Jπ [‡]	XREF	Comments
3790.2 5		E I	Jπ: σ(θ) and DWBA in (α,p) suggest (7/2,9/2), but it is in conflict with γ from a 1/2+ resonance at 6802 keV. There may be two separate levels near this energy, one of high spin 7/2 or 9/2 and the other of low spin of 1/2 or 3/2.
3820 5	1/2+	E K	Jπ: L(d,n)=0.
3853.5 5	(7/2, 5/2)	EF	Jπ: σ(θ) and DWBA in (α,p).
3863	1/2-, 3/2-	LM	Jπ: L(³ He,d)=1.
3942.54 ^b 12	(11/2+)	BCD F	
3944 5	(9/2+)	E	Jπ: σ(θ) and DWBA in (α,p).
3947.0? 6		I	
3967	1/2-, 3/2-	L	Jπ: L(³ He,d)=1.
3970.80 22	(13/2-)	B	
3980.6 5	(7/2-, 5/2)	E I	Jπ: σ(θ) and DWBA in (α,p).
4008 2	(1/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4041 5	(7/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4052.45 23	(13/2-)	B D	
4060		G	
4081.34 ^a 10	13/2+	BCD F	
4085 2	(9/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4132.8 4	9/2+	E I L	XREF: L(4125). Jπ: from (p,γ) resonance, IAR analysis.
4232 5	(11/2-)	E	Jπ: σ(θ) and DWBA in (α,p).
4260 5	(7/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4287.7 10	(13/2-)	BCD	
4296.1 10	(11/2-)	E I	
4333.0? 5	(7/2, 5/2+)	E G I	XREF: E(4337). Jπ: σ(θ) and DWBA in (α,p).
4357	(1/2)+	L	Jπ: L(³ He,d)=0.
4380.4 10		D I	
4386 5	(9/2-)	E	Jπ: σ(θ) and DWBA in (α,p).
4423 5	7/2-, 9/2-	E L	Jπ: L(d, ³ He)=3.
4463 5	(9/2-, 7/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4466.2 [@] 11	(15/2-)	BCD	
4470 50	3/2+, 5/2+	K	Jπ: L(d,n)=2.
4484	5/2-, 7/2-	L	Jπ: L(³ He,d)=3.
4516 5	(7/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4560 5	(5/2, 7/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4590.61 9	13/2+	BCD	
4598 2	(7/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4603	1/2-, 3/2-	L	Jπ: L(³ He,d)=1.
4665 5	(7/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4702 5	(7/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4756 5	(7/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4817 5	(9/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4819.57 21	(15/2-)	BCD	
4845 5	(9/2-, 7/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4859	5/2-, 7/2-	L	Jπ: L(³ He,d)=3.
4879 5	(7/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4909 5	(9/2, 7/2)	E K	
4943 5	(7/2)	E	Jπ: σ(θ) and DWBA in (α,p).
4990.65 ^b 25	(15/2+)	BC	
5015 2	(9/2)	E	Jπ: σ(θ) and DWBA in (α,p).
5063 5		E	
5072	7/2+, 9/2+	L	Jπ: L(³ He,d)=4.
5101 5		E	
5119.96 ^a 11	17/2+	BCD	
5126.3 5		I	
5135.6 14	(15/2+)	BCD	
5153 2	(9/2-, 7/2)	E	Jπ: σ(θ) and DWBA in (α,p).
5251.7 4		I K	
5278	7/2+, 9/2+	L	Jπ: L(³ He,d)=4.
5302.0 3		B	
5431	7/2+, 9/2+	L	Jπ: L(³ He,d)=4.

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Adopted Levels, Gammas (continued) ^{61}Cu Levels (continued)

E(level) [†]	$J\pi^{\ddagger}$	XREF		Comments
5464.4 5		C	I	
5513.7 11			I	
5532.03 $\pm$ 23	(13/2+)	B		
5579.9 $\pm$ 9	(17/2-)	B		
5580 50	1/2+		K	$J\pi$: L(d,n)=0.
5680.8 22			I	
5702.34 21	(15/2+)	BC		
5729.50 ^h 36	15/2+	B		
5732	3/2+, 5/2+		L	$J\pi$: L(^3He ,d)=2.
5748.75 23	(17/2-)	B		
5788	1/2+		L	$J\pi$: L(^3He ,d)=0.
5812.6 22			I	
5849.8 8			IJ	
5853.3 3	(17/2+)	B		
5856.3 ^b 14	19/2+	BCD		
5860.6 9			IJ	
5913.9 22			I	
5917.0 10			J	
5948.3 22			I	Probably a doublet.
5960.2 7			J	
5972.4 12			J	
5977.8 22			I	
5987.4 6			IJ	
6019.1 22			I	
6026.6 7			IJ	
6055.95 $\pm$ 14	(17/2+)	BC		
6084	1/2+		L	$J\pi$: L(^3He ,d)=0.
6091.9 22			I	
6098.3 9			IJ	
6101.7 22			I	
6109.6 22			I	
6123.9 7			IJ	
6125.3 22			I	
6150.1 9			IJ	
6158.8 22			I K	
6192.8 10			IJ	
6207.9 22			IJ	
6227.1 6	(1/2)		IJ	
6237.4 22			I	
6241.4 22			I	
6259.1 22			I	
6266.9 22			I	
6290.5 22			IJ	
6294.5 22			I	
6304.3 22			I	
6313.6 8			IJ	
6340.7 22			I	
6351.1 5	(3/2)		IJ	$J\pi$: D+Q γ to 1/2-.
6362.0 3	3/2		IJ	
6372.7 6	3/2		IJ	
6378.5 3	3/2		IJ	
6393.4 4	3/2-		IJ L	XREF: L(6402). $J\pi$: L(^3He ,d)=1; $\gamma(\theta)$ in (p, γ).
6412.5 22			I	
6418.2 6			IJ	
6420 50	1/2-, 3/2-		K	$J\pi$: L(d,n)=1.
6422.3 22			I	
6429.6 11	(1/2)		IJ	
6441.6 6	5/2		IJ	
6446.1 3	5/2		I	
6451.8 22			I	
6457	(1/2 to 7/2)-	G	L	$J\pi$,E(level): L(^3He ,d)=1+3; doublet with 1/2-,3/2- and 5/2-,7/2-.
6457.6 6	5/2		I	

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Adopted Levels, Gammas (continued)
⁶¹Cu Levels (continued)

E(level) [†]	Jπ [‡]	XREF	Comments
6466.4 4	3/2	IJ	
6470.5 22		I	
6485.6 14		IJ	
6493.1 22		I	
6505.6 5	3/2	I	
6509.3 7		IJ	
6528.5 22	3/2	I	
6535.1 6	(3/2)	I	
6541.1 5	3/2	IJ	
6554.1 22		I	
6564.6 15	3/2	IJ	
6572.2 ^h 3	(19/2+)	B	
6584.3 4	1/2+ [§]	IJ	
6585.2 10	(3/2, 5/2)	I	
6590.7 15		J	
6605.0 10	3/2	IJ	
6619.5 4	3/2	IJ	
6627.2 3	1/2- [§]	IJ	E(level): probably a fragment of the analog of the 283-keV, 1/2-, state in ⁶¹ Ni.
6629.8 8		IJ	
6645.1 4	1/2- [§]	IJ	E(level): there is probably a doublet at 1876 keV. The dominant component is probably a fragment of the analog of the 283-keV, 1/2-, state in ⁶¹ Ni.
6678.4 3	(1/2-) [§]	IJ	
6681.2 6	1/2-, 3/2-	JK	Jπ: L(d,n)=1.
6693.8 22	1/2+ [§]	IJ	
6699.0 7	1/2-, 3/2-	J L	Jπ: L(³ He,d)=1.
6706.5		I	
6712.4 9	3/2-	IJ	
6725.7 8		J	
6739.0 5	3/2-, 5/2-	I	
6744.7 6		J	
6762.7 6	3/2-, 5/2-	IJ	
6784.6 14		J	
6799.0		I	
6802.3 4	1/2+ [§]	IJ	
6804.0 8		J	
6814.1 6	(3/2, 5/2, 1/2)	IJ	
6822.1 ^a 14	21/2+	BCD	
6847.8 9		J	
6868.4 6		J L	
6889.5 7		J	
6912.5 8		J	
6915.0 6	(3/2-)	I	
6937.4 5	3/2-	I	
6940.3 7		J	
6953.4 22	1/2+ [§]	J	
6972.0 8		J L	
6991.8 22	1/2+ [§]	J	
6997.3 6		J	
7011.2 12	3/2-	IJ	E(level): probably a fragment of the analog of the 656-keV, 1/2-, state in ⁶¹ Ni. E(p)=2242 5 (1988Iz01).
7016.3 6	3/2-	I	
7025.9 11	5/2	IJ	
7039.0 22	1/2+ [§]	J	
7043.8 7	(3/2, 1/2-)	IJ	
7054.7 22	1/2+ [§]	IJ	E(level): probably a doublet.
7060.0 4	3/2-	IJ	E(level): 2299 in table 3 of 1988Iz01.
7084.2 22	(1/2-, 3/2-) [§]	J	
7090.5 8		J	
7107.3 4	(1/2+) [§]	IJ	
7113.7 22	(3/2-, 1/2-) [§]	J	
7120.8 7	3/2-	I	

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Adopted Levels, Gammas (continued) ^{61}Cu Levels (continued)

E(level) [†]	$J\pi^{\ddagger}$	XREF	Comments
7124.4 ^d 6	(19/2)	B	
7130 50	1/2-, 3/2-	K	$J\pi$: L(d,n)=1.
7159 5	5/2	I	
7192		L	
7197.3 22	1/2+ [§]	J	
7201.3 5	(3/2-)	I	
7214.3 5	3/2-	I	
7223.2 4	1/2+ [§]	IJ	
7241.6 22	(1/2-, 3/2-) [§]	J	
7262.9 4	1/2+ [§]	IJ	
7274.0 22	(3/2-, 1/2-) [§]	J	
7283.2 3	1/2+ [§]	IJ	
7306.02 25	21/2+	B	
7313.3		I	
7316.3 22	1/2+ [§]	J	
7319.2		I	
7329.1 22	(1/2-, 3/2-) [§]	J	
7370 50	5/2-, 7/2-	K	$J\pi$: L(d,n)=3.
7378.3 22	5/2+ [§]	J	
7387.1 ^b 17	23/2+	BCD	
7401	5/2-, 7/2-	L	$J\pi$: L(d,n)=3.
7414.6 22	(1/2-, 3/2-) [§]	J	
7428.4		I	
7430.4 22	1/2+ [§]	J	
7438.2 22	1/2+ [§]	J	
7455.2 10	(21/2+)	B	
7474.6 22	1/2- [§]	J	
7485.5 22	1/2- [§]	J	
7489.4 22	1/2- [§]	J	
7497.3 22	1/2- [§]	J	
7510.0 22	1/2+ [§]	IJ	
7519.9 22	(3/2-, 1/2-) [§]	J	
7525.8 22	(3/2+, 5/2+) [§]	J	
7535.4 13	(21/2-)	B	
7541.5 22	1/2- [§]	J	
7549.4 22	1/2+ [§]	IJ	
7554.3 22	1/2- [§]	J	
7556.3 22	1/2- [§]	IJ	
7560.2 22	1/2+ [§]	IJ	
7569.0 22	(5/2+, 3/2+) [§]	J	
7572.0		I	
7578.9 22	1/2- [§]	J	
7581.8 22	1/2- [§]	J	
7583.8 22	1/2- [§]	J	
7588.7 22	1/2- [§]	J	
7606.5 19	(21/2+)	B	
7608.4 22	(3/2-, 1/2-) [§]	J	
7620 50	1/2-, 3/2-	K	$J\pi$: L(d,n)=1.
7631.0 22	(5/2+, 3/2+) [§]	J	
7636.9 22	1/2+ [§]	J	
7638.9 22	(5/2+) [§]	J	
7643	(1/2 to 7/2)-	L	$J\pi, E(\text{level})$: L($^3\text{He}, d$)=1+3; doublet with 1/2-, 3/2- and 5/2-, 7/2-.
7645.8		I	
7647.7 22	1/2+ [§]	IJ	
7657.6 22	(3/2-, 1/2-) [§]	J	
7662.5 22	(5/2+, 3/2+) [§]	J	
7672.3 22	(5/2+, 3/2+) [§]	J	
7681.2 22	1/2+ [§]	J	
7702.1	3/2+ [§]	J	
7702.7	(5/2+) [§]	J	
7705.3	(1/2-) [§]	J	
7722.5	(3/2+) [§]	J	
7728.7	(1/2-) [§]	J	

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Adopted Levels, Gammas (continued)

 ^{61}Cu Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	XREF	Comments
7743.9	1/2+ $\S$	J	
7746.0	(5/2+) $\S$	J	
7762.0	(5/2+) $\S$	J	
7767.4	1/2+ $\S$	J	
7781.9	(3/2-) $\S$	J	
7785.1	(5/2+) $\S$	J	
7805.8	3/2+ $\S$	J	
7806.7	1/2+ $\S$	J	
7837.5	(3/2+) $\S$	J	
7842.6	1/2+ $\S$	J	
7847.1 5	3/2+ $\S$	IJ	
7849.5	(1/2-) $\S$	J	
7855.0	3/2- $\S$	J	
7858.6 ^c 9	(21/2)	B	
7886.2	(1/2-) $\S$	J	
7894.1	(1/2-) $\S$	J	
7896.4	1/2+ $\S$	J	
7919.2	1/2+ $\S$	J	
7921.1	1/2- $\S$	J	
7931.2	(5/2+) $\S$	J	
7937.0 17	23/2-	BCD	
7943.6	1/2+ $\S$	J	
7946.9	3/2+ $\S$	J	
7950.9	1/2- $\S$	J	
7962.4	1/2+ $\S$	J	
7970.2	1/2+ $\S$	J	
7971.9	3/2- $\S$	J	
7987.5	1/2+ $\S$	J	
7996.9	1/2+ $\S$	J	
8006.1	3/2- $\S$	J	
8015.3	3/2+ $\S$	J	
8016.3	1/2- $\S$	J	
8019.8	1/2- $\S$	J	
8023.3	5/2+ $\S$	J	
8028.3	(5/2+) $\S$	J	
8030.3 ^h 5	(23/2+)	B	
8031.6	(5/2+) $\S$	J	
8043.1	(5/2+) $\S$	J	
8054.8	(1/2-) $\S$	J	
8057.3	1/2+ $\S$	J	
8067.9	(5/2+) $\S$	J	
8075.4	3/2- $\S$	J	
8076.3	1/2+ $\S$	J	
8086.6	1/2+ $\S$	J	
8090.2	5/2+ $\S$	J	
8096.8	3/2- $\S$	J	
8101.8	1/2+ $\S$	J	
8103.1	(1/2-) $\S$	J	
8108.6	1/2+ $\S$	J	
8113.1	5/2+ $\S$	J	
8118.5	1/2- $\S$	J	
8120.7	(5/2+) $\S$	J	
8121.7	1/2+ $\S$	J	
8122.5	3/2- $\S$	J	
8127.7	(5/2+) $\S$	J	
8131.9 5	1/2+ $\S$	IJ	
8139.5	(1/2-) $\S$	J	
8139.6	(5/2+) $\S$	J	
8148.9	1/2+ $\S$	IJ	
8151.5	(5/2+) $\S$	J	
8156.1	5/2+ $\S$	J	
8162.0	5/2+ $\S$	J	
8164.9	(1/2-) $\S$	J	

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Adopted Levels, Gammas (continued)
⁶¹Cu Levels (continued)

E(level) [†]	Jπ [‡]	XREF	Comments
8167.8	5/2+ [§]	J	
8168.7	(1/2-) [§]	J	
8170.0	1/2- [§]	J	
8171.2	5/2+ [§]	J	
8173.6	1/2+ [§]	J	
8175.3	1/2+ [§]	J	
8177.9	3/2- [§]	J	
8181.2	1/2- [§]	J	
8187.5	(5/2+) [§]	J	
8194.4 5	(5/2+) [§]	IJ	
8212.1 8	(21/2-)	B	
8222.4	1/2- [§]	J	
8250.3	1/2- [§]	J	
8272.4	1/2- [§]	J	
8290.1	3/2- [§]	J	
8307.6	1/2- [§]	J	
8333.8 8	(23/2+)	B	
8358.1 7		B	
8361.0	1/2- [§]	J	
8364.6	1/2- [§]	J	
8415.3	1/2- [§]	J	
8426.8	1/2- [§]	J	
8431.4 4	5/2	I	
8436.4 7	1/2	I	
8440.0 4	1/2	I	
8442.8 7	3/2, 5/2	I	
8446.0 5		I	
8447.1 5	9/2+	I	
8448.2 4	9/2+	I	
8448.3	3/2- [§]	J	
8449.2	9/2+ [§]	J	
8454.5 4	9/2+ [§]	IJ	
8455.6	1/2, 3/2	IJ	
8458.6 4	9/2+ [§]	IJ	
8460.1	9/2+ [§]	J	
8464.4 4	9/2+ [§]	IJ	XREF: J(8466).
8465.9 4	9/2+ [§]	IJ	XREF: J(8467.8).
8466.0	1/2	I	
8468.7	1/2- [§]	J	
8469.5 6	5/2	I	
8473.1 4	9/2+ [§]	IJ	
8476.3 4	9/2+ [§]	IJ	
8477.9	1/2- [§]	J	
8478.3 4	9/2+ [§]	IJ	
8481.5 5	9/2+ [§]	IJ	
8481.7	3/2	I	
8483.5 5	9/2+ [§]	IJ	
8485.0 4	9/2+ [§]	IJ	
8488.0	1/2- [§]	J	
8489.9 6	1/2	I	
8492.4 5	3/2	I	
8497.8	3/2- [§]	J	
8499.9 6	5/2	I	
8503.7 10		I	
8507.3 10	1/2	I	
8508.1 5	1/2	I	
8509.9 4		I	
8515.4 10		I	
8522.6 7	1/2, 3/2	I	
8561	7/2+, 9/2+	L	Jπ: L(³ He,d)=4.
8591.0	3/2- [§]	J	
8625.4 ^d 9	(23/2)	B	
8631.1	3/2- [§]	J	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{61}Cu Levels (continued)

E(level) [†]	$J\pi^{\ddagger}$	XREF	Comments
8670 40		L	
8678.7 ⁱ 4	(21/2-)	B	
8692.5	1/2- $\S$	J	
8731.6	1/2- $\S$	J	
8734.3	1/2- $\S$	J	
8742.7	1/2- $\S$	J	
8789.0 ^g 4	(25/2+)	B	
8885.1 5	(25/2+)	B	
9138.8 23		B	
9142	(3/2 to 9/2)+	L	$J\pi$, E(level): $L(^3\text{He}, d)=2+4$; doublet with 3/2+, 5/2+ and 7/2+, 9/2+.
9287.1 ^j 4	(23/2-)	B	
9408.1 20	27/2-	BCD	
9474.4 ^c 10	(25/2)	B	
9643.9 15	(25/2-)	B	
9692.7 5	(25/2-)	B	
9725.1 ^h 5	(27/2+)	B	
9789.9 8	(27/2-)	B	
9957.5 ⁱ 3	(25/2-)	B	
9963	7/2+, 9/2+	L	$J\pi$: $L(^3\text{He}, d)=4$.
10342.4 ^d 10	(27/2)	B	
10347.2 11	(25/2+)	B	
10409.5 ^k 10	(25/2+)	B	E(level): any one of the 10409 or 10463 levels can be the bandhead of SD-1 band.
10462.7 12	(25/2+)	B	E(level): see comment for 10409.5 level for bandhead of SD-1 band.
10671.9	1/2+ $\S$	J	
10687.7 ^j 4	(27/2-)	B	
10906.6 ^g 9	(29/2+)	B	
11019 4		B	
11132.9 7	(31/2-)	B	
11144 4		B	
11237.0 19	(27/2-)	B	
11255 4		B	
11301.6 ⁱ 4	(29/2-)	B	
11303.2 14	(27/2-)	B	
11369.5 ^c 10	(29/2)	B	
11449 ^m 3	(25/2+)	B	
11752.7 ^r 18	(29/2-)	B	
11768 7		N	
11775.8 ^k 11	(29/2+)	B	
11798 7		N	
11822 7		N	
11831 7		N	
11852 7		N	
11881 7		N	
11902 7		N	
11919 7		N	
11935 7		N	
11946 7		N	
11969 7		N	
11994 7		N	
12003.7 ^j 5	(31/2-)	B	
12054 7		N	
12084 7		N	
12086.6 ^h 11	(31/2+)	B	
12090 ⁿ 3	(27/2+)	B	
12102 7		N	
12121 7		N	
12148 7		N	
12166 7		N	
12189 7		N	
12215 7		N	
12253 7		N	
12273 7		N	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

⁶¹Cu Levels (continued)

E(level) [†]	Jπ [‡]	XREF	E(level) [†]	Jπ [‡]	XREF
12303 7		N	19134 ^l 4	(41/2+)	B
12314 7		N	19472 ^r 6	(41/2-)	B
12355.5 ^d 11	(31/2)	B	19562 ^p 3	(43/2+)	B
12356 7		N	19878 ^q 4	(43/2-)	B
12394 7		N	19970 ^k 3	(45/2+)	B
12409 7		N	20285 ⁿ 4	(43/2+)	B
12452 7		N	20550.6 ^e 23	(45/2)	B
12478 7		N	20723 ^o 3	(45/2+)	B
12494 7		N	20913.2 25	(45/2)	B
12506 7		N	21536 ^l 4	(45/2+)	B
12520 7		N	21839 ^m 5	(45/2+)	B
12793.5 ^q 16	(31/2-)	B	22212 ^p 4	(47/2+)	B
12839.2 ⁱ 6	(33/2-)	B	22284 6	(45/2+)	B
12847.3 ^m 25	(29/2+)	B	22718 ^r 6	(45/2-)	B
13146 4	(31/2-)	B	22984 ^k 4	(49/2+)	B
13206.0 ^o 20	(29/2+)	B	23376 ^q 6	(47/2-)	B
13284.5 ^k 17	(33/2+)	B	23418 ⁿ 6	(47/2+)	B
13419.7 17	(33/2+)	B	23662 ^o 4	(49/2+)	B
13678 ⁿ 3	(31/2+)	B	24337 ^l 4	(49/2+)	B
13823 ^l 5	(29/2+)	B	24612 6	(49/2+)	B
13874.2 ^p 19	(31/2+)	B	25121 ^m 6	(49/2+)	B
13983.5 ^e 12	(33/2)	B	25325 ^p 5	(51/2+)	B
14020.6 ^c 12	(33/2)	B	26577 ^k 6	(53/2+)	B
14023.8 ^j 12	(35/2-)	B	26842 6	(53/2+)	B
14068 ^r 3	(33/2-)	B	26928 ⁿ 7	(51/2+)	B
14163 3		B	27023 ^o 4	(53/2+)	B
14563 ^m 3	(33/2+)	B	27525 ^l 5	(53/2+)	B
14587.1 ^o 19	(33/2+)	B	28885 ^p 7	(55/2+)	B
14628.1 ^q 24	(35/2-)	B	x ^s	J ₁ +1	B
14800.4 ^f 12	(35/2)	B	339+x 3		B
15201.7 ⁱ 15	(37/2-)	B	790+x ^t 6	J ₁	B
15232.0 ^k 20	(37/2+)	B	2037.0+x ^s 20	J ₁ +3	B
15311 ^l 5	(33/2+)	B	2520+x ^t 5	J ₁ +2	B
15434.6 ^p 20	(35/2+)	B	4288+x ^s 3	J ₁ +5	B
15524 ⁿ 3	(35/2+)	B	4465+x ^t 5	J ₁ +4	B
15742.3 ^e 13	(37/2)	B	6674+x ^t 4	J ₁ +6	B
16302.2 ^o 21	(37/2+)	B	6735+x ^s 4	J ₁ +7	B
16571.2 ^f 15	(39/2)	B	9261+x ^t 5	J ₁ +8	B
16588 ^m 4	(37/2+)	B	9434+x ^s 5	J ₁ +9	B
16615 ^r 5	(37/2-)	B	12369+x ^t 6	J ₁ +10	B
16921 4	(39/2-)	B	12482+x ^s 6	J ₁ +11	B
17039 ^q 4	(39/2-)	B	15897+x ^s 7	J ₁ +13	B
17067 ^l 5	(37/2+)	B	y ^u	J ₂	B
17310.6 ^p 22	(39/2+)	B	1833+y 4	J ₂ +2	B
17431 ^k 3	(41/2+)	B	1846.1+y ^u 18	J ₂ +2	B
17618.0 ^e 16	(41/2)	B	3998.3+y ^u 24	J ₂ +4	B
17750 ⁿ 4	(39/2+)	B	6459+y ^u 3	J ₂ +6	B
18353.0 ^o 23	(41/2+)	B	9258+y ^u 5	J ₂ +8	B
18857.3 ^f 19	(43/2)	B	12432+y ^u 5	J ₂ +10	B
18995 ^m 4	(41/2+)	B			

[†] Level energies with ΔE<5 keV are deduced from least-squares fit to the Adopted E_γ data. The others are weighted averages from (α,p), (¹⁶O,¹³N), (d,n) and (³He,d).

[‡] For high-spin states (J>9/2), assignments are generally as proposed in (³⁶Ar,3p_γ) (2008An06), based on γγ(θ) data, band structures, decay pattern, and yrast nature of population of states in heavy-ion γ-ray studies. Also based on DCO from 1999Vi12, R(DCO) and linear polarization from 2004Iz01. The assignments for low-spin states are primarily from pγ(θ) in (α,pγ) and (p,γ) together analysis of resonances in (p,γ). The assignments deduced from angular momentum transfers are stated in separate arguments.

§ From resonance analysis in (p,p),(p,p'):resonances.

From DSA measurements in ⁵⁸Ni(α,pγ) reaction, except as noted.

@ (A): Band based on 3/2- g.s.,α=-1/2. Normal-deformed structure.

& (B): Band based on 5/2-,α=+1/2 Normal-deformed structure.

a (C): Band based on 9/2+,α=+1/2. Normal-deformed structure.

Adopted Levels, Gammas (continued)

61Cu Levels (continued)

- b (D): Band based on 11/2+, $\alpha=-1/2$. Normal-deformed structure.
- c (E): Band based on (21/2), $\alpha=+1/2$. Dipole dominated structure. Population intensity=1% of the reaction channel.
- d (F): Band based on (19/2), $\alpha=-1/2$. Dipole dominated structure. Population intensity=1% of the reaction channel.
- e (G): Band based on (33/2), $\alpha=+1/2$. Continuation of band based on 19/2. Dipole dominated structure. Population intensity=1% of the reaction channel.
- f (H): Band based on (35/2), $\alpha=-1/2$. Continuation of band based on 19/2. Dipole dominated structure. Population intensity=1% of the reaction channel.
- g (I): Band based on (13/2+), $\alpha=+1/2$. Dipole dominated structure. Population intensity=20% of the reaction channel.
- h (J): Band based on 15/2+, $\alpha=-1/2$. Dipole dominated structure. Population intensity=20% of the reaction channel.
- i (K): Band based on 21/2-, $\alpha=+1/2$. Dipole dominated structure. Population intensity=5% of the reaction channel.
- j (L): Band based on 23/2-, $\alpha=-1/2$. Dipole dominated structure. Population intensity=5% of the reaction channel.
- k (M): SD-1 band. Band based on 25/2+. Population intensity=7% of the reaction channel.
- l (N): SD-2 band. Band based on 29/2+. Population intensity=1% of the reaction channel.
- m (O): SD-3 band, $\alpha=+1/2$. Band based on (25/2+). Population intensity=1% of the reaction channel.
- n (P): SD-3 band, $\alpha=-1/2$. Band based on (27/2+). Population intensity=1% of the reaction channel.
- o (Q): SD-4 band, $\alpha=+1/2$. Band based on 29/2+. Population intensity=2% of the reaction channel.
- p (R): SD-4 band, $\alpha=-1/2$. Band based on 31/2+. Population intensity=2% of the reaction channel.
- q (S): SD-5 band. Band based on 31/2-. Population intensity=1% of the reaction channel.
- r (T): SD-6 band. Band based on (29/2-). Population intensity=1% of the reaction channel.
- s (U): SD-7 band. SD-7 and SD-8 are Signature partners. Population intensity=0.5% of the reaction channel.
- t (V): SD-8 band. SD-7 and SD-8 are Signature partners. Population intensity=0.5% of the reaction channel.
- u (W): SD-9 band. Population intensity=0.5% of the reaction channel.

 $\gamma(^{61}\text{Cu})$

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\ddagger}$	Mult. [§]	δ	α	Comments
475.05	475.0 1	100#	M1 (+E2)	<0.004		δ : 0.04 from theoretical estimate by 1972Ca20 adopted by 1973Sa19 in ($\alpha, p\gamma$), but this value gives $B(E2)(W.u.)=2500\ 400$, much larger than RUL of 200; the latter value limits δ to <0.004.
970.07	494.8 2	0.9& 1	E2			$B(M1)(W.u.)=0.31\ 5$.
	969.98 7	100& 5	M1+E2	-0.35 4		$B(E2)(W.u.)=17\ 7$.
1310.49	340.45 21	6.6& 3	M1+E2	-0.017 15		$B(M1)(W.u.)=0.031\ 7$; $B(E2)(W.u.)=7.2\ 21$.
	1310.9 2	100& 3	E2			$B(M1)(W.u.)=0.065\ 10$; $B(E2)(W.u.)=0.3\ +6-3$.
1394.29	424.2 2	3.3@ 3				$B(E2)(W.u.)=18\ 3$.
	919.2 2	14.0@ 7	E2			$B(E2)(W.u.)=8.5\ 15$.
	1394.5 1	100@ 3	M1+E2	-3.55 18		$B(M1)(W.u.)=0.00060\ 12$; $B(E2)(W.u.)=7.0\ 12$.
1660.42	265.9 2	7.0& 5				
	690.3 1	24.0& 18	M1 (+E2)	+0.05 19		δ : -3.1 +9-14 also possible.
	1185.3 3	22.1& 14	M1+E2			$B(M1)(W.u.)=0.058\ 8$; $B(E2)(W.u.)=0.5\ +42-5$.
	1660.4 1	100.0& 23	M1+E2	+0.39 +10-18		δ : ≥ 0.26 and ≤ 1.00 from ($\alpha, p\gamma$).
						δ : +1.4 4 also possible.
1732.58	338.6 2	9.9 8	M1+E2	-1.2 +9-5		$B(M1)(W.u.)=0.0150\ 20$; $B(E2)(W.u.)=1.5\ 7$.
	422.0 2	44.4 26	M1 (+E2)	+0.08 7		$B(M1)(W.u.)<0.018$; $B(E2)(W.u.)<350$.
						Mult.: $\Delta J=0$ transition.
	762.5 1	19.8 16	M1+E2	+0.50 4		$B(M1)(W.u.)<0.054$; $B(E2)(W.u.)<9.4$.
	1732.54 7	100 3	E2			$B(M1)(W.u.)<0.0033$; $B(E2)(W.u.)<2.8$.
1904.20	593.5 2	53.1@ 24	M1+E2	-0.05 3		$B(E2)(W.u.)<1.0$.
	934.2 2	100@ 3	M1+E2	-0.14 4		$B(M1)(W.u.)=0.129\ 16$; $B(E2)(W.u.)=1.7\ +20-17$.
	1904.2 3	87@ 5	M1+E2	+0.68 9		$B(M1)(W.u.)=0.061\ 7$; $B(E2)(W.u.)=2.5\ 15$.
1932.52	962.4 5	11.3@ 16				$B(M1)(W.u.)=0.0044\ 7$; $B(E2)(W.u.)=1.01\ 22$.
	1457.8 2	38@ 3	M1+E2	+0.20 10		δ : -3.0 8 also possible.
						$B(M1)(W.u.)=0.020\ 3$; $B(E2)(W.u.)=0.7\ 7$.
	1932.4 1	100@ 6	M1+E2	+0.26 +12-8		δ : +1.8 +6-3 also possible.
						$B(M1)(W.u.)=0.022\ 4$; $B(E2)(W.u.)=0.7\ 7$.
1942.56	209.8 2	26 5	(M1)		0.0078	$B(M1)(W.u.)=0.27\ +14-13$.
	548.0 3	0.8@ 2				
	632.1 2	31 6	(M1)			Mult.: $\Delta J=0$ transition.
						$B(M1)(W.u.)=0.012\ 6$.
	972.2 2	100 15	M1+E2			
	1942.8 3	34 8	E2			$B(E2)(W.u.)=0.21\ +11-10$.

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Adopted Levels, Gammas (continued)

 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Mult. §	δ	Comments
2088.89	1613.5 2	47# 4			
	2088.9 1	100# 2			
2203.41	470.8 2	24.4@ 17			
	892.8 2	40.0@ 13	M1 (+E2)	-0.01 3	δ : -9 2 also possible. B(M1)(W.u.)=0.034 4; B(E2)(W.u.)=0.008 +46-8.
	1233.3 2	100.0@ 13	M1 (+E2)	-0.03 +4-2	B(M1)(W.u.)=0.032 4; B(E2)(W.u.)=0.03 +9-3.
	1728.2 3	49@ 3	E2		B(E2)(W.u.)=3.4 5.
2295.22	352.4 2	22.2@ 12	M1+E2	-0.20 8	B(M1)(W.u.)=0.023 8; B(E2)(W.u.)=13 12.
	562.8 4	49 4	M1+E2	+0.56 10	B(M1)(W.u.)=0.010 4; B(E2)(W.u.)=18 8.
	901.0 2	37 4	E2		B(E2)(W.u.)=5.3 19.
	985.1 6	100 9	M1+E2	-0.17 3	B(M1)(W.u.)=0.0048 17; B(E2)(W.u.)=0.26 13.
	1325.2 3	49 5	E2		B(E2)(W.u.)=1.0 4.
2336.39	393.4 4	2.3@ 10			
	942.2 ^a 5	1.6@ 3	E2		B(E2)(W.u.)=1.5 4.
	1025.9 2	29.3@ 20	M1+E2	-0.25 8	B(M1)(W.u.)=0.0098 14; B(E2)(W.u.)=1.1 7.
	1366.2 1	100@ 3	E2		B(E2)(W.u.)=14.6 18.
2358.13	425.6 3	31# 2			
	697.6 1	89# 8			
	1883.1 3	100# 2			
	2358.6 3	68# 5			
2399.35	1088.4 3	71.8@ 18	M1+E2	+0.6 +2-4	B(M1)(W.u.)=0.043 10; B(E2)(W.u.)=24 12.
	1429.0 3	100@ 5	M1+E2	-0.164 24	B(M1)(W.u.)=0.035 5; B(E2)(W.u.)=0.8 3.
2472.49	1502.4 1	12.0# 13			
	1997.4 2	100# 3	M1 (+E2)	-0.02 5	δ : -0.87 9 also possible. B(M1)(W.u.)=0.031 4; B(E2)(W.u.)=0.006 +28-6.
	2472.1 20	6.6# 27			
2583.77	641.5 3	22@ 4			
	850.9 3	100@ 11			
2584.6	2584.5 5	100@			
2611.99	316.6 ^a 2	2.4@ 2			
	669.6 2	89 8	M1+E2	+0.25 4	B(M1)(W.u.)=0.099 18; B(E2)(W.u.)=25 9.
	879.3 1	100 8	M1+E2	+0.36 10	B(M1)(W.u.)=0.046 9; B(E2)(W.u.)=14 8.
	1301.7 3	23.1 23	[M1+E2]		
	1642.2 8	7.7 8	[E2]		B(E2)(W.u.)=0.41 8.
2627.12	290.4 ^a 2	1.7@ 1			
	331.6 4	2.7@ 3			
	1316.8 1	100@ 3	E2		B(E2)(W.u.)<27.
2684.03	1289.8 ^a 6	$\leq 5\&$			
	2209.0 2	100& 6			
	2683.5 5	80& 6			
2720.34	109.5 2	8.3@ 13			
	320.9 ^a 2	2.2@ 5			
	777.2 ^a 3	2.5@ 7			
	987.6 2	68@ 9	E1		B(E1)(W.u.)<6.1 $\times 10^{-5}$.
	1409.1 3	100@ 3	E1		B(E1)(W.u.)<3.1 $\times 10^{-5}$.
2728.21	328.8 ^a 4	4.5@ 5			
	524.5 ^a 3	$\leq 6.5\&$			
	1417.8 2	55@ 3	M1+E2	+0.4 +7-4	B(M1)(W.u.)=0.010 5; B(E2)(W.u.)=1.4 +43-14.
	1758.2 3	100@ 13	M1+E2	-1.6 4	B(M1)(W.u.)=0.0030 13; B(E2)(W.u.)=4.5 12.
2792.56	1131.9 8	22# 14			
	1482.1 1	98# 3			
	2792.3 2	100# 3			
2840.53	751.6 1	100# 13			
	2842.1 7	79.5# 8			
2857.1	2381.4 20	25# 4			
	2857.0 3	100# 15			
2924.2	297.4 ^a 2	5.7@ 8			
	312.0 ^a 2	3.1@ 8			
	524.5 ^a 2	$\leq 5.7\&$			
	629.1 ^a 5	3.4@ 8			
	981.3 5	12.1@ 23			
	1191.8 4	100@ 6	M1 (+E2)	0.00 5	B(M1)(W.u.)=0.038 7.
2932.56	1538.9 2	13.0# 12			

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Adopted Levels, Gammas (continued)

 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Mult.§	δ	Comments
2932.56	2457.6 4	100# 6			
	2931.8 2	14# 4			
3001.67	798.0 3	22.4@ 15			
	1607.3 2	43@ 3			
	3002.6 5	100@ 5			
3015.73	679.25 14	22& 5	M1+E2		
	720.55 14	21& 5	M1 (+E2)	-0.01 2	B(M1)(W.u.)=0.030 9; B(E2)(W.u.)=0.010 +42-10.
	1705.4 3	100& 4	E2		B(E2)(W.u.)=6.6 11.
3019.3	2543.9 30	100@ 19	M1+E2	-0.6 4	B(M1)(W.u.)=0.010 5; B(E2)(W.u.)=1.0 +11-10.
	3019.3 11	41@ 6			
3042.0?	2566 ^a	100&			
	3042 ^a	62&			
3065.57	706.4 5	25@ 2			
	1161.1 3	100@ 8			
	1672.1 4	79@ 7			
	3065.9 5	52@ 8			
3092.1	3092.0 5	100&			
3198.58	1256.0 4	57@ 13			
	1466.1 3	100@ 15			
	1804.1 5	61@ 20			
3260.42	633.1 2	39& 3	(M1)		B(M1)(W.u.)=0.033 6.
	648.2 1	62& 10	(M1+E2)		
	964.8 5	28& 4			
	1317.8 5	65& 7			
	1528.0 1	100& 9	E2		B(E2)(W.u.)=4.6 9.
3277.1	3277	100&			
3323.1	2012.5 5	100@			
3372.9	1640.6 5	100@			
3454.4	1055.8 ^a 5	6.8@ 4			
	1721.7 5	27@ 8			
	2143.9 5	100@ 16			
3521.2	3521.1 15	100&			
3548.78	921.7 2	72 13	D		
	936.5 2	100 15	D+Q		
	1212.6 4	16.7 19			
	1253.9 3	28 6	D+Q		
	1606.4 6	25.9 19			
	2238.5 4	28.5 19			
3653.3	1041	100&			
3739.5	1444.4 4	100@			
3780.6	1153.5 6	22.5 23	D+Q		
	1443.4 5	100 3	E2		
3790.2	2820	100&			
3853.5	1132.4 4	100@			
3942.54	1222.2 1	100 9	D+Q		
	1315.0 5	9.1 18			
	1330.2 6	18.2 18			
3947.0?	2553 ^a				
	3471 ^a				
3970.80	710.4 2	100 9	D+Q		
	1343.2 3	76 6	D+Q		
	1358.4 7	58 3			
4052.45	791.7 4	63 8	D+Q		
	1424.9 ^a 7	38 5	D+Q		
	1715.9 3	100 10			
	1757.3 4	83 10			
4081.34	709.6 4	33& 6			
	1065.6 2	38& 6	E1		
	1361.0 1	100& 3	E2		
4132.8	2400.1	100& 3			
	2822.2	54& 3			
4287.7	1952.0 1	100 10	Q		
	1992.2 4	26.2 16			

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Mult. §	δ	Comments
4333.0?	3021.8 ^a	100&			
4380.4	2044	100			I γ from ⁴⁰ Ca(²⁸ Si, α 3p γ).
4466.2	686.8 6	6 2			
	1451.7 12	15 2			
	1841.3 1	100 4	Q		
4590.61	209				E γ : 209 γ and 935 γ from ⁴⁰ Ca(²⁸ Si, α 3p γ).
	509.7 2	7.4 15			
	648.0 2	23.7 22	D+Q		
	935				
	1041.9 2	65 6	D		
	1330.0 1	67 3	E1		
	1870.4 2	100 7	E2		
4819.57	767.2 3	50 6	D+Q		
	848.6 4	50 6			
	1559.4 2	100 8	Q		
	2193.1 10	78 8			
4990.65	908.9 3	100 9	D+Q		
	1048.0 5	43 6			
5119.96	300.3 2	8.4 10	D		
	529.2 2	94 6	E2		
	652.3 5	8.6 11	D		
	1038.6 1	100 3	E2		
5135.6	547.1 2	63 9	D+Q		
	849.7 2	100 11	D		
5251.7	2530.5	100& 8			
	4280.9	89& 8			
5302.0	1753.0 5	100			
5464.4	326.4 4	100&			
5532.03	1244.3 4	83 33			
	2270.5 6	100 33			
5579.9	1800 1	100	Q		
5702.34	170.3 2	17 4	D		
	400.3 2	8 4			
	564.4 2	100 12	D		
	582.2 2	29 4	D+Q		
	1111.5 3	17 4			
	1414.6 3	21 4	D		
	1731.9 3	100 12			
5729.50	197.4 2	29 14	D		
	591.6 2	100 29	D		Mult.: $\Delta J=0$ transition.
	1139.0 4	29 14	D+Q		
	1441.9 3	71 14	D		
	1647.9 3	57 14	D+Q		
	1758.7 5	14 14			
5748.75	928.8 3	100 5	D+Q		
	1280.7 3	38 5			
5853.3	1772.0 4	100	Q		
5856.3	719.2 7	2.9 4			
	736.0 1	100 5	M1		
6055.95	326.6 1	48 5	D		
	353.3 3	100 10	D		
	1065.4 4	6.4 9	D+Q		
	1236.5 2	28 4	D		
	1974.1 4	21 3	Q		
6351.1	3992.7				
	4690.1		D+Q	0.58 +24-10	
	5380.8				
	5874.8		D+Q	0.054 +54-14	
	6350.6		D+Q	0.56 10	
6362.0	2632	24 5			
	2656	24 5			
	2950	29 5			
	3270 ^a				

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Mult. §	δ	Comments
6362.0	3296 ^a				
	3343.9	38 5			
	3360 ^a				
	3505.4	29 5			
	3678 ^a		D+Q	0.045 +14-4	
	3778.0	<5			
	3888.6	38 5	D+Q	0.18 6	
	4003.6	24 5	D+Q	0.37 +20-15	
	4273.1	29 5	D(+Q)	<0.12	
	4701.0	<5			
	4967.7	90 5	D+Q	0.17 7	
	5391.7	38 5	D+Q	0.13 11	
	5885.7	14 5			
	6361.5	100 10	D+Q	0.15 3	
6372.7	2642	13 4			
	2666	13 4			
	2848	8 4			
	2942	29 4			
	3280 ^a				
	3307 ^a				
	3354.7	8 4			
	3516.2 ^a				
	3688 ^a		D+Q	0.30 10	
	3788.8	13 4			
	3899.4	13 4	D+Q	0.50 10	
	4169	21 4	D(+Q)	<0.3	
	4283.9	21 4	D(+Q)	0.00 4	
	4711.8	13 4			
	4978.5	75 4	D+Q	0.13 4	
	5402.5	46 4	D+Q	0.17 7	
6378.5	5896.5	46 4	D+Q	0.20 12	
	6372.3	100 8	D+Q	0.20 1	
	2854	5.6 19			
	3537	1.9 19			
	3586.6	3.7 19			
	3794.7	3.7 19			
	3905.3	3.7 19	D+Q	0.20 10	
	4289.8	7.4 19	D+Q	0.03 1	
	4473.9 ^a				
	4717.7	1.9 19			
	4984.4	27.8 19	D(+Q)	0.00 5	
	5408.4	9.3 19	D(+Q)	0.03 10	
	5902.4	16.7 19			
	6378.2	100 4	D+Q	0.10 2	
6393.4	2663	3.7 19			
	2687	9.3 19			
	2869	1.9 19			
	2963	1.9 19			
	3301	5.6 19			
	3328	<1.9			
	3375.3	1.9 19			
	3391 ^a				
	3536.8	7.4 19			
	3552	<1.9			
	3709 ^a		D+Q	0.40 15	
	4035.0 ^a		D+Q	0.16 10	
	4304.5	14.8 19	D(+Q)	0.00 10	
	4488.6	1.9 19			
	4732.4	<1.9			
	4999.1	33.3 19	D(+Q)	0.00 10	
6429.6	5423.1	1.9 19	D(+Q)	0.00 22	
	6392.9	100 4	D+Q	0.16 1	
	3955.5	1.4 14			

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Mult. §	δ	Comments
6429.6	4070.5	7.1 14			
	4340.0	2.9 14			
	5952.6	31 3			
	6428.4	100 3			
6441.6	3968.2	4.4 15			
	4497	5.9 15			
	5047.3	7.4 15			
	5130.8	11.8 15			
	5471.3	17.7 15			
	6441.1	100 3			
6446.1	3381	3 3			
	3444	3 3	D+Q	0.1	
	3719	36 3			
	3973.2	28 3	D(+Q)	0.0	
	4243	50 3	D+Q	0.2	
	4502	3 3			
	4513	3 3			
	4713.7	3 3			
	4785.6 ^a				
	5052.3	14 3	D+Q	0.4	
	5135.8	100 6	D+Q	0.05	
	5476.3	39 3	D+Q	0.31	
	5970.3 ^a				
	6446.1 ^a		D(+Q)	0.0	
6457.6	5147	53 3			
	5487	13.3 17			
	6457	100 3			
6466.4	3674.1	3.9 19			
	3882.2	3.9 19			
	4805.2	7.7 19	D+Q	0.17 8	
	5495.9	21.2 19	D(+Q)	0.07 8	
	5989.9	52 4	D(+Q)	0.01 4	
	6465.7	100 4	D+Q	0.07 2	
6505.6	4844.6		D+Q	0.35 18	
	5111.3		D(+Q)	0.06 16	
	5535.3		D(+Q)	0.16 18	
	6029.3		D(+Q)	0.05 10	
	6505.1		D+Q	0.51 6	
6535.1	4874.1		D+Q	0.08 6	
	6058.8		D+Q	0.39 4	
	6534.6		D+Q	0.19 3	
6541.1	4880.0		D+Q	0.32 7	
	6064.7		D(+Q)	0.08 7	
	6540.5		D(+Q)	0.02 2	
6564.6	6087.3		D+Q	0.14 7	
	6563.1		D+Q	0.23 8	
6572.2	515.9 3	100 12	D		
	718.7 3	5.8 5	D+Q		
	1451.7 3	61 4	D+Q		
6584.3	3566	100			
	3652	78			
	4111	39			
	4226	32			
	4651	22			
	4924	61			
	6584	26			
6585.2	4227		D+Q	0.36 9	
6605.0	4246		D+Q	0.12 7	
	4401		D+Q	0.22 13	
	5210		D+Q	0.14 8	
	6604		D+Q	0.19 5	
6619.5	3355 ^a	3.0 15			γ to 11/2- requiring E4 or M4 is unlikely.
	3554	1.5 15			

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Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Mult. §	δ	Comments
6619.5	3935	3.0 15			
	4219	3.0 15			
	4261	3.0 15			
	4416	3.0 15			
	4887	4.6 15			
	5225	22.7 15			
	5309	1.5 15			
	5649	7.6 15			
	6619	100 3	D+Q	0.78 12	
6627.2	2331 ^a	2.9			γ to (11/2-) requiring M5 is unlikely.
	2680 ^a	20			
	2837	26			
	2897	5.7			
	3037 ^a	20	[M2]		
	3350	5.7			γ to (7/2+,9/2+) level at 3277 keV from 6627, 1/2- level. Either this γ is questionable or there are two separate levels near 3277 keV.
	3535	17			
	3562	23			
	3609	5.7			
	3786	5.7			
	4269	8.6			
	4694	5.7			
	4966	8.6			
	6151	100			
	6627	31			
6645.1	3368	53 15			
	3580	18 15			
	3713 ^a				
	3789	24 15			
	3804	26 15			
	4172	44 15			
	4557	29 15			
	6169 ^a				
	6645	100 15			
6678.4	3248	7 4			
	3586	29 4			
	3613	11 4			
	3746	36 4			
	3822	14 4			
	3837	4 4			
	4205	39 4			
	4320	25 4			
	4745	32 4			
	4774	18 4			
	5018	7 4			
	5708	4 4			
	6202	32 4			
	6678	100 7			
6712.4	4808		D+Q	+0.44 36	
	5049		D+Q	+1.29 +0-79	
	5317		D+Q	+0.8 +0-5	
	6237		D(+Q)	-0.19 44	
	6712		D+Q	+1.25 +18-13	
6739.0	4266		D+Q	+34 16	
	5344		D+Q	+0.8 +0-3	
	5769		D+Q	+0.25 +19-13	
	6739		D+Q	+0.83 +46-18	
6802.3	3012	39			γ to (7/2,9/2) level at 3790 keV from 6802, 1/2+ level. Either this γ is questionable or there are two separate levels near 3790 keV.
	3444	21			
	3784	21			

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Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Mult. §	δ	Comments
6802.3	4714	20			
	4869	12			
	5142	47			
	6326	10			
	6802	100			
6822.1	967.6 3	6.1 6	M1+E2		
	1704.9 1	100 3	E2		
6915.0	4982		D+Q	+0.55 +74-23	
	6439		D(+Q)	-0.07 10	
	6914		D+Q	+0.70 +25-15	
6937.4	4849		D(+Q)	0.00 12	
	5033		D(+Q)	-0.01 14	
	5967		D(+Q)	+0.14 13	
	6937		D+Q	+0.37 9	
7011.2	3398 ^a	9.1			
	3599	4.6			
	3734	9.1			
	3946	23			
	4079	45	D(+Q)	-0.05 +13-18	
	4155	23			
	4219	14			
	4327	18	D(+Q)	-0.12 22	
	4538	4.6			
	4653	14			
	4808	23			
	4923	23	D+Q	+0.21 9	
	5067	9.1			
	5078	18			
	5342		D+Q	+0.49 +17-14	
	5617	100	D+Q	-0.21 +18-42	
	6041	14			
	6535	32	D(+Q)	+0.04 9	
	7011	68	D(+Q)	+0.02 14	
7016.3	5621		D(+Q)	-0.08 11	
	6541		D(+Q)	+0.03 9	
	7016		D+Q	+0.18 7	
7025.9	4007	12			
	4023	12			
	4169	7.7			
	4233	15			
	4552	15			
	4667	15			
	5092	35	D+Q	+0.30 16	
	5121	12			
	5293	35	D(+Q)	-0.02 11	
	5364	65	D+Q	+0.36 12	
	5631	7.7			
	5715	15			
	6055	38			
	7025	100	D(+Q)	+0.07 9	
7043.8	4957		D(+Q)	-0.11 10	
	5382		D+Q	+0.50 +14-10	
	7045		D+Q	+0.44 9	
7060.0	5398		D+Q	+0.50 +16-13	
	5666		D+Q	-0.25 15	
	6091		D+Q	+0.14 10	
	7058		D+Q	+0.55 12	
7107.3	3317	12			γ to (7/2,9/2) level at 3790 keV from 7107, (1/2+) level. Either this γ is questionable or there are two separate levels near 3790 keV.
	3749	11			

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Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Mult. [§]	δ	Comments
7107.3	3830	10			γ to (7/2+,9/2+) level at 3277 keV from 7107, (1/2+) level. Either this γ is questionable or there are two separate levels near 3277 keV.
	4175	28			
	4749	30			
	5019	4.4			
	5174	11			
	5446	35			
	6631	100			
	7107	15			
7120.8	6645		D+Q	-0.17 8	
	7120		D+Q	-0.42 10	
7124.4	1268.3 7	90 10	D		Mult.: $\Delta J=0$ transition.
	2004.0 20	100 10	D		
7201.3	5539		D+Q	+0.75 +54-19	
	5887		Q+O	-0.28 +14-17	
	6232		D(+Q)	-0.07 11	
	6727		D+Q	+0.08 +11-8	
	7202		D+Q	+0.65 +21-13	
7214.3	5819		D+Q	-0.50 +15-21	
	6244		D(+Q)	-0.04 12	
	6739		D+Q	+0.14 10	
	7214		D+Q	+0.24 6	
7223.2	4158	31			
	4205	35			
	4291	25			
	4750	12			
	4865	21			
	5290	36			
	5562	11			
	6747	62			
	7223	100			
7262.9	3904	3.2			
	3985	2.7			
	4244	1.7			
	4578	9.1			
	4789	2.8			
	4904	3.1			
	5174	0.8			
	5329	4.2			
	5602	10.4			
	6786	2.5			
	7262	100			
7283.2	3846 ^a	9.1			
	4006	5.3			
	4218	2.2			
	4265	0.74			
	4442	2.2			
	4599	3.1			
	4810	3.9			
	5195	0.74			
	5350	2.8			
	5622	12			
	6807	6.4			
	7283	100			
7306.02	733.1 4	100 10	D		
	1250.0 6	17.3 17	Q		
	1450.4 3	4.3 4	D+Q		
7387.1	564.4 4	39.5 66	M1+E2		
	1533.0 1	100 10	E2		
7455.2	1599.0 16	100	D+Q		
7535.4	1787.0 18	100 8			
	1955.4 20	42 8	Q		

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Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Mult. §	Comments
7606.5	1753.0 18	100 5	Q	
7847.1	6452	57		
	6537	100		
	6877	100		
	7370	86		
7858.6	734.0 7	100	D+Q	
7937.0	1112.2 2	100	E1	
8030.3	723.9 7	100 10	D	
	1206.0 12	28 3	D+Q	
	1458.3 7	39 4	Q	
8131.9	6744	22	[M2]	
	6819	100	[E3]	
	7159	61	[M2]	
	7653	67		
8151.5	6754	67		
	6839	100		
	7179	50		
	7673	43		
8194.4	6798	79		
	6887	79		
	7223	100		
	7717	63		
8212.1	2632 3	100	(Q)	
8333.8	1509.3 8	100	D+Q	
8358.1	2778 3	100		
8431.4	7120.3	54 5		
	8430.6	100 5		
8436.4	7960.0	100 5		
	8435.8	16 5		
8440.0	6778.8	69 17		
	7045.5	33 17		
	7963.5	100 28		
	8439.3	75 14		
8442.8	7472.3	100 5		
	8442.1	22 5		
8446.0	5724.9	100 7		
	7134.8	38 9		
	7969.3	17 5		
	8445.1	17 5		
8447.1	4114	16		
	4314	2 3		
	5725	100		
	6047	40		
	6504	21		
	7135	53		
8448.2	3199	13		
	3298	7 6		
	4319	25		
	4470	1 9		
	5434	17		
	5729	100		
	5823	3 8		
	6051	11		
	6155	9 4		
8454.5	3202	14		
	3332	24		
	4321	28		
	4473	10		
	5437	28		
	5732	100		
	5841	10		
	6054	41		
	6117	21		

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Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Mult. §	Comments
8454.5	6158	14		
	6511	17		
	6720	41		
8458.6	3206	3.3		
	3336	10		
	4325	6.7		
	5197	13		
	5736	100		
	6058	23		
	6121	47		
	6162	6.7		
	6515	13		
	6724	73		
	7146	37		
8464.4	3212	3.1		
	3342	1.6		
	4082	1.6		
	4131	3.1		
	4331	16		
	4483	3.1		
	5447	13		
	5742	100		
	6064	3.1		
	6168	1.6		
	6521	1.6		
	6730	1.6		
	7152	1.6		
8465.9	3214	3.1		
	4133	4.7		
	4333	14		
	4485	1.6		
	5449	13		
	5744	100		
	6129	16		
	6732	1.6		
	7154	3.1		
8469.5	6564.5 ^a	54.9		
	7158.5	100.12		
	8468.8	79.12		
8473.1	3221	4.8		
	4140	1.6		
	4340	18		
	5456	3.2		
	5470	3.2		
	5751	100		
	6073	6.5		
	6136	8.1		
	6177	4.8		
	6530	4.8		
	7161	6.5		
8476.3	3224	6.0		
	3354	10		
	4343	16		
	5473	4.0		
	5754	100		
	5863	6.0		
	6076	12		
	6139	12		
	6180	6.0		
	6533	6.0		
	7164	22		
8478.3	3226	1.5		
	3356	1.5		

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Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Mult. §	Comments
8478.3	4345	6.0		
	4497	3.0		
	5461	3.0	[E3]	
	5756	100		
	5850	9.0		
	5865	4.5		
	6078	4.5		
	6141	3.0		
	6182	3.0		
	6535	3.0		
	6744	3.0		
	7166	4.5		
8483.5	3016	2.6		
	3359	2.6		
	4148	1.3		
	4348	5.1		
	4500	2.6		
	5759	100		
	5853	10		
	7169	5.1		
8485.0	3233	1.8		
	4103	3.6		
	4352	15		
	4504	1.8		
	5468	5.5		
	5482	7.3		
	5763	100		
	5857	3.6		
	6148	3.6		
	6189	1.8		
	6542	13		
	6751	16		
	7173	9.1		
8489.9	6828.7	63.8		
	8013.4	29.10		
	8489.2	100.10		
8492.4	7181.4	55.12		
	7521.9	67.12		
	8015.9	82.12		
	8491.7	100.12		
8499.9	6766.2	92.10		
	7188.3	64.10		
	8499.6	100.10		
8503.7	8503.1	100		
8507.3	8506.7	100		
8508.1	6603.1 ^a	47.16		
	6846.9	58.14		
	8031.6	28.12		
	8507.4	100.14		
8509.9	6306 ^a	13.3		
	6576	14.3		
	6848.8	7.3		
	7199.0	7.4		
	8509.3	100.6		
8515.4	8039.0	100		
8522.6	8046.2	54.8		
	8522.0	100.8		
8625.4	767.0.8	100.8	D+Q	
	1501.0.15	23.8		
8678.7	2106.6.11	100.17	D	
	3101.2.16	50.8	Q	
8789.0	758.7.4	100.10	D+Q	
	1483.2.7	40.5	Q	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Mult. §	Comments
8885.1	854.9 4	100 10	D+Q	
	1429.9 14	21.0 20		
	1495.8 15	40.0 20	D+Q	
	1578.9 16	31.0 20	Q	
9138.8	2314.0 23	100		
9287.1	608.2 3	100 10	D	
	929.0 8	3.5 17		
	1075.0 11	3.5 17		
	1980.6 20	24 4	D	
9408.1	1471.4 3	100	E2	
9474.4	849.0 9	100 10	D+Q	
	1616.0 16	27 9		
9643.9	1707.0 17	100	D	
9725.1	840.1 4	66 7		
	935.9 5	100 9	D	
	1695.0 8	67 7	Q	
9789.9	1853.0 19	100	Q	
9957.5	670.3 3	100 11	D	
	1279.5 6	39 4		
	1928.0 19	24.1 19	D	
	2422.0 24	13.0 19	Q	
	2568 3	14.8 19		
10342.4	868.0 9	100 10	D+Q	
	1717.0 17	40 10	Q	
10347.2	2013.0 20	100 25		
	2317.1 23	50 25	D+Q	
	2958 3	75 25		
	3523 4	50 25		
10409.5	2472.4 12	65 6	D	
	2954 3	18 6		
	3584 4	100 12	Q	
10462.7	2127.9 21	77 8	D+Q	
	3008 3	15 8		
	3074 3	100 8	D+Q	
	3638 4	69	Q	
10687.7	730.1 4	100 10	D+Q	
	897.6 9	4.6 11		Mult.: $\Delta J=0$ transition.
	1400.9 7	43 5	Q	
	1802.5 18	11.5 11		
10906.6	1181.0 12	100 10	D+Q	
	2118.0 14	13.0 13	Q	
11019	3630 4	100		
11132.9	1343.4 13	9.7 16	Q	
	1723.7 9	100 10	Q	
11144	3755 4	100		
11237.0	3300 3	100		
11255	3866 4	100		
11301.6	613.8 3	100 11	D+Q	
	1344.4 7	29 3	Q	
	1893.1 19	5.3 13		
11303.2	1894.0 19	66 17	D	Mult.: $\Delta J=0$ transition.
	3367 3	100 17	Q	
11369.5	1027.0 10	100 10	D+Q	
	1644.4 16	50 10		
	1895.0 19	30 10		
11752.7	2060.0 21	60 20	Q	
	2109.0 21	60 20	(Q)	
	2344.0 23	100 20	(D+Q)	
11775.8	1313.0 15	67 17		
	1366.0 16	100 10		
	1428.6 14	25 3	Q	
	2367.9 24	50 5	D	
12003.7	702.2 4	100 10	D+Q	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Mult. §	Comments
12003.7	870.2 9	31 3	D	Mult.: $\Delta J=0$ transition.
	1316.8 13	61 7		
12086.6	1180.0 12	100 20	D+Q	
	2362.0 24	80 4	Q	
12355.5	986.0 10	100 12	D+Q	
	2013.0 20	37 12		
12793.5	1490.0 15	41 6		
	1556.5 16	5.9 6		
	3386 3	100 12	Q	
12839.2	835.5 4	100 10	D+Q	
	1537.3 8	32 4	Q	
12847.3	757.2 8	100 20		
	1398.0 14	100 20		
	3122.0 ^a 31	60 20		
	4058 ^a 4	40 20		
13146	3737 4	100	Q	
13206.0	3480 4	100		
13284.5	1509.4 15	100	Q	
13419.7	1642.9 16	100		
13678	830.6 8	17 8		
	1587.8 16	100 17	Q	
13874.2	668.2 7	100 14	D+Q	
	4150 4	57 14	Q	
13983.5	1628.0 16	36 7	D+Q	
	1897.0 19	100 7	D	
	2614 3	50 7	Q	
14020.6	1665.0 17	56 11	D+Q	
	1934.0 19	100 11		
	2651 3	44 11		
14023.8	1183.6 13	100 10	D+Q	
	2021.3 20	27 2	Q	
14068	2315.0 23	100	Q	
14163	3030 3	100		
14563	885.4 10	27 9		
	1716.0 17	100 18		
14587.1	713.1 7	30 10	D+Q	
	1381.0 14	100 10	Q	
	2500.5 ^a 25	10 10	D+Q	
14628.1	1834.6 18	100	Q	
14800.4	780.0 10	11 4	D+Q	
	817.0 10	64 7	D	
	1961.0 20	100 7	D	
15201.7	1177.4 13	100 9	D+Q	
	2364.3 24	82 9	Q	
15232.0	1811.0 18	13.3 25	Q	
	1948.9 20	100 10	Q	
15311	1488.0 15	100		
15434.6	848.0 10	36 5	D+Q	
	1559.8 16	100 18	Q	
15524	960.3 10	20 10		
	1845.7 19	100 20	Q	
15742.3	942.0 10	100 5	D	
	1721.0 17	15 5		
	1759.0 18	50 5	Q	
16302.2	868.0 10	67 8	D+Q	
	1714.3 17	100 42		
16571.2	829.0 10	64 5	D	
	1771.0 18	100 5	Q	
16588	2025.0 20	100	Q	
16615	2547 3	100	Q	
16921	2293.0 23	100		
17039	2411.0 24	100		
17067	1756.0 18	100		

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{61}\text{Cu})$ (continued)

E(level)	$E\gamma^\dagger$	$I\gamma^\ddagger$	Mult. [§]	E(level)	$E\gamma^\dagger$	$I\gamma^\ddagger$	Mult. [§]
17310.6	1008.4 10	15 5		23418	3133 3	100	
	1875.9 19	100 20	Q	23662	2939 3	100	
17431	2198.7 22	100	Q	24337	2801 3	100 33	
17618.0	1047.0 10	100 6	D+Q		4367 4	33 33	(Q)
	1875.0 19	56 6	Q	24612	4642 5	100	
17750	2226.7 22	100	(Q)	25121	3281 3	100	
18353.0	1042.3 10	5.6 56		25325	3113 3	100	(Q)
	2050.7 21	100 17		26577	3592 4	100	Q
18857.3	1239.0 12	100 6	D+Q	26842	3857 4	100	(Q)
	2286.0 23	47 6		26928	3510 4	100	
18995	2407.0 24	100	Q	27023	3362 3	100	
19134	2067.0 21	100 17			4038 4	100	
	3902 4	50 17	Q	27525	3188 3	100	
19472	2857 3	100	Q	28885	3560 4	100	
19562	1209.0 12	59 6		2037.0+x	1698.0 17	100 33	
	2252.1 23	100 18	Q		2037.0 20	100 33	
19878	2839 3	100 33		2520+x	1730.0 17	100	
	2957 3	67 33		4288+x	2251.0 23	100	
19970	2538.9 25	100	Q	4465+x	1945.0 19	100	
20285	2534.8 25	100	Q	6674+x	2209.0 22	100 20	
20550.6	1692.8 17	100 25			2385.6 24	40 20	
	2934 3	75 25		6735+x	2447.2 24	100	
20723	2370.0 24	100		9261+x	2587 3	100	
20913.2	2055.9 21	100 17		9434+x	2699 3	100	
	3295 3	83 17		12369+x	3108 3	100	
21536	2402.0 24	100 20	Q	12482+x	3048 3	100	
	4105 4	40 20	Q	15897+x	3414 3	100	
21839	2844 3	100	(Q)	1846.1+y	1846.1 18	100	
22212	2650 3	100	Q	3998.3+y	2152.2 22	100	
22284	4853 5	100			2165.0 22	33	
22718	3246 3	100		6459+y	2460.3 25	100	
22984	3014 3	100	(Q)	9258+y	2799 3	100	
23376	3498 4	100		12432+y	3174 3	100	

[†] Weighted averages of all available data from γ -ray studies.

[‡] Primarily from $^{28}\text{Si}(^{36}\text{Ar}, 3p\gamma)$ reaction (2008An06), unless otherwise stated.

[§] From assignments in 2008An06 based on DCO ratios and band structure, except as noted. All mult=Q transitions are assumed as $\Delta J=2$, E2 and mult=D+Q as $\Delta J=1$, M1+E2 transitions. For levels below 9 MeV excitation, several assignments are from γ -ray linear polarization measurements and DCO data from 2004Iz01.

From ^{61}Zn ϵ decay (89.1 s).

@ From 1973Sa19 in $^{58}\text{Ni}(\alpha, p\gamma)$ reaction.

& From weighted averages of all available data.

a Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas (continued)

Adopted Levels, Gammas (continued)

Adopted Levels, Gammas (continued)

 (G) Band based on (33/2), $\alpha=+1/2$.

 (H) Band based on (35/2),
 $\alpha=-1/2$.

 (I) Band based on (13/2+), $\alpha=+1/2$.

Adopted Levels, Gammas (continued)(J) Band based on $15/2+, \alpha=-1/2$.(K) Band based on $21/2-, \alpha=+1/2$.(L) Band based on $23/2-, \alpha=-1/2$.

Adopted Levels, Gammas (continued)

(M) SD-1 band.

(N) SD-2 band.

(O) SD-3 band, $\alpha=+1/2$.

Adopted Levels, Gammas (continued)(P) SD-3 band, $\alpha=-1/2$.(Q) SD-4 band, $\alpha=+1/2$.(R) SD-4 band, $\alpha=-1/2$.

(S) SD-5 band. Band based on 31/2-.

Adopted Levels, Gammas (continued)

 (T) SD-6 band. Band
based on (29/2-).

(U) SD-7 band.

(V) SD-8 band.

(W) SD-9 band.

61Zn ε Decay (89.1 s) 1970Ho29,1972Du09

Parent ⁶¹Zn: E=0; Jπ=3/2-; T_{1/2}=89.1 s 2; Q(g.s.)=5635 16; %ε+%β⁺ decay=100.

⁶¹Zn-J,T_{1/2}: From Adopted Levels for ⁶¹Zn.

⁶¹Zn-Q(ε): From 2012Wa38.

Source produced by ⁵⁸Ni(α,n) (1970Ho29,1969Ho02).

1970Ho29: measured Eγ, Iγ, γ(t) with Compton suppression spectrometer.

1972Du09: measured Eγ, Iγ, γ(t) with Ge(Li). Mass separated source.

Others: 1955Li39, 1959Cu86, 1969Ho02, 1974YoZT.

The decay scheme is based on γγ coin data from 1969Ho02 and on energy sums.

Data are from 1970Ho29, except as noted. There is good agreement between the results of 1970Ho29 and 1972Du09.

From RADLIST code, deduced total decay energy is 5638 keV 70 agrees with 5640 keV 16 from Q(ε) value.

61Cu Levels

E(level) [†]	Jπ [‡]	E(level) [†]	Jπ [‡]	E(level) [†]	Jπ [‡]
0.0	3/2-	1904.5 3	5/2-	2840.53 14	1/2-, 3/2-
474.98 7	1/2-	1932.60 8	3/2-	2857.1 3	1/2-, 3/2-
970.10 11	5/2-	2088.86 9	(1/2)-	2932.91 16	3/2-
1310.94 10	7/2-	2358.13 11	3/2-	3019.3 11	3/2-
1394.52 8	5/2-	2472.50 13	3/2-	3092.4 13	3/2-
1660.44 7	3/2-	2683.96 20	3/2-	3521.2 15	1/2-, 3/2-, 5/2-
1732.4 12	7/2-	2792.98 13	5/2-		

[†] From least-squares fit to Eγ data.

[‡] From Adopted Levels.

β⁺,ε Data

Measured endpoint energy of β⁺ radiation is 4380 200. This β⁺ endpoint must correspond to g.s. feeding from intensity arguments (1959Cu86).

Eε	E(level)	Iβ ^{†‡§}	Iε ^{‡§}	Log ft	I(ε+β ⁺) ^{†§}	Comments
(2114 16)	3521.2	0.09 3	0.047 14	5.5 2	0.14 4	
(2543 16)	3092.4	0.098 20	0.017 4	6.1 1	0.115 24	
(2616 16)	3019.3	0.23 3	0.035 4	5.80 6	0.26 3	
(2702 16)	2932.91	0.73 6	0.094 8	5.39 4	0.82 7	
(2778 16)	2857.1	0.48 6	0.054 7	5.66 6	0.53 7	
(2794 16)	2840.53	0.50 5	0.055 5	5.66 5	0.55 5	
(2842 16)	2792.98	1.58 14	0.160 14	5.21 4	1.74 15	
(2951 16)	2683.96	1.37 9	0.116 8	5.38 4	1.49 10	
(3163 16)	2472.50	1.29 8	0.079 6	5.60 4	1.37 9	
(3277 16)	2358.13	1.29 9	0.068 5	5.70 4	1.36 9	
(3546 16)	2088.86	0.58 6	0.022 2	6.27 5	0.60 6	
(3702 16)	1932.60	0.79 11	0.024 3	6.25 6	0.81 11	
(3731 16)	1904.5	0.23 6	0.0070 18	6.8 1	0.24 6	
(3903# 16)	1732.4	<0.16	<0.0027	>7.5	<0.16	No β feeding is expected to this level, small apparent feeding of <0.11% 5 is probably due to missing γ rays from higher levels.
(3975 16)	1660.44	10.8 7	0.252 17	5.30 3	11.1 7	
(4240 16)	1394.52	0.66 6	0.012 1	6.69 4	0.67 6	
(4324# 16)	1310.94	<0.098	<0.002	>7.6	<0.10	No β feeding is expected to this level, small apparent feeding of <0.10% is probably due to missing γ rays from higher levels.
(4665 16)	970.10	0.46 19	0.0057 23	7.1 2	0.47 19	
(5160 16)	474.98	10.8 6	0.091 5	5.97 3	10.9 6	
(5635 16)	0.0	66.3 17	0.405 12	5.40 2	66.7 17	

[†] From intensity imbalance at each level.

[‡] From I(γ+ε) and theoretical β⁺/ε.

[§] Absolute intensity per 100 decays.

[#] Existence of this branch is questionable.

^{61}Zn ϵ Decay (89.1 s) 1970Ho29,1972Du09 (continued) $\gamma(^{61}\text{Cu})$

The 1234.0 γ and 1289.8 γ seen by 1970Ho29 were not observed by 1972Du09 ($I_{\gamma} \leq 0.6$).

I_{γ} normalization: Measured annihilation radiation intensity is 2600 130 (1969Ho02) relative to 100 for 1660 γ . From theoretical β^+/ϵ ratios for g.s. and some of the intensely populated levels, intensity of electron capture fraction is estimated as 5.0 relative units, thus the total $I(\beta^+/\epsilon) = 1305$ 65 units which gives normalization factor of 0.0766 38 for 100 decays.

E_{γ}	E(level)	$I_{\gamma}^{\dagger\#}$	Mult. ‡	$\delta^{\S}$	Comments
$^{x}149.0$ 3		2.2 9			
265.9 1	1660.44	7.0 4			
421 § 2	1732.4	<1.2 §	M1 (+E2)	+0.08 7	
426.0 4	2358.13	1.9 1			
475.0 1	474.98	216 3	M1+E2	0.04	δ : theoretical estimate by 1972Ca20 adopted by 1973Sa19 in (α, γ).
594.2 § 15	1904.5	0.8 § 5	M1+E2	-0.05 3	
$^{x}604.5$ § 10		<1.1 §			
$^{x}638.2$ § 5		<1.0 §			
690.3 1	1660.44	24.0 18	M1 (+E2)	+0.05 19	
697.6 1	2358.13	5.5 5			
751.6 1	2840.53	4.0 5			
919.6 3	1394.52	1.2 2	E2		
934.4 3	1904.5	1.1 5	M1+E2	-0.14 4	
970.0 § 3	970.10	33.0 § 15	M1+E2	-0.35 4	
1131.9 § 8	2792.98	2.3 § 14			
$^{x}1147.3$ 3		2.0 3			
1185.3 3	1660.44	22.1 14	M1+E2		δ : ≥ 0.26 and ≤ 1.00 from (α, γ).
1311.0 1	1310.94	12.0 2	E2		
1394.6 1	1394.52	15.6 4	M1+E2	-3.55 18	
1457.8 1	1932.60	4.0 12	M1+E2	+0.20 10	
1482.1 1	2792.98	10.1 3			
1502.4 1	2472.50	1.8 2			
1538.9 2	2932.91	1.09 10			
$^{x}1565.6$ § 14		<1.4 §			
1613.3 2	2088.86	3.8 3			
1660.4 1	1660.44	100.0 23	M1+E2	+0.39 +10-18	
1732.6 § 15	1732.4	<1.8 §	E2		
1883.1 3	2358.13	6.15 12			
1904.1 9	1904.5	1.17 16	M1+E2	+0.68 9	
1932.4 1	1932.60	8.5 5	M1+E2	+0.26 +12-8	
1997.4 2	2472.50	15.1 4	M1 (+E2)	-0.02 5	
2088.9 1	2088.86	8.05 13			
2209.0 2	2683.96	10.8 6			
2358.6 3	2358.13	4.2 3			
2381.4 20	2857.1	1.4 2			
2457.6 4	2932.91	8.4 5			
2472.1 § 20	2472.50	1.0 § 4			
2543.9 30	3019.3	0.97 18	M1+E2	-0.6 4	
2683.3 6	2683.96	8.7 6			
2792.3 3	2792.98	10.3 3			
2842.8 6	2840.53	3.18 3			
2857.0 3	2857.1	5.5 8			
2931.8 3	2932.91	1.2 3			
3019.3 11	3019.3	2.4 3			
3092.3 13	3092.4	1.5 3			
3521.1 15	3521.2	1.8 4			

† From 1970Ho29.

‡ From Adopted Gammas.

§ From 1972Du09.

$^{\#}$ For absolute intensity per 100 decays, multiply by 0.0766 38.

x γ ray not placed in level scheme.

61Zn ε Decay (89.1 s) 1970Ho29,1972Du09 (continued)

Decay Scheme

Intensities: I(γ+ce) per 100 parent decays

3/2- 0.0 89.1 s
⁶¹Zn₃₁
 %ε+%β⁺=100
 Q⁺(g.s.)=5635¹⁶

28Si(36Ar,3py) 2008An06

2008An06: Three experiments were performed: GS54, GSFMA42 and GSFMA138. All experiments used the GAMMASPHERE array to measure E_γ, I_γ, γγ, (particle)γ coin, γγ(θ)(DCO). The protons and α particles were detected using the MICROBALL array and Si strip telescopes used for ΔE-E measurements. Comparisons with cranked Nilsson and Strutinsky model calculations for collective structures and with large-scale shell-model calculations for normal-deformed states.

Experiment	GS54	GSFMA42	GSFMA138
Beam energy	143 MeV	148 MeV	142 MeV
Target thick.	0.42 mg/cm ²	0.42 mg/cm ²	0.2 mg/cm ²
Support foil	0.9 mg/cm ² Ta	1.0 mg/cm ² Au	1.1 mg/cm ² Ta
Germanium	82 detectors	86 detectors	77 detectors
Microball	95 elements	65 elements	16 elements
Si ΔE-E telescopes	--	4	8
Liquid scintillators (neutron shell)	15 detectors	20 detectors	30 detectors
Laboratory	LBNL	Argonne	Argonne

61Cu Levels

E(level) [†]	Jπ [‡]	Comments
0.0 [#]	3/2-	
970.10 ^{@ 14}	5/2-	
1310.50 ^{# 15}	7/2-	
1394.28 ¹⁶	5/2-	
1732.69 ¹⁵	7/2-	
1942.58 ¹⁷	7/2-	
2295.59 ¹⁷	9/2-	

Continued on next page (footnotes at end of table)

$^{28}\text{Si}(^{36}\text{Ar}, 3\text{p}\gamma)$ 2008An06 (continued) ^{61}Cu Levels (continued)

E(level) [†]	$J\pi^{\ddagger}$	Comments
2336.45@ 19	9/2-	
2612.35 18	9/2-	
2627.44# 19	11/2-	
2720.31& 19	9/2+	
3015.92 20	11/2-	
3260.60 19	11/2-	
3549.04 19	11/2-	
3780.8@ 3	13/2-	
3942.61 ^a 22	11/2+	
3970.80 22	13/2-	
4052.45 23	13/2-	
4081.44& 20	13/2+	
4287.74 23	13/2-	
4467.67# 24	15/2-	
4590.84 19	13/2+	
4819.57 21	15/2-	
4990.65 ^a 25	15/2+	
5120.10& 20	17/2+	
5137.96 22	15/2+	
5302.0 3		
5532.03 ^f 23	13/2+	
5579.9@ 9	17/2-	
5702.34 21	15/2+	
5729.50 ^g 21	15/2+	
5748.4 3	17/2-	
5853.5 4	17/2+	
5856.3 ^a 3	19/2+	
6056.08 ^f 21	17/2+	
6572.2 ^g 3	19/2+	
6824.4& 3	21/2+	
7124.6 ^c 7	19/2	
7306.2 ^f 3	21/2+	
7389.0 ^a 5	23/2+	
7455.2 10	21/2+	
7535.4 13	21/2-	
7606.5 19	21/2+	
7858.6 ^b 9	21/2	
7936.6 4	23/2-	
8030.3 ^g 5	23/2+	
8212.1 12	(21/2-)	
8333.8 8	23/2+	
8358.1 10		
8625.6 ^c 10	23/2	
8678.8 ^h 7	21/2-	
8789.1 ^f 5	25/2+	
8885.1 5	25/2+	
9138.4 24		
9287.1 ⁱ 7	23/2-	
9408.5 7	27/2-	
9474.6 ^b 11	25/2	
9643.6 16	(25/2-)	
9692.7 5	(25/2-)	
9725.2 ^g 6	27/2+	
9789.9 9	27/2-	
9957.6 ^h 7	25/2-	
10342.6 ^c 11	27/2	
10347.1 12	25/2+	
10409.2 ^j 10	25/2+	E(level): any one of the 10409 or 10463 levels can be the bandhead of SD-1 band.
10462.6 12	25/2+	E(level): see comment for 10409 level for bandhead of SD-1 band.
10687.8 ⁱ 7	27/2-	
10906.6 ^f 10	29/2+	
11019 4		
11132.9 8	31/2-	

Continued on next page (footnotes at end of table)

²⁸Si(³⁶Ar,3py) 2008An06 (continued)

⁶¹Cu Levels (continued)

E(level) [†]	Jπ [‡]	E(level) [†]	Jπ [‡]	E(level) [†]	Jπ [‡]
11144 4		15311 ^k 5	(33/2+)	23418 ^m 6	(47/2+)
11236.9 20	27/2-	15434.6 ^o 21	35/2+	23662 ⁿ 4	(49/2+)
11255 4		15524 ^m 3	(35/2+)	24337 ^k 4	49/2+
11301.6 ^h 7	29/2-	15742.4 ^d 14	37/2	24612 6	(49/2+)
11303.1 15	27/2-	16302.3 ⁿ 22	37/2+	25121 ^l 6	(49/2+)
11369.6 ^b 11	29/2	16571.3 ^e 16	39/2	25325 ^o 5	(51/2+)
11449 ^l 3	(25/2+)	16588 ^l 4	(37/2+)	26577 ^j 6	53/2+
11752.6 ^q 19	(29/2-)	16615 ^q 5	(37/2-)	26842 6	53/2+
11775.7 ^j 11	29/2+	16921 ^p 4	(39/2-)	26928 ^m 7	(51/2+)
12003.7 ⁱ 7	31/2-	17039 ^p 4	(39/2-)	27023 ⁿ 4	(53/2+)
12086.7 ^g 11	31/2+	17067 ^k 5	(37/2+)	27525 ^k 5	(53/2+)
12090 ^m 3	(27/2+)	17310.6 ^o 23	39/2+	28885 ^o 7	(55/2+)
12355.6 ^c 12	31/2	17431 ^j 3	41/2+	x ^r	J ₁ +1
12793.4 ^p 17	31/2-	17618.1 ^d 17	41/2	339+x 3	
12839.2 ^h 8	33/2-	17750 ^m 4	(39/2+)	790+x ^s 6	J ₁
12847.3 ^l 25	(29/2+)	18353.0 ⁿ 24	(41/2+)	2037.0+x ^r 20	J ₁ +3
13146 4	31/2-	18857.4 ^e 19	43/2	2520+x ^s 5	J ₁ +2
13206.0 ⁿ 21	29/2+	18995 ^l 4	(41/2+)	4288+x ^r 3	J ₁ +5
13284.3 ^j 18	33/2+	19134 ^k 4	41/2+	4465+x ^s 5	J ₁ +4
13419.6 18	33/2+	19472 ^q 6	(41/2-)	6674+x ^s 4	J ₁ +6
13678 ^m 3	(31/2+)	19562 ^o 3	(43/2+)	6735+x ^r 4	J ₁ +7
13823 ^k 5	(29/2+)	19878 ^p 4	(43/2-)	9261+x ^s 5	J ₁ +8
13874.2 ^o 20	31/2+	19970 ^j 4	45/2+	9434+x ^r 5	J ₁ +9
13983.0 ^d 13	33/2	20285 ^m 5	(43/2+)	12369+x ^s 6	J ₁ +10
14020.7 ^b 13	33/2	20550.7 ^d 24	(45/2)	12482+x ^r 6	J ₁ +11
14023.9 ⁱ 13	35/2-	20723 ⁿ 4	(45/2+)	15897+x ^r 7	J ₁ +13
14068 ^q 3	(33/2-)	20913.3 25	(45/2)	y ^t	J ₂
14163 4		21536 ^k 4	45/2+	1833+y 4	J ₂ +2
14563 ^l 3	(33/2+)	21839 ^l 5	(45/2+)	1846.1+y ^t 18	J ₂ +2
14587.2 ⁿ 20	33/2+	22212 ^o 4	47/2+	3998+y ^t 3	J ₂ +4
14628.0 ^p 25	35/2-	22284 6	(45/2+) [§]	6459+y ^t 4	J ₂ +6
14800.5 ^e 12	35/2	22718 ^q 6	(45/2-)	9258+y ^t 5	J ₂ +8
15201.8 ^h 16	37/2-	22984 ^j 4	49/2+	12432+y ^t 6	J ₂ +10
15231.9 ^j 20	37/2+	23376 ^p 6	(47/2-)		

[†] From least-squares fit to E_γ data.

[‡] Spin-parities of high-spin states (>9/2) are assigned from γγ(θ) and band structure (2008An06). Assignments of low-spin levels are from Adopted Levels.

[§] From Fig. 1 of 2008An06, not given in authors' table 2.

(A): Band based on 3/2-, g.s., α=-1/2. Normal-deformed structure.

@ (B): Band based on 5/2-, α=+1/2. Normal-deformed structure.

& (C): Band based on 9/2+, α=+1/2. Normal-deformed structure.

a (D): Band based on 11/2+, α=-1/2. Normal-deformed structure.

b (E): Band based on 21/2-, α=+1/2. Dipole dominated structure. Population intensity=1% of the reaction channel.

c (F): Band based on 19/2-, α=-1/2. Dipole dominated structure. Population intensity=1% of the reaction channel.

d (G): Band based on 33/2, α=+1/2. Continuation of band based on 19/2. Dipole dominated structure. Population intensity=1% of the reaction channel.

e (H): Band based on 35/2, α=-1/2. Continuation of band based on 19/2. Dipole dominated structure. Population intensity=1% of the reaction channel.

f (I): Band based on 13/2+, α=+1/2. Dipole dominated structure. Population intensity=20% of the reaction channel.

g (J): Band based on 15/2+, α=-1/2. Dipole dominated structure. Population intensity=20% of the reaction channel.

h (K): Band based on 21/2-, α=+1/2. Dipole dominated structure. Population intensity=5% of the reaction channel.

i (L): Band based on 23/2-, α=-1/2. Dipole dominated structure. Population intensity=5% of the reaction channel.

j (M): SD-1 band. Band based on 25/2+. Population intensity=7% of the reaction channel.

k (N): SD-2 band. Band based on 29/2+. Population intensity=1% of the reaction channel.

l (O): SD-3 band, α=+1/2. Band based on (25/2+). Population intensity=1% of the reaction channel.

m (P): SD-3 band, α=-1/2. Band based on (27/2+). Population intensity=1% of the reaction channel.

n (Q): SD-4 band, α=+1/2. Band based on 29/2+. Population intensity=2% of the reaction channel.

o (R): SD-4 band, α=-1/2. Band based on 31/2+. Population intensity=2% of the reaction channel.

p (S): SD-5 band. Band based on 31/2-. Population intensity=1% of the reaction channel.

q (T): SD-6 band. Band based on (29/2-). Population intensity=1% of the reaction channel.

r (U): SD-7 band. SD-7 and SD-8 are Signature partners. Population intensity=0.5% of the reaction channel.

s (V): SD-8 band. SD-7 and SD-8 are Signature partners. Population intensity=0.5% of the reaction channel.

t (W): SD-9 band. Population intensity=0.5% of the reaction channel.

28Si(36Ar,3py) 2008An06 (continued) $\gamma(^{61}\text{Cu})$

DCO values are for 30°–83° geometry with gates on $\Delta J=2$, quadrupole and $\Delta J=1$, dipole transitions. Expected values of DCOs are: 1. for gate on $\Delta J=2$, quadrupole: 1.0 for $\Delta J=2$, quadrupole; ≤ 1.0 for $\Delta J=0$ and ≈ 0.6 for $\Delta J=1$ transitions.

2. for gate on $\Delta J=1$, dipole transitions: ≈ 1.0 for $\Delta J=1$, dipole; 1.7 for $\Delta J=2$, quadrupole or $\Delta J=0$, dipole.

DCO(1) corresponds to value for gate on $\Delta J=2$, quadrupole.

DCO(2) corresponds to value for gate on $\Delta J=1$, dipole, except for one case where the value is for gate on $\Delta J=0$ transition, as indicated.

E_γ	E(level)	$I_\gamma^\dagger$	Mult. [‡]	Comments
170.3 2	5702.34	0.4 1	D	DCO(2)=0.99 19.
197.4 2	5729.50	0.2 1	D	DCO(2)=0.91 7.
210.1 2	1942.58	2.6 5	D	DCO(1)=0.96 11. Mult.: $\Delta J=0$ transition.
300.4 2	5120.10	3.7 4	D	DCO(1)=0.57 4.
326.6 1	6056.08	5.3 5	D	DCO(1)=0.63 3.
338.6 2	1732.69	3.8 3	D	DCO(2)=1.03 6.
340.8 2	1310.50	6.2 4	D	DCO(1)=0.63 4; DCO(2)=1.24 12.
353.6 4	6056.08	11.0 11	D	DCO(1)=0.61 1; DCO(2)=1.04 14.
400.3 2	5702.34	0.2 1		
422.2 2	1732.69	17.0 10	D	DCO(1)=1.11 2; DCO(2)=1.68 4. Mult.: $\Delta J=0$ transition.
424.2 2	1394.28	0.6 2		Mult.: $\Delta J=0$ transition.
509.7 2	4590.84	1.0 2		Mult.: $\Delta J=0$ transition.
515.9 3	6572.2	20.5 25	D	DCO(1)=0.50 6; DCO(2)=0.97 3.
529.2 2	5120.10	41.3 25	Q	DCO(1)=1.05 4.
547.1 2	5137.96	2.2 3	D+Q	DCO(1)=0.32 4.
563.1 § 2	2295.59	4.8 4	D+Q	DCO(2)=0.98 8.
564.2 2	5702.34	2.4 3	D	DCO(2)=1.67 3. Mult.: $\Delta J=0$ transition.
564.4 § 4	7389.0	3.0 5	D+Q	DCO(1)=0.56 10; DCO(2)=1.17 22.
582.2 2	5702.34	0.7 1	D+Q	DCO(1)=0.76 17; DCO(2)=0.92 10.
591.6 2	5729.50	0.7 2	D	DCO(2)=1.27 7. Mult.: $\Delta J=0$ transition.
608.2 3	9287.1	5.8 6	D	DCO(1)=0.64 5; DCO(2)=0.99 7.
613.8 3	11301.6	7.5 8	D+Q	DCO(1)=0.46 3; DCO(2)=1.03 4.
632.3 2	1942.58	3.1 6	D	DCO(1)=1.07 5. Mult.: $\Delta J=0$ transition.
633.1 § 2	3260.60	3.8 3	D	DCO(1)=1.08 3. Mult.: $\Delta J=0$ transition.
648.1 § 2	4590.84	3.2 3	D+Q	DCO(1)=0.45 2.
648.4 2	3260.60	6.2 8	D+Q	DCO(1)=0.77 4; DCO(2)=0.97 4.
652.6 2	5120.10	3.8 5	D	DCO(1)=0.58 2.
668.2 7	13874.2	0.7 1	D+Q	DCO(1)=0.62 3.
670.0 2	2612.35	11.6 10	D+Q	DCO(1)=0.73 4.
670.3 3	9957.6	5.4 6	D	DCO(2)=1.02 2.
679.3 2	3015.92	3.5 4	D+Q	DCO(1)=0.53 9.
686.8 6	4467.67	0.3 1		
702.2 4	12003.7	7.4 7	D+Q	DCO(1)=0.57 14; DCO(2)=1.09 2.
710.4 2	3970.80	3.3 3	D+Q	DCO(1)=0.78 4.
713.1 7	14587.2	0.3 1	D+Q	DCO(2)=0.94 5.
718.7 3	6572.2	1.2 1	D+Q	DCO(1)=0.41 2.
719.2 7	5856.3	0.8 1		
720.6 2	3015.92	3.4 4	D+Q	DCO(1)=0.88 7.
723.9 7	8030.3	17.4 17	D	DCO(1)=0.66 8; DCO(2)=1.21 6.
730.1 4	10687.8	8.7 9	D+Q	DCO(2)=1.09 4.
733.1 4	7306.2	23.1 23	D	DCO(2)=1.13 8.
734.0 7	7858.6	1.6 1	D+Q	DCO=0.41 2.
736.2 2	5856.3	27.4 15	D+Q	DCO(1)=0.49 2.
757.2 8	12847.3	0.5 1		
758.7 4	8789.1	8.7 9	D+Q	DCO(2)=1.11 9.
762.8 2	1732.69	7.6 6	D+Q	DCO(1)=0.47 6.
767.0 8	8625.6	1.3 1	D+Q	DCO(1)=0.76 13.
767.2 3	4819.57	1.8 2	D+Q	DCO(1)=0.72 7.
780.0 10	14800.5	0.3 1	D+Q	DCO(2)=1.22 10.
791.7 4	4052.45	2.5 3	D+Q	DCO(1)=0.90 7.
817.0 10	14800.5	1.8 2	D	DCO(1)=0.7 3; DCO(2)=1.06 5.

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28Si(36Ar,3py) 2008An06 (continued) $\gamma(^{61}\text{Cu})$ (continued)

E_γ	E(level)	$I_\gamma^\dagger$	Mult. [‡]	Comments
829.0 10	16571.3	1.4 1	D	DCO(2)=0.91 5.
830.6 8	13678	0.2 1		
835.5 4	12839.2	7.6 8	D+Q	DCO(2)=1.02 2.
840.1 4	9725.2	3.8 4		DCO(2)=0.84 4.
848.0 10	15434.6	0.8 1	D+Q	DCO(1)=0.42 3.
848.6 4	4819.57	1.8 2		
849.0 9	9474.6	1.1 1	D+Q	DCO(2)=0.88 3.
850.0 6	5137.96	3.5 4	D	DCO(1)=0.64 5; DCO(2)=1.11 10.
854.9 4	8885.1	5.2 5	D+Q	DCO(2)=1.02 4.
868.0 9	10342.6	1.0 1	D+Q	DCO(2)=1.28 9.
868.0 10	16302.3	0.8 1	D+Q	DCO(1)=0.53 2.
870.2 9	12003.7	2.3 2	D	DCO(2)=1.24 4. Mult.: $\Delta J=0$ transition.
879.4 2	2612.35	13.0 11	D+Q	DCO(1)=0.78 7.
885.4 10	14563	0.3 1		
897.6 9	10687.8	0.4 1		Mult.: $\Delta J=0$ transition.
901.2 2	2295.59	3.6 4		
909.2 2	4990.65	3.5 3	D+Q	DCO(1)=0.27 6.
921.7 2	3549.04	3.9 7	D	DCO(1)=1.09 4. Mult.: $\Delta J=0$ transition.
928.8 3	5748.4	2.1 1	D+Q	DCO(1)=0.74 8.
929.0 8	9287.1	0.2 1		Mult.: E2/M1 assigned in table 2 of 2008An06 based only on $J\pi$ assignments.
935.9 5	9725.2	5.8 5	D	DCO(2)=1.03 3.
936.5§ 2	3549.04	5.4 8	D+Q	DCO(1)=0.92 7.
942.0 10	15742.4	2.0 1	D	DCO(2)=1.09 4.
960.3 10	15524	0.2 1		
967.6 3	6824.4	3.0 3	D+Q	DCO(2)=0.75 1.
970.2 2	970.10	49.6 24	D+Q	DCO(1)=0.45 1.
972.2§ 2	1942.58	10.0 15	D+Q	DCO(1)=0.39 2.
985.7 2	2295.59	9.8 9	D+Q	E_γ : level-energy difference=985.1 2. DCO(2)=0.82 5. DCO(2)=0.92 6.
986.0§ 10	12355.6	0.8 1	D+Q	DCO(1)=0.56 6; DCO(2)=1.24 7.
987.7 2	2720.31	27.8 16	D	
1008.4 10	17310.6	0.3 1		
1025.9 2	2336.45	6.3 2	D+Q	DCO(1)=0.40 3.
1027.0 10	11369.6	1.0 1	D+Q	DCO(1)=0.54 4; DCO(2)=0.92 4.
1038.6 2	5120.10	44.1 15	Q	DCO(1)=0.92 1; DCO(2)=1.81 8.
1041.9 2	4590.84	8.8 8	D	DCO(1)=0.49 2.
1042.3 10	18353.0	0.1 1		
1047.0 10	17618.1	1.8 1	D+Q	DCO(1)=0.44 2; DCO(2)=1.10 4.
1048.0 5	4990.65	1.5 2		
1065.4 4	6056.08	0.7 1	D+Q	DCO(1)=0.52 8.
1065.6 2	4081.44	17.1 5	D	DCO(1)=0.68 3; DCO(2)=1.38 12.
1075.0 11	9287.1	0.2 1		
1111.5 3	5702.34	0.4 1		
1112.2 2	7936.6	34.7 9	D	DCO(1)=0.47 1; DCO(2)=0.97 3.
1139.0 4	5729.50	0.2 1	D+Q	DCO(2)=1.14 12.
1153.5 6	3780.8	2.0 2	D+Q	DCO(1)=0.31 5.
1177.4 13	15201.8	2.2 2	D+Q	
1180.0§ 12	12086.7	2.5 5	D+Q	DCO(2)=1.03 9.
1181.0§ 12	10906.6	7.7 8	D+Q	DCO(2)=1.03 9.
1183.6 13	14023.9	5.2 5	D+Q	DCO(2)=0.96 4.
1206.0 12	8030.3	4.9 5	D+Q	DCO(1)=0.94 18.
1209.0 12	19562	1.0 1		
1212.6 4	3549.04	0.9 1		
1222.2 2	3942.61	5.5 5	D+Q	DCO(2)=0.53 4.
1236.5 2	6056.08	3.1 4	D	DCO(2)=1.03 7.
1239.0 12	18857.4	1.7 1	D+Q	DCO(2)=1.20 10.
1244.3 4	5532.03	0.5 2		Mult.: $\Delta J=0$ transition.
1250.0 6	7306.2	4.0 4	Q	DCO(2)=1.52 18.
1253.9 3	3549.04	1.5 3	D+Q	DCO(1)=1.35 8.
1268.3 7	7124.6	0.9 1	D	DCO(1)=1.08 15. Mult.: $\Delta J=0$ transition.

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28Si(36Ar,3py) 2008An06 (continued) $\gamma(^{61}\text{Cu})$ (continued)

E_γ	E(level)	$I_\gamma^\dagger$	Mult. [‡]	Comments
1279.5 6	9957.6	2.1 2		
1280.7 3	5748.4	0.8 1		
1301.7 6	2612.35	3.0 3		
1310.4 3	1310.50	100 3	Q	DCO(1)=1.00 2; DCO(2)=1.57 2.
1313.0 15	11775.7	4.0 10		
1315.0 5	3942.61	0.5 1		Mult.: $\Delta J=0$ transition.
1316.6 § 3	2627.44	26.2 15	Q	DCO(1)=1.15 14.
1316.8 13	12003.7	4.5 5		
1317.8 5	3260.60	6.0 6		
1325.2 3	2295.59	4.8 5		
1329.8 § 3	4590.84	9.0 4	D	DCO(1)=0.55 7.
1330.2 6	3942.61	1.0 1		
1343.2 3	3970.80	2.5 2	D+Q	DCO(1)=0.67 5.
1343.4 13	11132.9	0.6 1	Q	DCO(2)=1.44 23.
1344.4 7	11301.6	2.2 2	Q	DCO(2)=1.28 6.
1358.4 7	3970.80	1.9 1		
1361.1 § 3	4081.44	40.9 12	Q	DCO(1)=0.98 2; DCO(2)=1.83 9.
1366.0 16	11775.7	6.0 6		
1366.1 3	2336.45	19.0 10	Q	DCO(1)=0.95 5.
1381.0 14	14587.2	1.0 1	Q	DCO(2)=1.62 16.
1394.4 3	1394.28	9.1 3	D+Q	DCO(1)=0.60 2.
1398.0 14	12847.3	0.5 1		
1400.9 7	10687.8	3.7 4	Q	DCO(2)=1.40 11.
1409.1 3	2720.31	34.0 10	E1	DCO(1)=0.62 3; DCO(2)=1.00 6.
1414.6 § 3	5702.34	0.5 1	D	DCO(2)=0.96 9.
1424.9 # 7	4052.45	1.5 2	D+Q	DCO(1)=1.44 13.
1428.6 14	11775.7	1.5 2	Q	DCO(1)=0.97 8.
1429.9 14	8885.1	1.1 1		
1441.9 3	5729.50	0.5 1	D	DCO(2)=1.02 6.
1444.4 3	3780.8	8.9 3	Q	DCO(1)=1.25 17.
1450.4 3	7306.2	1.0 1	D+Q	DCO(2)=1.43 6.
1451.7 12	4467.67	0.8 1		
1451.7 § 3	6572.2	12.5 8	D+Q	DCO(1)=1.24 4.
1458.3 7	8030.3	6.7 7	Q	DCO(2)=1.42 13.
1471.4 7	9408.5	23.5 23	Q	DCO(1)=1.02 2; DCO(2)=1.87 3.
1483.2 7	8789.1	3.5 4	Q	DCO(2)=1.33 8.
1488.0 15	15311	0.3 1		
1490.0 15	12793.4	0.7 1		
1495.8 15	8885.1	2.1 1	D+Q	DCO(1)=1.04 10.
1501.0 15	8625.6	0.3 1		
1509.3 § 8	8333.8	5.9 6	D+Q	DCO(1)=1.06 7.
1509.4 § 15	13284.3	15.5 16	Q	DCO(1)=0.96 2; DCO(2)=1.59 16.
1527.8 § 3	3260.60	9.2 8	Q	DCO(1)=1.17 7.
1533.5 8	7389.0	7.6 8	Q	DCO(1)=1.00 12; DCO(2)=1.92 4.
1537.3 8	12839.2	2.4 3	Q	DCO(2)=1.47 8.
1556.5 16	12793.4	0.1 1		
1559.3 3	4819.57	3.6 3	Q	DCO(1)=0.97 5.
1559.8 16	15434.6	2.2 4	Q	DCO(1)=1.02 4.
1578.9 16	8885.1	1.6 1	Q	DCO(2)=1.69 36.
1587.8 16	13678	1.2 2	Q	DCO(1)=0.93 7.
1599.0 16	7455.2	4.1 2	D+Q	DCO(2)=1.28 14.
1606.4 6	3549.04	1.4 1		
1616.0 16	9474.6	0.3 1		
1628.0 16	13983.5	0.5 1	D+Q	DCO(2)=1.31 7.
1642.2 8	2612.35	1.0 1		
1642.9 16	13419.6	2.0 3		
1644.4 16	11369.6	0.5 1		Mult.: $\Delta J=1$ transition.
1647.9 3	5729.50	0.4 1	D+Q	DCO(2)=1.39 9.
1665.0 17	14020.7	0.5 1	D+Q	DCO(2)=1.13 24.
1692.8 17	20550.7	0.4 1		
1695.0 8	9725.2	3.9 4	Q	DCO(2)=1.43 8.
1698.0 17	2037.0+x	0.3 1		
1704.5 3	6824.4	49.3 16	Q	DCO(1)=1.05 2; DCO(2)=1.96 6.

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²⁸Si(³⁶Ar,3pγ) 2008An06 (continued)

γ(⁶¹Cu) (continued)

Eγ	E(level)	Iγ [†]	Mult. [‡]	Comments
1705.3 § 6	3015.92	11.5 8	Q	DCO(1)=1.14 2.
1707.0 § 17	9643.6	0.6 1	D	DCO(1)=0.58 3.
1714.3 17	16302.3	1.2 5		
1715.9 3	4052.45	4.0 4		
1716.0 17	14563	1.1 2		
1717.0 17	10342.6	0.4 1	Q	DCO(2)=1.55 6.
1721.0 17	15742.4	0.3 1		
1723.7 9	11132.9	6.2 6	Q	DCO(1)=1.25 9.
1730.0 17	2520+x	0.3 1		
1731.9 3	5702.34	2.4 3		
1732.3 3	1732.69	38.3 12	Q	DCO(1)=1.00 7.
1753.0 5	5302.0	0.9 3		
1753.0 18	7606.5	2.0 1	Q	DCO(1)=1.01 7.
1756.0 18	17067	0.6 1		
1757.3 4	4052.45	3.3 4		
1758.7 5	5729.50	0.1 1		
1759.0 18	15742.4	1.0 1	Q	DCO(1)=1.07 10.
1771.0 18	16571.3	2.2 1	Q	DCO(2)=1.60 8.
1772.0 4	5853.5	5.8 4	Q	DCO(1)=1.08 6.
1787.0 18	7535.4	1.2 1		
1800 1	5579.9	3.8 4	Q	DCO(1)=1.13 7.
1802.5 18	10687.8	1.0 1		
1811.0 18	15231.9	1.6 3	Q	DCO(1)=1.12 9.
1834.6 18	14628.0	1.4 1	Q	DCO(1)=0.95 7.
1840.9 4	4467.67	5.2 2	Q	DCO(1)=0.99 8; DCO(2)=1.71 6.
1845.7 19	15524	1.0 2	Q	DCO(1)=1.05 9.
1846.1 18	1846.1+y	0.3 1		
1853.0 19	9789.9	2.3 2	Q	DCO(2)=1.71 13.
1870.1 4	4590.84	13.5 9	Q	DCO(1)=1.09 5.
1875.0 19	17618.1	1.0 1	Q	DCO(2)=1.60 8.
1875.9 19	17310.6	2.0 4	Q	DCO(1)=1.06 9.
1893.1 19	11301.6	0.4 1		
1894.0 19	11303.1	0.4 1	D	DCO(1)=0.71 9. Mult.: ΔJ=0 transition.
1895.0 19	11369.6	0.3 1		
1897.0 19	13983.5	1.4 1	D	DCO(2)=1.10 6.
1928.0 19	9957.6	1.3 1	D	DCO(2)=0.89 6.
1934.0 19	14020.7	0.9 1		Mult.: ΔJ=1 transition.
1943.0 8	1942.58	3.4 8	Q	DCO(2)=1.49 12.
1945.0 19	4465+x	0.3 1		
1948.9 20	15231.9	12.0 12	Q	DCO(1)=0.97 7.
1951.4 4	4287.74	6.1 6	Q	DCO(1)=1.14 6.
1955.4 20	7535.4	0.5 1	Q	DCO(1)=1.03 9.
1961.0 20	14800.5	2.8 2	D	DCO(1)=0.47 5; DCO(2)=0.80 11.
1974.1 4	6056.08	2.3 3	Q	DCO(1)=0.96 11.
1980.6 20	9287.1	1.4 2	D	DCO(2)=0.87 10.
1992.2 4	4287.74	1.6 1		
2004.0 20	7124.6	1.0 1	D	DCO(1)=1.33 22.
2013.0 20	10347.1	0.4 1		
	12355.6	0.3 1		
2021.3 20	14023.9	1.4 1	Q	DCO(2)=1.39 8.
2025.0 20	16588	1.1 2	Q	DCO(1)=1.05 11.
2037.0 20	2037.0+x	0.3 1		
2050.7 21	18353.0	1.8 3		
2055.9 21	20913.3	0.6 1		
2060.0 21	11752.6	0.3 1	Q	DCO(1)=0.98 22.
2067.0 21	19134	0.6 1		
2106.6 11	8678.8	1.2 2	D	DCO(2)=1.06 9. Mult.: assigned by the evaluators, consistent with DCO ratio. Mult=E2/M1 in table 2 of 2008An06 seems a misprint since it is inconsistent with Jπ values of levelS involved.
2109.0 21	11752.6	0.3 1	(Q)	DCO(1)=0.81 12.
2118.0 14	10906.6	1.0 1	Q	DCO(2)=1.27 7.

Continued on next page (footnotes at end of table)

28Si(36Ar,3pγ) 2008An06 (continued)γ(61Cu) (continued)

E _γ	E(level)	I _γ [†]	Mult. [‡]	Comments
2127.9 21	10462.6	1.0 1	D+Q	DCO(1)=0.65 3.
2152.2 22	3998+y	0.6 1		
2165.0 22	3998+y	0.2 1		
2191.0 4	4819.57	2.8 3		
2198.7 22	17431	10.0 10	Q	DCO(1)=1.03 2; DCO(2)=1.37 17.
2209.0 22	6674+x	0.5 1		
2226.7 22	17750	0.8 1	(Q)	DCO(1)=0.87 9.
2238.5 4	3549.04	1.0 1		
2251.0 23	4288+x	0.7 1		
2252.1 23	19562	1.7 3	Q	DCO(1)=1.05 6.
2270.5 6	5532.03	0.6 2		
2286.0 23	18857.4	0.8 1		
2293.0 23	16921	0.3 1		
2314.0 23	9138.4	1.1 1		
2315.0 23	14068	1.0 1	Q	DCO(1)=1.16 14.
2317.1 23	10347.1	0.2 1	D+Q	DCO(2)=1.08 18.
2344.0 23	11752.6	0.5 1	(D+Q)	DCO(1)=1.3 3.
2362.0 24	12086.7	2.0 1	Q	DCO(2)=1.93 21.
2364.3 24	15201.8	1.8 2	Q	DCO(2)=1.35 17.
2367.9 24	11775.7	3.0 3	D	DCO(1)=0.60 6; DCO(2)=1.16 6.
2370.0 24	20723	1.3 1		
2385.6 24	6674+x	0.2 1		
2402.0 24	21536	0.5 1	Q	DCO(1)=1.23 17.
2407.0 24	18995	0.8 3	Q	DCO(1)=0.93 9.
2411.0 24	17039	0.5 1		
2422.0 24	9957.6	0.7 1	Q	DCO(2)=2.0 3.
2447.2 24	6735+x	0.4 1		
2460.3 25	6459+y	0.7 1		
2472.4 12	10409.2	1.1 1	D	DCO(1)=0.69 7.
2500.5# 25	14587.2	0.1 1	D+Q	
2534.8 25	20285	0.6 1	Q	DCO(1)=0.92 7.
2538.9 25	19970	6.0 6	Q	DCO(1)=1.11 7.
2547.3	16615	0.8 1	Q	DCO(1)=1.00 10.
2568.3	9957.6	0.8 1		
2587.3	9261+x	0.6 1		
2614.3	13983.5	0.7 1	Q	DCO(2)=1.70 11.
2632.3	8212.1	0.5 1	(Q)	DCO(1)=1.3 3.
2650.3	22212	1.3 2	Q	DCO(1)=1.03 7.
2651.3	14020.7	0.4 1		
2699.3	9434+x	0.3 1		
2778.3	8358.1	0.3 1		
2799.3	9258+y	0.5 1		
2801.3	24337	0.3 1		
2839.3	19878	0.3 1		
2844.3	21839	0.4 1	(Q)	DCO(1)=0.88 6.
2857.3	19472	0.3 1	Q	DCO(1)=0.90 12.
2934.3	20550.7	0.3 1		
2939.3	23662	0.4 1		
2954.3	10409.2	0.3 1		
2957.3	19878	0.2 1		
2958.3	10347.1	0.3 1		
3008.3	10462.6	0.2 1		
3014.3	22984	2.4 3	(Q)	DCO(1)=0.89 3.
3030.3	14163	0.4 1		
3048.3	12482+x	0.1 1		
3074.3	10462.6	1.3 1	D+Q	DCO(1)=1.36 13.
3101.2 16	8678.8	0.6 1	Q	DCO(1)=1.08 16.
3108.3	12369+x	0.2 1		
3113.3	25325	0.4 1	(Q)	DCO(1)=0.87 8.
3122# 3	12847.3	0.3 1		
3133.3	23418	0.2 1		
3174.3	12432+y	0.2 1		
3188.3	27525	0.1 1		

Continued on next page (footnotes at end of table)

²⁸Si(³⁶Ar,3pγ) 2008An06 (continued)

^γ(⁶¹Cu) (continued)

E _γ	E(level)	I _γ [†]	Mult. [‡]	Comments
3246 3	22718	0.1 1		
3281 3	25121	0.1 1		
3295 3	20913.3	0.5 1		
3300 3	11236.9	0.8 1		
3362 3	27023	0.1 1		
3367 3	11303.1	0.6 1	Q	DCO(2)>1.
3386 3	12793.4	1.7 2	Q	DCO(1)=0.95 7.
3414 3	15897+x	0.1 1		
3480 4	13206.0	0.2 1		
3498 4	23376	0.1 1		
3510 4	26928	0.1 1		
3523 4	10347.1	0.2 1		
3560 4	28885	0.1 1		
3584 4	10409.2	1.7 2	Q	DCO(1)=1.25 15.
3592 4	26577	0.1 1	Q	DCO(1)=0.91 8.
3630 4	11019	0.4 1		
3638 4	10462.6	0.9 2	Q	DCO(1)=0.87 14.
3737 4	13146	0.8 1	Q	DCO(1)=1.00 15.
3755 4	11144	0.4 1		
3857 4	26842	0.3 1	(Q)	DCO(1)=0.87 10.
3866 4	11255	0.6 1		
3902 4	19134	0.3 1	Q	DCO(1)=0.91 20.
4038 4	27023	0.1 1		
4058 [#] 4	12847.3	0.2 1		
4105 4	21536	0.2 1	Q	DCO(1)=0.98 18.
4150 4	13874.2	0.4 1	Q	DCO(1)=0.89 19; DCO(2)=1.8 4.
4367 4	24337	0.1 1	(Q)	DCO(1)=0.87 21.
4642 5	24612	0.1 1		
4853 5	22284	0.1 1		

[†] Relative to 100 for 1310.4γ measured in the ²⁸Si(³⁶Ar,3pγ) reaction (2008An06).

[‡] Deduced from DCO measurements in 2008An06. In the absence of polarization or other confirming data, the evaluators assign Mult=Q for ΔJ=2, quadrupole transitions, mult=D or D+Q for ΔJ=1 or 0 dipole or dipole+quadrupole transitions. From systematics and band assignments, 2008An06 assign E2 for all ΔJ=2 transitions and M1+E2, M1 or E1 for ΔJ=1 or 0 transitions.

[§] DCO value is for an unresolved doublet.

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

⁴⁰Ca(²⁴Mg,3pγ) 1999Vi12,1999Vi07,2004Iz01

2004Iz01: E(⁴⁰Ca)=96 MeV beam provided by LNL Tandem accelerator, bombarding a ²⁴Mg target. Measured E_γ, I_γ, γγ, γγ(θ)(DCO), γγ(lin pol) with the EUROBALL Ge-detector array consisting of 26 Clover detectors and 15 Cluster detectors. Evaporated charged particles were detected in the 40-element silicon ΔE-E array ISIS.

1999Vi07, 1999Vi12: E=65 MeV. Measured E_γ, γγ, I_γ, and γγ(θ)(DCO) using the AYEBALL array with TESSA type detectors, eight EUROGAM detectors and one GAMMASPHERE detector.

⁶¹Cu Levels

E(level) [†]	Jπ [‡]	Comments
0.0	3/2-	
969.99 8	5/2-	
1310.37 7	7/2-	
1732.49 7	7/2-	
1942.26 18	7/2-	Jπ: 7/2- based on 972 keV M1 γ to 5/2- (2004Iz01). 1999Vi12 quote J=(7/2-).
2336.23 12	9/2-	
2612.17 [§] 12	9/2-	
2627.14 11	11/2-	
2720.13 11	9/2+	
3015.8 4	11/2-	
3260.54 10	11/2-	Jπ: =11/2-, based on 1528.1 keV E2 γ to 7/2- (2004Iz01). 1999Vi12 quote J=(11/2).

Continued on next page (footnotes at end of table)

40Ca(24Mg,3pγ) 1999Vi12,1999Vi07,2004Iz01 (continued)**61Cu Levels (continued)**

E(level) [†]	Jπ [‡]	Comments
3548.67 [§] 20	11/2(-)	
3779.44 23	13/2-	Jπ: =13/2-, based on 1443.2 keV E2 γ to 9/2- (2004Iz01). 1999Vi12 quote J=(11/2-).
3942.37 [§] 14	11/2+	
4081.20 13	13/2+	
4288.26 [§] 16	13/2-	
4468.46 [§] 14	15/2-	
4590.58 12	13/2+	
4820.25 [§] 16	(15/2-)	
4989.70 [§] 24	(15/2+)	
5119.91 13	17/2+	
5137.99 [§] 25	(15/2+)	
5464.4 [§] 5		
5702.6 [§] 3	(15/2+)	
5855.82 17	19/2+	Jπ: 19/2+, based on 735.9 keV M1 γ to 17/2+ (2004Iz01). 1999Vi12 quote J=19/2-.
6055.7 [§] 5	(17/2+)	
6824.82 17	21/2+	Jπ: 21/2+, based on 1704.9 keV E2 γ to 17/2+ (2004Iz01). 1999Vi12 quote J=(21/2+).
7388.84 19	23/2+	Jπ: 23/2+, based on 1533.0 keV E2 γ to 19/2+ (2004Iz01).
7937.0 3	23/2-	Jπ: 23/2-, based on 1112.2 keV E1 γ to 21/2+ (2004Iz01).
9408.5 5	27/2-	Jπ: 27/2-, based on 1471.4 keV E2 γ to 23/2- (2004Iz01).

[†] From least-squares fit to Eγ data.[‡] Assignments based on DCO(1999Vi12), R(DCO) and linear polarization (2004Iz01).[§] Not observed by 2004Iz01.**γ(61Cu)**

DCO=[(I(158°) gated at I(79°,101°,134°))/(I(79°,101°,134°) gated at I(158°))] $\times\epsilon$, where I is the number of counts in a peak and ϵ is an efficiency multiplication factor (1999Vi12 and 1999Vi07).

R_{DCO}=I(γ₁ at 156°; gated with γ₂ at 77°,103°)/I(γ₁ at 77°,103°; gated with γ₂ at 156°), CLOVER detectors at 77° and 103° are equivalent as far as DCO ratios are concerned. Known stretched E2 transitions were used for gating, such the R_{DCO}=1.0 is expected for stretched quadrupole transitions and R_{DCO}=0.6 for stretched dipoles, ΔJ=0 transitions have values similar to stretched quadrupole transitions (2004Iz01).

POL=[aN(perpendicular)-N(parallel)]/[aN(perpendicular)+N(parallel)], where a(Eγ)=normalization function determined from the ¹⁵²Eu source calibration. POL takes positive values for pure stretched electrical radiation and negative values for pure stretched magnetic radiation (2004Iz01).

Eγ [†]	E(level)	Iγ [‡]	Mult. [§]	Comments
209.6 2	1942.26	2.6 1		DCO=0.78 10.
300.2 3	5119.91	1.8 1		DCO=0.62 13.
326.4 4	5464.4	2.5 4		DCO=0.65 35.
340.2 2	1310.37	7.5 5	M1+E2	DCO=0.64 11. R(DCO)=0.56 4, POL=-0.104 23.
352.9 5	6055.7	7.2 5		DCO=0.49 11.
422.0 1	1732.49	13.6 13		DCO=1.16 12. R(DCO)=1.28 6, POL=+0.105 15. Mult.: ΔJ=0 transition.
529.3 1	5119.91	23.7 15	E2	DCO=0.94 10. R(DCO)=1.04 5, POL=+0.101 11.
564.6 2	5702.6	1.1 1	D	DCO=0.8 4. R(DCO)=0.57 6. Iγ: from γγ coin.
632.7 9	3260.54	6.2 7		DCO=1.02 9.
647.5 5	4590.58	2.1 3		
648.2 1	3260.54	8.9 3		
651.6 3	5119.91	1.7 1		DCO=0.55 8.
669.5 3	2612.17	8.6 13		DCO=0.95 12.
735.9 1	5855.82	26.1 22	M1	DCO=0.56 3. R(DCO)=0.65 8, POL=-0.137 17.
762.5 1	1732.49	8 5		DCO=0.93 2.
849.7 2	5137.99	8.5 9		DCO=0.63 10.
879.2 2	2612.17	8.9 15		DCO=0.94 1.
908.5 2	4989.70	2.6 2		DCO=0.30 1.

Continued on next page (footnotes at end of table)

$^{40}\text{Ca}(^{24}\text{Mg},3\text{p}\gamma)$ 1999Vi12,1999Vi07,2004Iz01 (continued) $\gamma(^{61}\text{Cu})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger$	Mult.§	Comments
936.5 3	3548.67	19.0 13		DCO=0.94 24.
968	6824.82			E γ : γ transition from Fig. 3 of 2004Iz01.
969.9 1	969.99	36.7 7	M1+E2	DCO=0.45 3.
				R(DCO)=0.30 2, POL=+0.015 13.
972	1942.26	7.1 4	M1	I γ : from $\gamma\gamma$ coin, doublet 969.9 keV to g.s.
				POL=-0.044 24.
987.5 3	2720.13	19.8 7	E1	DCO=0.61 5.
				R(DCO)=0.52 3, POL=+0.050 17.
1026.3 5	2336.23	4.5 8	M1+E2	DCO=0.33 9.
				R(DCO)=0.40 5, POL=+0.03 3.
1038.5 2	5119.91	24.8 8	E2	DCO=1.02 4.
				R(DCO)=0.95 4, POL=+0.063 16.
1041.9 2	4590.58	12.0 13		DCO=0.67 1.
1065.5 4	4081.20	10.8 6	E1	DCO=0.66 9.
				R(DCO)=0.52 3, POL=+0.028 14.
1112.2 3	7937.0	11.1 8	E1	DCO=0.82 15.
				R(DCO)=0.51 2, POL=+0.056 14.
1222.2 1	3942.37	4.0 5		DCO=0.46 11.
1310.4 1	1310.37	100 6	E2	DCO=1.10 4.
				R(DCO)=1.04 4, POL=+0.104 9.
1316.9 1	2627.14	23 4	E2	DCO=1.03 10.
				R(DCO)=1.04 4, POL=+0.082 16.
1330.0 1	4590.58	11.6 19	E1	DCO=0.63 4.
				R(DCO)=0.69 5, POL=+0.069 21.
1361.0 1	4081.20	35.9 21	E2	DCO=0.94 12.
				R(DCO)=1.02 4, POL=+0.115 15.
1366.2 1	2336.23	14.7 21	E2	DCO=1.09 11.
				POL=+0.110 18.
1409.7 1	2720.13	20.8 14	E1	DCO=0.56 5.
				R(DCO)=0.51 3, POL=+0.064 10.
1443.2 2	3779.44	12 3	E2	R(DCO)=1.07 9, POL=+0.05 4.
1471.4 3	9408.5	7.1 16	E2	DCO=1.12 8, POL=+0.113 17.
1528.1 1	3260.54	17 4	E2	DCO=1.1 3.
				R(DCO)=1.02 9, POL=+0.11 5.
1533.0 1	7388.84	3.2 2	E2	DCO=0.50 14.
				R(DCO)=1.02 10, POL=+0.060 19.
1559.4 2	4820.25	6.0 4		DCO=1.50 12.
1704.9 1	6824.82	11.1 10	E2	DCO=1.18 3.
				R(DCO)=0.90 4, POL=+0.075 22.
				E γ : 1704.9+1706 keV a doublet structure.
1706 1	3015.8	23.6 21	E2	R(DCO)=0.90 4, POL=+0.055 22.
				E γ : 1704.9+1706 keV a doublet structure.
1732.5 1	1732.49	28.0 16	E2	DCO=0.93 7.
				R(DCO)=1.04 4, POL=+0.062 20.
1841.3 1	4468.46	12.9 10		DCO=1.06 21.
1870.5 2	4590.58	9.4 3	E2	DCO=1.04 4.
				R(DCO)=1.12 6, POL=+0.11 3.
1952.0 1	4288.26	4.8 2		DCO=1.02 7.
1975 1	6055.7	1.8 4		
2193.6 2	4820.25	4.4 8		DCO=0.6 4.

† From 1999Vi12.

‡ Intensities listed are singles. 1999Vi12 also quote $\gamma\gamma$ coin intensities.

§ From DCO (1999Vi12). R(DCO) and linear polarization (2004Iz01) values are given in comments.

⁴⁰Ca(²⁸Si,α3pγ) 1997Ha45

1997Ha45: ⁴⁰Ca(²⁸Si,α3pγ), E=120 MeV beam provided by the tandem accelerator at the Japan Atomic Energy Research Institute. γ-rays were detected with an array of germanium detectors with BGO shields and in coincidence with Si ball. Measured Eγ, Iγ, γγ-coin, DCO analysis.

⁶¹Cu Levels

E(level) [†]	Jπ [‡]	E(level) [†]	Jπ [‡]	E(level) [†]	Jπ [‡]
0.0	3/2-	2719.2 8	9/2+	4588.9 8	13/2+
969.9 7	5/2-	3014.6 8	11/2-	4818.0 10	
1310.2 7	7/2-	3259.3 8		5118.0 9	17/2+
1394.1 7	5/2-	3653.3 11		5135.6 14	
1731.8 6	7/2-	3941.1 10	11/2+	5854.0 14	(19/2)
1941.8 9	7/2-	4051.2 11		6822.1 14	21/2+
2294.5 8	9/2-	4079.9 9	13/2+	7387.1 17	
2335.6 8	9/2-	4285.6 10		7934.1 17	(23/2)
2611.6 8	9/2-	4379.8 10		9405.1 20	(27/2)
2626.4 9		4466.2 11			

[†] From a least squares fit to the Eγ data assuming a 1 keV uncertainty for the γ energies.

[‡] As listed in 1997Ha45 based on previous assignments and from their DCO analysis. But no data details are available in this short note.

γ(⁶¹Cu)

Eγ [†]	E(level)	Eγ [†]	E(level)	Eγ [†]	E(level)
209	4588.9	850	5135.6	1366	2335.6
300	5118.0	880	2611.6	1394	1394.1
338	1731.8	900	2294.5	1409	2719.2
340	1310.2	935	4588.9	1471	9405.1
422	1731.8	970	969.9	1528	3259.3
529	5118.0	972	1941.8	1533	7387.1
563	2294.5	987	2719.2	1559	4818.0
648§	3259.3	1025	2335.6	1704§	3014.6
	4588.9	1038	5118.0		6822.1
652	5118.0	1041	3653.3	1732	1731.8
670	2611.6	1065	4079.9	1840	4466.2
679	3014.6	1112	7934.1	1869	4588.9
720	3014.6	1222	3941.1	1950	4285.6
736	5854.0	1310	1310.2	1991	4285.6
762	1731.8	1316	2626.4	2044	4379.8
767	4818.0	1330	4588.9	2191	4818.0
792	4051.2	1361	4079.9		

[†] From 1997Ha45 level energy diagram, where available.

§ Multiply placed; undivided intensity given.

⁵⁸Ni(α,p) 2001Ny01

2001Ny01: Target of ⁵⁸Ni evaporated on to carbon foil of ≈40 μg/cm², was bombarded with 25-MeV α particles from the Niels Bohr Institute Tandem Accelerator. Measured angular distributions protons from the (α,p) reaction were momentum analyzed in multigap spectrometer and registered with photographic emulsions. Spectra were recorded at angles ranging from 7.5° to 77.5° in steps of 5°, and energy resolution is ≈25 keV. The emulsions were manually scanned in 1/2 mm strips. Spin and parity assignments made from comparison of the experimental angular distributions of the emerging protons with theoretical angular distributions calculated with the DWUCK-4 code using a cluster form factor.

1972Bu17: Eα=19.3 MeV. Semi, FWHM=150–200 keV. Enriched target. Measured σ(θ), θ(c.m.)=10°–130°. A total of eight groups are in the spectral figure 1, four of which (0, 470, 970 and 2700) were analyzed for σ(θ) data.

1971Ho21: Eα=12.5 MeV. Magnetic spectrograph, FWHM=12 keV. θ(lab)= 90° and 154°. Levels up to 3978 keV.

Others: 1965Le05, 1973Ma38.

$^{58}\text{Ni}(\alpha, p)$ 2001Ny01 (continued) **^{61}Cu Levels**

E(level) [†]	$J\pi^{\ddagger}$	$d\sigma/d\Omega$ ($\mu\text{b/sr}$) ^c	E(level) [†]	$J\pi^{\ddagger}$	$d\sigma/d\Omega$ ($\mu\text{b/sr}$) ^c
0.0 §	3/2-	512	3578# 6		
475 § 2	1/2-	197	3591 2	(5/2+)	114
970 § 2	5/2-	189	3618# 6		
1310 5	7/2-	45	3647 5	(5/2, 7/2)	35
1393 5	5/2-	32	3660# 6		
1658# 2			3686# 7		
1732# 3			3705 ^a 5	(11/2-)	14
1919# 3			3748# 7		
1934@ 2	3/2-	58	3795& 5	(7/2, 9/2)	19
2088#b 3			3820 ^a 5		18
2203 2	5/2-	56	3849 5	(7/2, 5/2)	24
2294# 3			3944 5	(9/2+)	23
2335 5	(5/2-)	42	3983 2	(7/2-, 5/2)	88
2355 5	(3/2-)	15	4008 2	(1/2)	72
2400# 3			4041 5	(7/2)	44
2472# 3			4085 2	(9/2)	81
2586# 4			4134 5	(9/2)	15
2610# 4			4232 5	(11/2-)	13
2626 5	(7/2-, 11/2-)	37	4260 5	(7/2)	33
2684# 4			4292 5	(11/2-)	29
2721 §@ 2	9/2+	633	4337 2	(7/2, 5/2+)	159
2793# 4			4386 5	(9/2-)	23
2843# 4			4423 5	(9/2-, 7/2)	17
2853 5	3/2-	36	4463 5	(9/2-, 7/2)	20
2926@ 5	(5/2, 7/2-)	10	4516 5	(7/2)	43
3005# 5			4560 5	(5/2, 7/2)	35
3015@ 2	(11/2-, 7/2-)	84	4598 2	(7/2)	223
3066# 5			4665 5	(7/2)	36
3095# 5			4702 5	(7/2)	20
3203# 5			4756 5	(7/2)	41
3256 5	(7/2-, 11/2-)	11	4817 5	(9/2)	18
3276# 5			4845 5	(9/2-, 7/2)	26
3325 5	(3/2)	13	4879 5	(7/2)	36
3364# 6			4910 5	(9/2, 7/2)	21
3410 2	5/2+	426	4943 5	(7/2)	32
3437# 6			5015 2	(9/2)	149
3459# 6			5063 5		29
3528# 6			5101 5		48
3552# 6			5153 2	(9/2-, 7/2)	170

[†] From 2001Ny01, except as noted. The uncertainties in 2001Ny01 are stated as ≈ 2 keV for strongest groups and ≈ 5 keV for the weakest groups. The evaluators assign these as follows: 2 keV for $d\sigma/d\Omega > 50$ $\mu\text{b/sr}$ and 5 keV for weaker peaks.

[‡] From $\sigma(\theta)$ data and comparisons with DWBA calculations (2001Ny01).

§ The $\sigma(\theta)$ distribution shown in 1972Bu17 but no conclusions about L-transfers have been drawn.

From 1971Ho21, not reported in 2001Ny01.

@ A doublet (from γ -ray data, see $^{58}\text{Ni}(\alpha, p\gamma)$).

& Probably the same as 3802 7 in 1971Ho21.

^a E(level) not reported in 1971Ho21.

^b Also reported in 1972Bu17. 2001Ny01 do not report this level, however, in their spectral figure 2, a weak peak near this energy is present.

^c The absolute cross sections were obtained by measuring the (α, p) -yield relative to elastic scattering at forward angles and normalizing to optical model predictions, $d\sigma/d\Omega$ ($\mu\text{b/sr}$) measured at 12.5° angle with the uncertainties above 20%.

58Ni(α ,p γ) 1973Sa19,1971He14

1973Sa19, 1971Ho21: $E\alpha=4.6-20$ MeV. Escape-suppression spectrometer, $\Delta E-E$ semi telescope. Measured $p\gamma(0)$, $\gamma\gamma$ coin, $\gamma(0)$, DSA (centroid and line-shape analysis). Also 1971Ho22 from the same group.

1971He14, 1971He17: $E\alpha=10.0$ MeV. Measured $p\gamma$ angular correlations, DSA.

1971Ho22 (from the same group as 1973Sa19): $E=15-22$ MeV, measured excitation functions, deduced spins.

1974Sa01 (from the same group as 1973Sa19): $E=19.7$ MeV. Measured lifetimes of γ cascades: $\tau=0.29$ ps 12, 0.19 ps 7 and 0.43 ps 14 from the continuum at ≈ 9.5 MeV feeding the 2336, 2612 and 3016 states, respectively.

Data are from 1973Sa19, except as noted.

61Cu Levels

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}^{\S}$	E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}^{\S}$
0.0	3/2-		2728.35 19	7/2-	230 fs 30
475.07 8	1/2-	0.66 ps 9	2792.63 22	5/2-	116 fs +20-40
970.05 7	5/2-	0.69 ps 13	2840.57 25	1/2-, 3/2-	
1310.57 10	7/2-	0.53 ps 7	2857.1 3	1/2-, 3/2-	
1394.19 10	5/2-	0.85 ps 14	2924.2 4	-	270 fs 40
1660.35 11	3/2-	182 fs 19	2932.84 18	3/2-	65 fs 13
1732.59 10	7/2-	≥ 1.40 ps	3001.60 18	5/2	0.17 ps 6
1904.18 14	5/2-	180 fs 19	3015.70 17	11/2-	290 fs 40
1932.78 15	3/2-	87 fs 10	3019.3 11	3/2-	69 fs 11
1942.49 12	7/2-	1.2 ps +11-4	3065.56 22	3/2-	40 fs 6
2088.85 17	(1/2)-	40 fs 4	3092.1 5	3/2-	33 fs 5
2203.39 12	5/2-	173 fs 20	3198.58 23		
2295.09 12	9/2-	1.8 ps 6	3259.8 3	11/2(-)	0.35 ps 5
2336.46 18	9/2-	0.43 ps 5	3323.1 5		
2358.30 16	3/2-	197 fs 24	3372.9 4	(9/2)	
2399.02 23	7/2-	121 fs 14	3454.4 4	3/2+, 5/2+	
2472.44 22	3/2-	75 fs 8	3521.2 15	1/2-, 3/2-, 5/2-	
2583.74 24		102 fs 12	3546.8 4	11/2-	
2584.6 5	3/2, 5/2	98 fs 12	3739.5 5	(11/2)	
2611.79 14	9/2-	280 fs 40	3853.3 5		
2627.17 20	11/2-	≥ 350 fs	3943.1 4	11/2+	
2684.10 21	3/2-	85 fs 12	4082.3 3	13/2+	
2720.91 17	9/2+	≥ 2.80 ps			

[†] From level scheme and $E\gamma$ data using least-squares fit to data.

[‡] From Adopted Levels.

[§] From DSA (1973Sa19). $\Delta T_{1/2}$ includes 10% from stopping power uncertainty. For calibration of stopping power with known lifetimes, see 1973Ho21.

 $\gamma(^{61}\text{Cu})$

A_2 and A_4 coefficients are from 1971He14.

E(level)	$E\gamma$	$I\gamma^{\dagger}$	Mult. [‡]	$\delta^{\S b}$	Comments
475.07	475.0 1	100	M1+E2	0.04 CA	δ : theoretical estimate by 1972Ca20 adopted by 1973Sa19. $A_2=-0.02$ 4.
970.05	494.8 2	0.9 1	E2		
	970.0 1	99.1 6	M1+E2	-0.35& 4	$A_2=-1.03$ 3; $A_4=+0.10$ 2.
1310.57	340.2 3	6.2 2	M1+E2	-0.017& 15	$A_2=+0.43$ 8; $A_4=+0.18$ 8.
	1310.5 2	93.8 2	E2		$A_2=+0.55$ 3; $A_4=-0.36$ 4.
					$\delta=+0.01$ 3 from 1971He14.
1394.19	424.1 3	2.8 3			$A_2=+0.5$ 3; $A_4=-0.7$ 3.
	919.1 2	11.9 6	E2		$A_2=+0.58$ 12; $A_4=-0.50$ 14.
					$\delta=+(0.03 -8+12)$ from 1971He14.
	1394.2 2	85.3 25	M1+E2	-3.55& 18	$A_2=-0.39$ 5; $A_4=+0.43$ 5.
1660.35	265.9 2	4.6 3			
	690.2 2	15.7 12	M1(+E2)	+0.05& 19	$\delta: -3.1 +9-14$ also possible.
					$A_2=+0.02$.
	1185.3 3	14.4 9	M1+E2		$\delta: \geq 0.26$ and ≤ 1.00 (1971He14).
					$A_2=-1.04$ 7.
	1660.5 2	65.3 15	M1+E2	+0.39& +10-18	$\delta: +1.4$ 4 also possible.
					$A_2=+0.88$ 5.
1732.59	338.4 3	2.3 5	M1+E2	-1.2 ^a +9-5	
	421.8 2	22 3	M1(+E2)	+0.08& 7	$A_2=+0.30$ 6; $A_4=-0.06$ 6.

Continued on next page (footnotes at end of table)

$^{58}\text{Ni}(\alpha, \text{p}\gamma)$ 1973Sa19, 1971He14 (continued) $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E_γ	$I_\gamma^\dagger$	Mult. ‡	$\delta^\S\text{b}$	Comments
1732.59	762.4 2 1732.7 2	13.6 10 62 3	M1+E2 E2	+0.50& 4	$A_2=+0.47$ 8; $A_4=-0.14$ 9. $A_2=+0.41$ 5; $A_4=-0.31$ 6. $\delta=-0.02$ -6 +4 from 1971He14.
1904.18	593.5 2 934.1 2 1904.2 3	22.1 10 41.6 13 36.3 19	M1+E2 M1+E2 M1+E2	-0.05@ 3 -0.14@ 4 +0.68# 9	$A_2=+0.06$ 14. $A_2=+0.34$ 15; $A_4=+0.29$ 17. $A_2=+0.78$ 12; $A_4=+0.28$ 13.
1932.78	962.4 5 1457.8 2 1932.4 3	7.6 11 25.3 17 67 4	M1+E2 M1+E2	+0.20& 10 +0.26# +12-8	$\delta: -3.0$ 8 also possible. $A_2=-0.14$ 9. $\delta: +1.8$ +6-3 also possible. $A_2=+0.58$ 3.
1942.49	209.6 2 548.0 ^c 3 631.9 2 972.4 4 1942.8 3	9.9 2 0.5 1 19.2 5 60 4 10.4 6	M1(+E2) M1+E2 E2	-0.01# 4 -0.26@ 6	$\delta: +0.76$ 16 also possible.
2088.85	1613.7 2 2088.7 3	 	 	 	$A_2=+0.59$ 13. $A_2=-0.05$ 13. $A_2=+0.04$ 8.
2203.39	470.8 2 892.8 2 1233.3 2 1728.2 3	11.4 8 18.7 6 46.8 6 23.1 14	M1(+E2) M1+E2 E2	-0.01# 3 -0.030# +35-22	$\delta: -9$ 2 also possible.
2295.09	352.4 2 562.4 2 900.8 2 984.6 2 1325.3 3	7.6 4 19.9 6 25.8 8 34.2 11 12.5 7	M1+E2 M1+E2 E2 M1+E2 E2	-0.20 ^a 8 +0.56@ 10 -0.17 ^a 3	
2336.46	393.4 ^c 4 942.2 ^c 5 1025.8 3 1366.4 3	1.7 7 1.2 2 22.0 13 75.1 22	M1+E2 E2	-0.25 ^a 8 a	
2358.30	425.3 3 697.6 3 1883.1 3 2358.6 3	 	 	 	
2399.02	1088.4 3 1429.0 3	41.8 10 58 3	M1+E2 M1+E2	+0.6# +2-4 -0.164# 24	
2472.44	1502.4 3 1997.3 3	10.7 12 89.3 24	M1(+E2)	-0.02# 5	$\delta: -0.87$ 9 also possible.
2583.74	641.5 3 850.9 3	18 3 82 9			
2584.6	2584.5 5	100			
2611.79	316.6 ^c 2 669.3 2 879.3 2 1301.7 3	1.4 1 30.1 5 58.6 17 9.9 7	M1+E2 M1+E2	+0.25# +5-3 +0.36 ^a 10	
2627.17	290.4 ^c 2 331.6 4 1316.7 2	1.6 1 2.6 3 96 3	E2		
2684.10	1289.8 ^c 6 2209.0 2 2683.8 8	≤ 2.7 53 3 43 3			
2720.91	109.5 2 320.9 ^c 2 777.2 ^c 3 987.6 ^c 3	4.6 7 1.2 3 1.4 4 38 5	E1		
2728.35	1409.9 2 328.8 ^c 4 524.5 ^{cd} 3 1417.8 2 1758.2 3	55.1 18 2.7 3 $\leq 3.9^d$ 33.2 16 60 8	E1 M1(+E2) M1+E2	+0.4# +7-4 -1.6# 4	
2792.63	1482.2 3 2792.4 3	51 4 49 5			

Continued on next page (footnotes at end of table)

⁵⁸Ni(α , γ) 1973Sa19,1971He14 (continued)

 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E γ	I $\gamma^{\dagger}$	Mult. ‡	$\delta^{\S b}$	Comments
2840.57	751.6 2				
	2841.5 6				
2857.1	2381.4 20	20 3			
	2857.0 3	80 12			
2924.2	297.4 ^c 2	4.4 6			
	312.0 ^c 2	2.4 6			
	524.5 ^{c d} 2	$\leq 4.4^d$			
	629.1 ^c 5	2.6 6			
	981.3 5	9.3 18			
	1191.8 4	77 4	M1 (+E2)	+0.00# 5	
2932.84	1538.9 2				
	2457.6 4				
	2931.8 4				
3001.60	798.0 3	13.5 9			
	1607.3 2	26.2 20			
	3002.6 5	60 3			
3015.70	679.2 2	13.7 14			
	720.5 2	13.4 13	M1 (+E2)	-0.01# 2	
	1705.4 3	73 4	E2		
3019.3	2543.9 30	71 13	M1+E2	-0.6# 4	
	3019.3 11	29 4			
3065.56	706.4 5	9.8 9			
	1161.1 3	39 3			
	1672.1 4	31 3			
	3065.9 5	20 3			
3092.1	3092.0 5	100			
3198.58	1256.0 4	26 6			
	1466.1 3	46 7			
	1804.1 5	28 9			
3259.8	647.9 3	39.7 13			
	964.8 5	13.3 18			
	1527.4 5	47 4			
3323.1	2012.5 5	100			
3372.9	1640.6 5	100			
3454.4	1055.8 ^c 5	5.1 3			
	1721.7 5	20 6			
	2143.9 5	75 12			
3521.2	3521.1 15	100			
3546.8	1343.4 ^c 3	100			E γ : this γ is placed from 3970 level in Adopted Gammas based on other in-beam studies, thus the placement is questionable here.
3739.5	1444.4 4	100			
3853.3	1132.4 4	100			
3943.1	1222.2 3	100			
4082.3	709.6 4	25 5			
	1361.3 3	75 4			

[†] Relative branching from each level.

[‡] From $\gamma(0)$, T_{1/2} and RUL.

[§] From $\gamma\gamma$ angular correlations or singles $\gamma(0)$ with parallel E2 branch, except as noted. Values of angular correlation coefficients are not given in 1973Sa19.

From 1973Sa19 from singles $\gamma(0)$ with Hauser-Feshbach estimates for the population of magnetic substates.

@ From 1971Ho21.

& From 1971He14.

a From 1973Sa19.

b From $\gamma(0)$ data.

c Placement of transition in the level scheme is uncertain.

d Multiply placed; undivided intensity given.

⁵⁸Ni(¹⁶O, ¹³N) 1986OkZV, 1985OkZX, 1983OkZY

1986OkZV: E=80 MeV; measured $\sigma(E(^{13}\text{N}), \theta)$, reaction $Q=-8.3274$ MeV. DWBA analysis.
All data are from 1983OkZY, except as noted.

⁶¹Cu Levels

E(level)	J $\pi^{\dagger}$	E(level)	J $\pi^{\dagger}$	E(level)	J $\pi^{\dagger}$
0.0	3/2- [§]	1940	3/2-	3400	
480	1/2-	2100	1/2-	3740	(11/2-)
970	5/2-	2400	7/2-	4060	
1330	7/2-	2720	9/2+	4330	
1700	7/2-	3250	(11/2-)	6460 [‡] 16	3/2- ^{‡§}

[†] From DWBA analysis of $\sigma(\theta)$ and isobaric analog state analysis. These are treated as tentative and not used by the evaluators in the Adopted Levels dataset.

[‡] From 1985OkZX.

[§] T=3/2 for g.s. and T=5/2 for 6460 keV from 1985OkZY.

⁵⁹Co(³He, n γ) 2014Pa50

Two-proton transfer experiment.

2014Pa50: E(³He)=22.5 MeV from iThemba Labs Separated Sector cyclotron facility. Target=9.6 mg/cm² thick. Gamma rays were detected using AFRODITE array of nine BGO-shielded Clover HPGe detectors, five at 90° and four at 135° with respect to the beam direction. Neutron detector consisted of an array of nine large-volume NE102A plastic scintillators, placed symmetrically about $\theta(\text{lab})=0^\circ$ and 90° to the beam direction. Measured E γ , n γ -coin. Deduced population strengths of L=0, 7/2- states and compared to shell model and reaction cross section model calculations. J $\pi(^{59}\text{Co})=7/2-$.

⁶¹Cu Levels

E(level) [†]	J $\pi^{\dagger}$	Two-proton stripping strengths [§]
0.0	3/2-	
475.1	1/2-	
970.1	5/2-	
1310.5 [‡]	7/2-	100
1394.2	5/2-	
1660.5	3/2-	
1732.6 [‡]	7/2-	68 14
1904.2	5/2-	
1932.7	3/2-	
1942.5 [‡]	7/2-	115 30

[†] Taken by 2014Pa50 from ⁶¹Cu Adopted dataset in 1999-NDS of A=61 (1999Bh04). Energies are rounded values.

[‡] Populated through L(2p)=0 from 7/2- target.

[§] Values are relative to 100 for the population of 1310, 7/2- state.

$\gamma(^{61}\text{Cu})$

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Comments
475.1	475		
970.1	970		
1310.5	340		
	1311		
1394.2	1394		
1732.6	338	2.3	
	422	22.3	
	762	13.6	
	1733	61.8	
1942.5	210	10.0	
	548.0 [§]	0.5	E γ : from ⁶¹ Cu Adopted dataset in 1999-NDS of A=61 (1999Bh04).
	632	19.2	

Continued on next page (footnotes at end of table)

⁵⁹Co(³He,n γ) 2014Pa50 (continued)

γ (⁶¹Cu) (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\ddagger}$	Comments
1942.5	972	60.0	
	1943	10.3	

$\dagger$ From spectrum figure 3 and level-scheme figure 4 in 2014Pa50, unless otherwise stated.

$\ddagger$ Branching ratios deduced by 2014Pa50 from relative branching ratios in ⁶¹Cu Adopted dataset in 1999-NDS of A=61 (1999Bh04).

$\S$ Placement of transition in the level scheme is uncertain.

⁶⁰Ni(p, γ): Resonances

1990Sz01: E=3.67–3.83 MeV. Measured $\sigma(E)$, $\gamma(\theta)$; deduced IAS. See also 1993Ca12 for the assignment of spins of resonances deduced using multi-dimensional scaling method for γ -ray data.

1989Ti01: E=1–4 MeV. Measured γ -ray yields, resonance strengths.

1989Iz01, 1989IzZZ: E=5 MeV. Measured $\gamma(\theta)$.

1988Iz01: E=1.931–2.455 MeV. Measured γ spectra, $\gamma(\theta)$.

1983Si06: E=1.57–3.45 MeV, measured γ -multiplicity, $\sigma(E)$. See also 1989Si25 for analysis of data.

1981BY03: E=1.57–1.85 MeV, measured E γ , I γ , $\gamma(\theta)$.

1979Bo09: E=1.80–2.90 MeV. Measured $\sigma(E)$, E γ , I γ .

1977Ho29: E=3.5–4.1 MeV, measured $\sigma(E)$.

1976Be30: E=3.69–3.79 MeV, measured E γ , I γ , absolute γ yields.

1976Kr19: E=1.57–1.90 MeV, measured E γ , $\gamma(\theta)$.

1975Kr06: E<5 MeV, measured $\sigma(E)$.

1975Kr05: E=1674, 1856, 1873 keV, measured $\sigma(E\gamma)$, deduced B(M1).

1974Kr26: E=1588, 1599, 1605, 1620 keV, measured E γ , I γ .

1974Tr03: E=1840–1880, 2220–2300 keV, measured E γ , $\gamma(\theta)$, σ .

1974Ad06: E=3.67–3.95 MeV, measured E γ , I γ , $\gamma(\theta)$, $\sigma(E)$.

1973Tr06: E=1.5–1.9 MeV, measured E γ , $\gamma(\theta)$, $\sigma(E)$.

1972Sz01: Measured $\sigma(E)$.

1971Ki29: E=1588–1620 keV, measured E γ , $\gamma(\theta)$, $\sigma(E)$.

1965Go02: E=1588, 1599, 1620 keV; measured $p\gamma\gamma(\theta)$.

1957Bu64: E=0.7–1.8 MeV. 54 proton resonances from 725 to 1793 keV. Measured yields, primary and secondary E γ , I γ .

1989Iz01, 1988Iz01, 1983Si06, 1981By03, 1976Kr19, 1975Kr06, 1975Kr05, and 1974Kr26 are from the same group.

1974Tr03 and 1973Tr06 are from the same group.

1965Go02 and 1957Bu64 are from the same group.

Measured $\sigma(E)$, scin. Measured E γ , I γ , semi, enriched target. E(p)=1800–2900 (1979Bo09), E(p)=3690–3790 (1976Be30), E=1930–2450 (1988Iz01), E=1020–4420 (1989Ti01), E=1599–3407 (1983Si06).

Measured $\sigma(E)$, scin. Measured E γ , I γ , $\gamma(\theta)$, semi, enriched target. E(p)=1550–1950

(1971Ki29, 1973Tr06, 1974Tr03, 1974Kr26, 1975Kr05, 1975Kr06, 1976Kr19), E(p)=2220–2300 (1974Tr03), E(p)=3620–3830

(1972Sz01, 1974Ad06, 1977Ho29, 1990Sz01), E=1000–4000 (1989Ti01).

Measured $\sigma(E)$, E γ , I γ , $\gamma(\theta)$, scin. E(p)=700–1800 (1957Bu64), E=1930–2450 (1988Iz01).

Measured $\gamma\gamma(\theta)$, scin (1965Go02).

Measured intermediate structure existence: E=1930–2450 (1989Si25, 1989IzZZ, 1989Iz01, 1988Iz01).

1993Ca12: assigned spins to proton resonances using the method of multidimensional scaling (MDS) using γ decay branching ratios from earlier data.

⁶¹Cu Levels

For the unstatistical effects: E=1588–1620 (1986Iz01).

For thick target yields of resonances between 700 and 1800 keV, see 1957Bu64. The values reported on resonance strength are inconsistent, see 1972Sz01, 1973Tr06, 1974Ad06, 1974Tr03, 1975Kr06, 1976Be30, 1979Bo09.

E(level) †	J $\pi^{\ddagger}$	E(p)(lab)	E(level) †	J $\pi^{\ddagger}$	E(p)(lab)
0.0	3/2 ⁻ d		1943.2 ^g 4	7/2 ⁻ h	
475.84 [#] 19	1/2 ⁻ d		2088.2 [@] 3	1/2 ⁻ d	
970.00 [#] 22	5/2 ⁻ d		2203.2 4	5/2 ⁻	
1310.88 [#] 24	7/2 ⁻ h		2295.6 ^{#g} 4	9/2 ⁻ h	
1393.94 [@] 25	5/2 ⁻ d		2336.9 ^g 5	9/2 ⁻ h	
1661.09 [@] 22	3/2 ⁻ d		2358.1 [@] 3	3/2 ⁻ d	
1733.1 [#] 3	7/2 ⁻ h		2399.7 ^g 4	7/2 ⁻ h	
1904.4 [@] 3	5/2 ⁻ d		2473.0 [@] 3	3/2 ⁻ d	
1933.0 3	3/2 ⁻ d		2583.8 [@] 4	3/2, 5/2	

Continued on next page (footnotes at end of table)

$^{60}\text{Ni}(\text{p},\gamma)$: Resonances (continued) **^{61}Cu Levels (continued)**

E(level) [†]	$J\pi^{\ddagger}$	E(p)(lab)	E(level) [†]	$J\pi^{\ddagger}$	E(p)(lab)
2613.1g 6	9/2 ⁻ h		6294.1 22		1519
2627.2g 6	11/2 ⁻ §		6303.9 22		1529
2684.0 4	3/2 ⁻ §		6312.8 22		1538
2721.2#eg 5	9/2 ⁺ eh		6340.3 22		1566
2722.2 4	7/2 ⁻ §		6351.1 5	(3/2)	1577
2791.9@ 4	5/2 ⁻ §		6361.9& 3	3/2	1588
2841.2 4	1/2 ⁻ , 3/2 ⁻ §		6372.4& 3	3/2	1599
2856.2@ 4	1/2 ⁻ , 3/2 ⁻ §		6378.5& 3	3/2	1605
2932.1 4	3/2 ⁻ §		6393.2& 3	3/2	1620
3002.4 i 4	5/2		6412.1 22		1639
3016.6 i 10	11/2 ⁻ §		6416.0 22		1643
3017.4@ 3	3/2 ⁻ d		6421.9 22		1649
3042.0? 7			6428.7 5	(1/2)	1656
3065.1 3	3/2 ⁻ §		6441.3 ^a 4	5/2	1669
3092.1 4	3/2 ⁻ §		6446.1 ^a 3	5/2	1674
3262.7g 8	11/2 ⁻ §		6451.4 22		1679
3277.1 4			6457.6 ^a 6	5/2 ^j	1685
3358.2 6			6466.2 4	3/2	1694
3411.7 7			6470.1 22		1698
3430.3 6			6482.9 22		1711
3437.1? 11			6492.7 22		1721
3524.3 6			6505.6 5	3/2	1734
3590.1? 10			6510.4 22		1739
3612.6? 10			6528.1 22	3/2	1757
3706.1 6			6535.1 6	3/2, (5/2)	1764
3730.1 5			6541.0 6	3/2	1770
3790.2 5			6553.7 22		1783
3947.0? 6			6563.5 7	3/2	1793
3980.6#i 5			6584.3 4	3/2 ^j	1814
4132.8 ^e 4	9/2 ⁺ eh		6585.2 ^l 10	3/2, (5/2)	1815
4296.1? 10			6604.3 ^l 5	3/2	1835
4333.0#i 5			6619.3 3	3/2	1850
4382.0?i 8			6627.2 ⁿ 3	(1/2)	1858
5126.3#i 5			6629.8		1860
5251.7#i 4			6645.3 ⁿ 4	(1/2)	1876
5465			6678.4 3	1/2 ^j	1910
5513.3 11		725	6693.8		1925
5680.4 22		895	6706.5		1938
5812.2 22		1029	6711.9 ^c 5	3/2 ⁻ d	1944
5848.6 22		1066	6739.0 ^c 5	3/2 ⁻ , 5/2 ⁻ d	1972
5860.4 22		1078	6762.6 ^c	3/2 ⁻ , 5/2 ⁻ d	1995
5913.5 22		1132	6799.0		2032
5947.9 ^k 22		1167	6802.3 ^{bc} 4	1/2 ⁻ , 3/2 ^{dm}	2035
5977.4 22		1197	6813.7 ^c	3/2, 5/2, (1/2) ^d	2047
5989.2 22		1209	6915.0 ^c 6	(3/2 ⁻) ^d	2150
6018.7 22		1239	6937.4 ^c 5	3/2 ⁻ d	2173
6026.6 22		1247	7010.7 ⁿ 3	3/2 ⁻ d	2248
6091.5 22		1313	7016.3 ^c 6	3/2 ⁻ d	2253
6097.4 22		1319	7025.4 3	5/2	2263
6101.3 22		1323	7044.7 ^c 6	(1/2), 3/2 ⁻ d	2283
6109.2 22		1331	7054.7 ^k		2292
6121.0 22		1343	7059.8 ^{cn} 5	3/2 ⁻ d	2295
6124.9 22		1347	7107.3 4	1/2 ^j	2346
6148.5 22		1371	7120.8 ^c 7	3/2 ⁻ d	2359
6158.4 22		1381	7159 ^c 5	5/2 ^d	2398
6191.8 22		1415	7201.3 ^c 5	(3/2 ⁻) ^d	2442
6207.5 22		1431	7214.3 ^c 5	3/2 ⁻ d	2455
6227.2 22	(1/2)	1451	7223.2 4	1/2 ^j	2464
6237.0 22		1461	7262.3 3	1/2, 3/2 ^j	2504
6241.0 22		1465	7283.2 3	1/2, 3/2 ^j	2525
6258.7 22		1483	7313.3		2555
6266.5 22		1491	7319.2		2561
6290.1 22		1515	7428.4		2672

Continued on next page (footnotes at end of table)

⁶⁰Ni(p,γ): Resonances (continued)**⁶¹Cu Levels (continued)**

E(level) [†]	Jπ [‡]	E(p)(lab)	E(level) [†]	Jπ [‡]	E(p)(lab)
7510.0		2755	8464.4 ^{b g 4}	9/2+ ^{hm}	3727.6
7549.4		2795	8465.9 ^{g 4}	9/2+ ^h	3728.9
7559.2		2805	8466.0	1/2 ^j	3727
7561.2		2807	8469.5 ⁶	5/2 ^j	3730
7572.0		2818	8473.1 ^{b g 4}	9/2+ ^{hm}	3736.7
7645.8		2893	8476.3 ^{b g 4}	9/2+ ^{hm}	3738.8
7647.7		2895	8478.3 ^{b g 4}	9/2+ ^{hm}	3741.6
7847.1 ^{f 5}		3098	8481.5 ^{b g 5}	9/2+ ^{hm}	3744.4
8131.9 ^{f 5}		3385	8481.7	3/2 ^j	3743
8149.4 ^{g fn 5}		3407	8485.0 ^{b g 4}	9/2+ ^{hm}	3748.5
8194.4 ^{f 5}		3450	8489.9 ⁶	1/2 ^j	3751
8431.4 ⁷	5/2 ^j	3692	8492.4 ⁵	3/2 ^j	3754
8436.4 ⁷	1/2 ^j	3697	8499.9 ⁶	5/2 ^j	3761
8440.0 ⁵	1/2 ^j	3700	8503.7 ¹⁰		3765
8442.8 ⁷	3/2, 5/2 ^j	3703	8507.3 ¹⁰	1/2 ^j	3769
8446.0 ^{b 5}	m	3706	8508.1 ⁵	1/2 ^j	3770
8447.1 ^{b g 5}	9/2+ ^m	3710.0	8509.9 ⁵		3772
8448.2 ^{b g 4}	9/2+ ^{hm}	3714.4	8515.4 ¹⁰		3777
8454.5 ^{b g 4}	9/2+ ^{hm}	3717.4	8522.6 ⁷	1/2, 3/2 ^j	3784
8455.1	1/2, 3/2 ^j	3716			
8458.6 ^{b g 4}	9/2+ ^{hm}	3721.0			

[†] From 1957Bu64, 1973Tr06, 1974Tr03, 1974Kr26, 1976Be30, 1979Bo09, except as noted. For resonance state, E(level) are deduced from S(p)+E(p), where E(p) is proton energy in c.m. system, S(p)=4800.3 10 (2012Wa38). High-lying levels which are reported at only one resonance are treated as questionable.

[‡] J from γ(θ), except as noted.

[§] From Adopted Levels.

[#] Weighted average of 1971Ki29, 1974Ad06 and 1976Be30.

[@] From 1971Ki29.

[&] Probably a fragment of the analog of the 3/2- g.s. in ⁶¹Ni.

^a Possibly a fragment of the analog of the 67-keV, 5/2-, state in ⁶¹Ni.

^b A fragment of the analog of the 2122-keV, 9/2+, state in ⁶¹Ni.

^c From 1988Iz01.

^d From γ(θ) (1988Iz01).

^e Antianalog state of 9/2+ analog state.

^f From 1983Si06.

^g From 1990Sz01.

^h From γ(θ) and isobaric analog resonance analysis (1990Sz01).

ⁱ Seen also by 1990Sz01.

^j From the method of multidimensional scaling (MDS) using γ decay branching from earlier data (1993Ca12).

^k E(level) probably a doublet.

^l E(level) from 1981By03.

^m J=1/2 from (1993Ca12), MDS method.

ⁿ E=6627.2 keV, probably a fragment of the analog of the 283 keV, 1/2-, state in ⁶¹Ni. E=6645.3 keV, there is probably a doublet at 1876 keV. The dominant component is probably a fragment of the analog of the 283 keV, 1/2-, state in ⁶¹Ni. E=7010.7 keV, probably a fragment of the analog of the 656 keV, 1/2-, state in ⁶¹Ni. E(p)=2242 5 (1988Iz01). E=7059.8 keV, E(p)=2299 in Table 3 of 1988Iz01. E=8149.4 keV, may be a misprint in Table 1 of 1983Si06.

γ(⁶¹Cu)

E(level)	E _γ [§]	I _γ [#]	Mult. ^e	δ ^f	Comments
475.84	475.8	100			
970.00	969.8	100	(M1+E2)	-0.35 ^{h 3}	
1310.88	340.5	4.2 ^{& 9}			
	1310.3	95.8 ^{& 9}			
1393.94	424.0	1 ^a			
	918.0	8 ^a			
	1393.8	91 ^a	(M1+E2)	-3.78 ^h +13-15	
1661.09	690.7	17 ^a			
	1184.7	22 ^a			
	1660.5	61 ^a	(M1+E2)		δ: +0.29 to +1.68 (1965Go02) for J=(3/2-).

Continued on next page (footnotes at end of table)

⁶⁰Ni(p,γ): Resonances (continued)

γ(⁶¹Cu) (continued)

E(level)	E _γ ^{\$}	I _γ [#]	Mult. ^e	δ ^f	Comments
1733.1	422.1	25& 4			
	1732.4	75& 4			
1904.4	594.0	37 ^a			
	934.5	36 ^a			
	1904.3	27 ^a			
1933.0	1933.0	100 ^a	(M1+E2)		δ: +0.08 to +0.42 or +1.2 to +2.5 (1965Go02).
2088.2	1612.6	39 ^a			
	2088.4	61 ^a			
2203.2	893	27 ^a			
	1233	73 ^a			
2358.1	425	20 ^a			
	697.4	14 ^a			
	1882.1	30 ^a			
	2357.9	36 ^a			
2473.0	1503.1	22 ^a			
	1997.1	78 ^a			
2583.8	851.1	26 ^a			
	2583.5	74 ^a			
2684.0	2208	54 ^a			
	2684	46 ^a			
2721.2	987.8	34.3 ^b 15			
	1409.9	65.7 ^b 15			
2791.9	1481.3	40 ^a			
	2791.6	60 ^a			
2856.2	2856.1	100 ^a			
3002.4	3002	100 ^a			
3016.6	1705.7	100 ^b			
3017.4	2541.8	87 ^a			
	3017.6	13 ^a			
3042.0?	2566 ⁱ	62 ^a			
	3042 ⁱ	38 ^a			
3065.1	3065	100 ^a			
3092.1	3092	100 ^a			
3277.1	3277	100 ^c			
3790.2	2820	c			
3947.0?	2553 ⁱ	c			
	3471 ⁱ	c			
4132.8	2400.1	65.2 ^b 18			
	2822.2	34.8 ^b 18			
4333.0	3021.8 ⁱ	100 ^b			
5251.7	2530.5	53 ^b 4			
	4280.9	47 ^b 4			
6351.1	3992.7				
	4690.1		D+Q	0.58 +24-10	
	5380.8				
	5874.8		D+Q	0.054 +54-14	
	6350.6		D+Q	0.56 10	
6361.9	2632	5 1			
	2656	5 1			
	2950	6 1			
	3270 ⁱ				
	3296 ⁱ				
	3343.9	8 1			
	3360 ⁱ				
	3505.4	6 1			
	3678 ⁱ		D+Q	0.045 +14-4	
	3778.0	<1			
	3888.6	8 1	D+Q	0.18 6	
	4003.6	5 1	D+Q	0.37 +20-15	
	4273.1	6 1	D+Q	<0.12	
	4701.0	<1			
	4967.7	19 1	D+Q	0.17 7	
	5391.7	8 1	D+Q	0.13 11	

Continued on next page (footnotes at end of table)

⁶⁰Ni(p,γ): Resonances (continued)

 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E γ^{S}	I $\gamma^{\text{#}}$	Mult. ^e	δ^{f}	Comments
6361.9	5885.7	3 1			
	6361.5	21 2	D+Q	0.15 3	
6372.4	2642	3 1			
	2666	3 1			
	2848	2 1			
	2942	7 1			
	3280 ⁱ				
	3307 ⁱ				
	3354.7	2 1			
	3516.2 ⁱ				
	3688 ⁱ		D+Q	0.30 10	
	3788.8	3 1			
	3899.4	3 1	D+Q	0.50 10	
	4169	5 1	D+Q	<0.3	
	4283.9	5 1	D(+Q)	0.00 4	
	4711.8	3 1			
	4978.5	18 1	D+Q	0.13 4	
	5402.5	11 1	D+Q	0.17 7	
	5896.5	11 1	D+Q	0.20 12	
	6372.3	24 2	D+Q	0.20 1	
6378.5	2854	3 1			
	3537	1 1			
	3586.6	2 1			
	3794.7	2 1			
	3905.3	2 1	D+Q	0.20 10	
	4289.8	4 1	D+Q	0.03 1	
	4473.9 ⁱ				
	4717.7	1 1			
	4984.4	15 1	D(+Q)	0.00 5	
	5408.4	5 1	D(+Q)	0.03 10	
	5902.4	9 1			
	6378.2	54 2	D+Q	0.10 2	
6393.2	2663	2 1			
	2687	5 1			
	2869	1 1			
	2963	1 1			
	3301	3 1			
	3328	<1			
	3375.3	1 1			
	3391 ⁱ				
	3536.8	4 1			
	3552	<1			
	3709 ⁱ		D+Q	0.40 15	
	4035.0 ⁱ		D+Q	0.16 10	
	4304.5	8 1	D(+Q)	0.00 10	
	4488.6	1 1			
	4732.4	<1			
	4999.1	18 1	D(+Q)	0.00 10	
	5423.1	1 1	D(+Q)	0.00 22	
	6392.9	54 2	D+Q	0.16 1	
6428.7	3955.5	1 1			
	4070.5	5 1			
	4340.0	2 1			
	5952.6	22 2			
	6428.4	70 2			
6441.3	3968.2	3 1			
	4497	4 1			
	5047.3	5 1			
	5130.8	8 1			
	5471.3	12 1			
	6441.1	68 2			
6446.1	3381	1 1			
	3444	1 1	D+Q	0.1	

Continued on next page (footnotes at end of table)

⁶⁰Ni(p,γ): Resonances (continued)

 $\gamma(^{61}\text{Cu})$ (continued)

E(level)	E $\gamma^{\S}$	I $\gamma^{\#}$	Mult. ^e	δ^f	Comments
6446.1	3719	13 1			
	3973.2	10 1	D(+Q)	0.0	
	4243	18 1	D+Q	0.2	
	4502	1 1			
	4513	1 1			
	4713.7	1 1			
	4785.6 ⁱ				
	5052.3	5 1	D+Q	0.4	
	5135.8	36 2	D+Q	0.05	
	5476.3	14 1	D+Q	0.31	
	5970.3 ⁱ				
	6446.1 ⁱ		D(+Q)	0.0	
6457.6	5147	32 2			
	5487	8 1			
	6457	60 2			
6466.2	3674.1	2 1			
	3882.2	2 1			
	4805.2	4 1	D+Q	0.17 8	
	5495.9	11 1	D+Q	0.07 8	
	5989.9	27 2	D(+Q)	0.01 4	
	6465.7	52 2	D+Q	0.07 2	
6505.6	4844.6		D+Q	0.35 18	
	5111.3		D(+Q)	0.06 16	
	5535.3		D+Q	0.16 18	
	6029.3		D(+Q)	0.05 10	
	6505.1		D+Q	0.51 6	
6535.1	4874.1		D+Q	0.08 6	
	6058.8		D+Q	0.39 4	
	6534.6		D+Q	0.19 3	
6541.0	4880.0		D+Q	0.32 7	
	6064.7		D+Q	0.08 7	
	6540.5		D+Q	0.02 2	
6563.5	6087.3		D+Q	0.14 7	
	6563.1		D+Q	0.23 8	
6584.3	3566	27.9			
	3652	21.8			
	4111	11.0			
	4226	8.9			
	4651	6.1			
	4924	17.1			
	6584	7.3			
6585.2	4227		D+Q	0.36 9	
6604.3	4246		D+Q	0.12 7	
	4401		D+Q	0.22 13	
	5210		D+Q	0.14 8	
	6604		D+Q	0.19 5	
6619.3	3355 ⁱ	1 1			γ to 11/2- from 3/2 resonance, requiring E4 or M4 is unlikely.
	3554	2 1			
	3935	1 1			
	4219	2 1			
	4261	2 1			
	4416	2 1			
	4887	3 1			
	5225	15 1			
	5309	1 1			
	5649	5 1			
	6619	66 2	D+Q	0.78 12	
6627.2	2331 ⁱ	1			γ to (11/2-) from (1/2) resonance, requiring E5 or M5 is unlikely.
	2680 ⁱ	7			
	2837	9			
	2897	2			
	3037 ⁱ	7			

Continued on next page (footnotes at end of table)

⁶⁰Ni(p,γ): Resonances (continued)

γ(⁶¹Cu) (continued)

E(level)	E _γ ^s	I _γ [#]	Mult. ^e	δ ^f	Comments
6627.2	3350	2			
	3535	6			
	3562	8			
	3609	2			
	3786	2			
	4269	3			
	4694	2			
	4966	3			
	6151	35			
	6627	11			
6645.3	3368	18 5			
	3580	6 5			
	3713 ⁱ				
	3789	8 5			
	3804	9 5			
	4172	15 5			
	4557	10 5			
	6169 ⁱ				
	6645	34 5			
6678.4	3248	2 1			
	3586	8 1			
	3613	3 1			
	3746	10 1			
	3822	4 1			
	3837	1 1			
	4205	11 1			
	4320	7 1			
	4745	9 1			
	4774	5 1			
	5018	2 1			
	5708	1 1			
	6202	9 1			
	6678	28 2			
6711.9	4808 ^d		D+Q	+0.44 ^g 36	
	5049 ^d		D+Q	+1.29 ^g +0-79	
	5317 ^d		D+Q	+0.8 ^g +0-5	
	6237 ^d		D(+Q)	-0.19 ^g 44	
	6712 ^d		D+Q	+1.25 ^g +18-13	
6739.0	4266 ^d		D+Q	+34 ^g 16	
	5344 ^d		D+Q	+0.8 ^g +0-3	
	5769 ^d		D+Q	+0.25 ^g +19-13	
	6739 ^d		D+Q	+0.83 ^g +46-18	
6802.3	3012	14.5			
	3444	7.8			
	3784	7.7			
	4714	7.4			
	4869	4.6			
	5142	17.3			
	6326	3.6			
	6802	37.0			
6915.0	4982 ^d		D+Q	+0.55 ^g +74-23	
	6439 ^d		D+Q	-0.07 ^g 10	
	6914 ^d		D+Q	+0.70 ^g +25-15	
6937.4	4849 ^d		D(+Q)	+0.00 ^g 12	
	5033 ^d		D(+Q)	-0.01 ^g 14	
	5967 ^d		D+Q	+0.14 ^g 13	
	6937 ^d		D+Q	+0.37 ^g 9	
7010.7	3398 ⁱ	2			
	3599	1			
	3734	2			
	3946	5			
	4079	10	D+Q	-0.05 +13-18	
	4155	5			

Continued on next page (footnotes at end of table)

⁶⁰Ni(p,γ): Resonances (continued)

γ(⁶¹Cu) (continued)

E(level)	E _γ ^s	I _γ [#]	Mult. ^e	δ ^f
7010.7	4219	3		
	4327	4	D+Q	-0.12 22
	4538	1		
	4653	3		
	4808	5		
	4923	5	D+Q	+0.21 9
	5067	2		
	5078	4		
	5342 ^d		D+Q	+0.49 ^g +17-14
	5617	22	D+Q	-0.21 +18-42
	6041	3		
	6535	7	D+Q	+0.04 9
	7011	15	D+Q	+0.02 14
	7016.3		D(+Q)	-0.08 ^g 11
	6541 ^d		D(+Q)	+0.03 ^g 9
7025.4	7016 ^d		D+Q	+0.18 ^g 7
	4007	3		
	4023	3		
	4169	2		
	4233	4		
	4552	4		
	4667	4		
	5092	9	D+Q	+0.30 16
	5121	3		
	5293	9	D(+Q)	-0.02 11
	5364	17	D+Q	+0.36 12
	5631	2		
	5715	4		
	6055	10		
	7025	26	D+Q	+0.07 9
7044.7	4957 ^d		D+Q	-0.11 ^g 10
	5382 ^d		D+Q	+0.50 ^g +14-10
	7045 ^d		D+Q	+0.44 ^g 9
	7059.8		D+Q	+0.50 ^g +16-13
7059.8	5666 ^d		D+Q	-0.25 ^g 15
	6091 ^d		D+Q	+0.14 ^g 10
	7058 ^d		D+Q	+0.55 ^g 12
7107.3	3317	4.6		
	3749	4.1		
	3830	3.8		
	4175	10.9		
	4749	11.8		
	5019	1.7		
	5174	4.4		
	5446	13.8		
	6631	38.9		
	7107	6.0		
7120.8	6645 ^d		D+Q	-0.17 ^g 8
	7120 ^d		D+Q	-0.42 ^g 10
7201.3	5539 ^d		D+Q	+0.75 ^g +54-19
	5887 ^d		Q+O	-0.28 ^g +14-17
	6232 ^d		D+Q	-0.07 ^g 11
	6727 ^d		D+Q	+0.08 ^g +11-8
	7202 ^d		D+Q	+0.65 ^g +21-13
7214.3	5819 ^d		D+Q	-0.50 ^g +15-21
	6244 ^d		D(+Q)	-0.04 ^g 12
	6739 ^d		D+Q	+0.14 ^g 10
	7214 ^d		D+Q	+0.24 ^g 6
7223.2	4158	9.3		
	4205	10.4		
	4291	7.6		
	4750	3.6		
	4865	6.2		

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⁶⁰Ni(p,γ): Resonances (continued)

γ(⁶¹Cu) (continued)

E(level)	Eγ ^s	Iγ [#]	Mult. ^e	E(level)	Eγ ^s	Iγ [#]	Mult. ^e
7223.2	5290	10.9		8448.2	3199@	7@	
	5562	3.3			4319@	13@	
	6747	18.6			4470@	1@	
	7223	30.1			5434@	9@	
7262.3	3904	2.3			5729@	53@	
	3985	1.9			5823@	2@	
	4244	1.2			6051@	6@	
	4578	6.5			6155@	5@	
	4789	2.0		8454.5	3202@	4@	
	4904	2.2			3332@	7@	
	5174	0.6			4321@	8@	
	5329	3.0			4473@	3@	
	5602	7.4			5437@	8@	
	6786	1.8			5732@	29@	
	7262	71.1			5841@	3@	
7283.2	3846 ⁱ	6.1			6054@	12@	
	4006	3.6			6117@	6@	
	4218	1.5			6158@	4@	
	4265	0.5			6511@	5@	
	4442	1.5			6720@	12@	
	4599	2.1		8458.6	3206@	1@	
	4810	2.6			3336@	3@	
	5195	0.5			4325@	2@	
	5350	1.9			5197@	4@	
	5622	8.0			5736	30@	
	6807	4.3			6058@	7@	
	7283	67.4			6121@	14@	
7847.1	6452	8			6162@	2@	
	6537 [†]	14 [‡]			6515@	4@	
	6877 [†]	14 [‡]			6724@	22@	
	7370 [†]	12 [‡]			7146@	11@	
8131.9	6744 [†]	4 [‡]		8464.4	3212@	2@	
	6819 [†]	18 [‡]			3342@	1@	
	7159 [†]	11 [‡]			4082@	1@	
	7653 [†]	12 [‡]			4131@	2@	
8149.4?	6754 [†]	20 [‡]			4331@	10@	
	6839 [†]	30 [‡]			4483@	2@	
	7179 [†]	15 [‡]			5447@	8@	
	7673 [†]	13 [‡]			5742@	64@	
8194.4	6798 [†]	15 [‡]			6064@	2@	
	6887 [†]	15 [‡]			6168@	1@	
	7223 [†]	19 [‡]			6521@	1@	
	7717 [†]	12 [‡]			6730@	1@	
8431.4	7120.3	35.3			7152@	1@	
	8430.6	65.3		8465.9	3214@	2@	
8436.4	7960.0	86.4			4133@	3@	
	8435.8	14.4			4333@	9@	
8440.0	6778.8	25.6			4485@	1@	
	7045.5	12.6			5449@	8@	
	7963.5	36.10			5744@	64@	
	8439.3	27.5			6129@	10@	
8442.8	7472.3	82.4			6732@	1@	
	8442.1	18.4			7154@	2@	
8446.0	5724.9	58.4		8469.5	6564.5 ⁱ	23.4	
	7134.8	22.5			7158.5	43.5	
	7969.3	10.3			8468.8	34.5	
	8445.1	10.3		8473.1	3221@	3@	
8447.1	4114@	7@			4140@	1@	
	4314@	1@			4340@	11@	
	5725@	43@			5456@	2@	
	6047@	17@			5470@	2@	
	6504@	9@			5751@	62@	
	7135@	23@			6073@	4@	

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$^{60}\text{Ni}(\text{p},\gamma)$: Resonances (continued) $\gamma(^{61}\text{Cu})$ (continued)

E(level)	$E_{\gamma}^{\S}$	$I_{\gamma}^{\#}$	Mult. ^e	E(level)	$E_{\gamma}^{\S}$	$I_{\gamma}^{\#}$
8473.1	6136@	5@		8485.0	4103@	2@
	6177@	3@			4352@	8@
	6530@	3@@			4504@	1@
	7161@	4@			5468@	3@
8476.3	3224@	3@			5482@	4@
	3354@	5@			5763@	55@
	4343@	8@			5857@	2@
	5473@	2@			6148@	2@
	5754@	50@			6189@	1@
	5863@	3@			6542@	7@
	6076@	6@			6751@	9@
	6139@	6@			7173@	5@
	6180@	3@		8489.9	6828.7	33 4
	6533@	3@			8013.4	15 5
	7164@	11@			8489.2	52 5
8478.3	3226@	1@		8492.4	7181.4	18 4
	3356@	1@			7521.9	22 4
	4345@	4@			8015.9	27 4
	4497@	2@			8491.7	33 4
	5461@	2@	[E3]	8499.9	6766.2	36 4
	5756@	67@			7188.3	25 4
	5850@	6@			8499.6	39 4
	5865@	3@		8503.7	8503.1	100
	6078@	3@		8507.3	8506.7	100
	6141@	2@		8508.1	6603.1 ⁱ	20 7
	6182@	2@			6846.9	25 6
	6535@	2@			8031.6	12 5
	6744@	2@			8507.4	43 6
	7166@	3@		8509.9	6306 ⁱ	9 2
8481.5	3016@	2@			6576	10 2
	3359@	2@			6848.8	5 2
	4148@	1@			7199.0	5 3
	4348@	4@			8509.3	71 4
	4500@	2@		8515.4	8039.0	100
	5759@	78@		8522.6	8046.2	35 5
	5853@	8@			8522.0	65 5
	7169@	4@				
8485.0	3233@	1@				

[†] From level energy difference (1983Si06).[‡] From 1983Si06.[§] From level energy difference.[#] Relative branching from each level. Decay of resonances from 1973Tr06, 1974Tr03, 1974Kr26, 1975Kr05, 1976Be30, 1979Bo09.

@ From 1990Sz01.

& From 1974Kr26.

^a From 1974Ad06.^b From 1976Be30.^c From 1974Tr03.^d From level energy difference (1988Iz01).^e From $\gamma(\theta)$ measurements, see δ .^f Dipole-quadrupole mixing, 1974Tr03, 1976Kr19, 1981By03, 1988Iz01. When there are two solutions, only the smaller δ has been given.^g From 1988Iz01.^h From $\text{p}\gamma\gamma(\theta)$ data of 1965Go02.ⁱ Placement of transition in the level scheme is uncertain.

60Ni(p,p),(p,p'): Resonances 1989Ti01,1976FlZY,1970Br33

1970Br33: E(p)=1.8–3.0 MeV. Measured $\sigma(E, \theta)$, $\theta=90^\circ$, 120° , 135° , 160° , semi, enriched target, FWHM=0.3–0.45 $\Delta E(p)=2$, $\Delta\Gamma(p)=10\%$ for $\Gamma(p)>100$ and $\approx 50\%$ for $\Gamma(p)=10$ –20.

1976FlZY: E(p)=2.95–3.45 MeV. Measured $\sigma(E, \theta)$, $\theta=90^\circ$, 105° , 122° , 160° , semi, enriched target, FWHM=0.3, $\Delta E(p)=2$.

1976Ar01: E(p)=2.94–4.02 MeV. Measured $\sigma(E, \theta)$, $\theta=90^\circ$, 120° , 135° , 160° , semi, enriched target, FWHM=0.4, $\Delta E(p)=3$.

1957Bu64: E=0.7–1.8 MeV; 54 proton resonances from 725 to 1793 keV. Measured yields, primary and secondary $E\gamma$, $I\gamma$.

For possible analogs at E(p)=5.76, 5.88, and 5.96 MeV, see 1979El06.

For possible analogs at E(p)=4.67, 5.08, 5.33, and 5.44 MeV, see 1969Gu07.

61Cu Levels

S_0 values are given as $[2J(\text{res})+1]\Gamma(p)\Gamma(\gamma_0)/\Gamma$ in meV (1989Ti01).

E(level) [†]	$J\pi^\&$	$T_{1/2}$	E(p)(Lab) keV	$\Gamma(p)$ eV ^b	Comments
5849.9 $\frac{1}{2}^+$ 9					$S_0=4.9$ 19.
5860.6 $\frac{1}{2}^+$ 10					E(level): evaluators assume 5860.6, but it could be 5906.6 as well. A 5960.6 10 level in table 4 of 1989Ti01 seems a misprint. In 1999–NDS (1999Bh04), Ep(lab) deduced from this value was listed at 1108.2, which also seems a misprint.
5917.0 $\frac{1}{2}^+$ 10					$S_0=6.7$ 19.
5960.2 $\frac{1}{2}^+$ 7					$S_0=8$ 2.
5972.4 $\frac{1}{2}^+$ 12					$S_0=2.6$ 7.
5987.2 $\frac{1}{2}^+$ 6					$S_0=4.5$ 14.
6026.6 $\frac{1}{2}^+$ 7					$S_0=32$ 5.
6098.4 $\frac{1}{2}^+$ 10					$S_0=44$ 6.
6124.1 $\frac{1}{2}^+$ 6					$S_0=140$ 20.
6150.4 $\frac{1}{2}^+$ 10					$S_0=180$ 30.
6193.0 $\frac{1}{2}^+$ 11					$S_0=22$ 8.
6210 $\frac{1}{2}^+$ 3					$S_0=25$ 9.
6227.1 $\frac{1}{2}^+$ 6					$S_0=22$ 9.
6293.4 $\frac{1}{2}^+$ 8					$S_0=400$ 50.
6313.6 $\frac{1}{2}^+$ 8					$S_0=83$ 16.
6352.2 $\frac{1}{2}^+$ 8					$S_0=160$ 20.
6362.7 $\frac{1}{2}^+$ 8					$S_0=110$ 20.
6374.0 $\frac{1}{2}^+$ 6					$S_0=99$ 1.
6379.9 $\frac{1}{2}^+$ 6					$S_0=390$ 50.
6394.3 $\frac{1}{2}^+$ 6					$S_0=450$ 50.
6418.3 $\frac{1}{2}^+$ 6					$S_0=530$ 60.
6431.0 $\frac{1}{2}^+$ 6					$S_0=480$ 60.
6442.7 $\frac{1}{2}^+$ 7					$S_0=540$ 60.
6467.1 $\frac{1}{2}^+$ 8					$S_0=150$ 30.
6486.4 $\frac{1}{2}^+$ 13					$S_0=260$ 40.
6509.1 $\frac{1}{2}^+$ 7					$S_0=51$ 13.
6541.3 $\frac{1}{2}^+$ 8					$S_0=140$ 20.
6566.7 $\frac{1}{2}^+$ 10					$S_0=430$ 50.
6584.6 22	1/2+		1814	25	$S_0=65$ 16.
6590.7 $\frac{1}{2}^+$ 15					$S_0=100$ 20.
6606.4 $\frac{1}{2}^+$ 7					$S_0=93$ 18.
6620.3 $\frac{1}{2}^+$ 6					$S_0=580$ 70.
6625.9 22	1/2–		1856	25	
6629.8 $\frac{1}{2}^+$ 8					$S_0=65$ 14.
6644.5 $\frac{1}{2}^+$ 8	1/2–				$S_0=170$ 30.
6678.0 22	(1/2–)		1909	5	
6681.2 $\frac{1}{2}^+$ 6					$S_0=280$ 40.
6693.8 22	1/2+		1925	20	
6699.0 $\frac{1}{2}^+$ 7					$S_0=370$ 50.
6713.8 $\frac{1}{2}^+$ 8					$S_0=89$ 15.
6725.7 $\frac{1}{2}^+$ 8					$S_0=72$ 13.
6744.7 $\frac{1}{2}^+$ 6					$S_0=350$ 40.
6762.7 $\frac{1}{2}^+$ 6					$S_0=210$ 30.
6784.6 $\frac{1}{2}^+$ 14					$S_0=69$ 14.
6802.9? 22	1/2+		2036	15	May be the same as E(p)=2038.
6804.0 $\frac{1}{2}^+$ 8					$S_0=115$ 18.
6815.0 $\frac{1}{2}^+$ 7					$S_0=160$ 20.
6847.8 $\frac{1}{2}^+$ 9					$S_0=150$ 20.

Continued on next page (footnotes at end of table)

$^{60}\text{Ni}(\text{p,p}),(\text{p,p}')$: Resonances 1989Ti01,1976FlZY,1970Br33 (continued) **^{61}Cu Levels (continued)**

$E(\text{level})^\dagger$	J^π	$T_{1/2}$	$E(\text{p})(\text{Lab}) \text{ keV}$	$\Gamma(\text{p}) \text{ eV}^b$	Comments
6868.4 $\frac{1}{2}^+$ 6					$S_0=490 \text{ 50.}$
6889.5 $\frac{1}{2}^+$ 7					$S_0=200 \text{ 30.}$
6912.5 $\frac{1}{2}^+$ 8					$S_0=260 \text{ 30.}$
6940.3 $\frac{1}{2}^+$ 7					$S_0=280 \text{ 30.}$
6953.4 22	1/2+		2189	90	
6972.0 $\frac{1}{2}^+$ 8					$S_0=480 \text{ 50.}$
6991.8 22	1/2+		2228	25	Probable misprint in 1970Br33.
6997.3 $\frac{1}{2}^+$ 6					$S_0=540 \text{ 60.}$
7014.1 $\frac{1}{2}^+$ 7					$S_0=180 \text{ 20.}$
7028.5 $\frac{1}{2}^+$ 7					$S_0=140 \text{ 20.}$
7039.0 22	1/2+		2276	60	
7043.2 $\frac{1}{2}^+$ 5					$S_0=1040 \text{ 10.}$
7054.7 22	1/2+		2292	45	
7060.3 $\frac{1}{2}^+$ 6					$S_0=650 \text{ 70.}$
7084.2 22	(1/2-, 3/2-)		2322	5	
7090.5 $\frac{1}{2}^+$ 8					$S_0=200 \text{ 30.}$
7107.8 22	(1/2+)		2346	5	
7113.7 22	(3/2-, 1/2-)		2352	5	
7197.3 22	1/2+		2437	60	
7223.8 22	1/2+		2464	25	
7241.6 22	(1/2-, 3/2-)		2482	5	
7263.2 22	1/2+		2504	145 15	
7274.0 22	(3/2-, 1/2-)		2515	5	
7283.8 22	1/2+		2525	20	
7316.3 22	1/2+		2558	90	
7329.1 22	(1/2-, 3/2-)		2571	15	
7378.3 22	5/2+		2621	25	
7414.6 22	(1/2-, 3/2-)		2658	10	
7430.4 22	1/2+		2674	10	
7438.2 22	1/2+		2682	75	
7474.6 22	1/2-		2719	40	
7485.5 22	1/2-		2730	15	
7489.4 22	1/2-		2734	30	
7497.3 22	1/2-		2742	15	
7510.0 22	1/2+		2755	10	
7519.9 22	(3/2-, 1/2-)		2765	5	
7525.8 22	(3/2+, 5/2+)		2771	5	
7541.5 22	1/2-		2787	35	
7549.4 22	1/2+		2795	55	
7554.3 22	1/2-		2800	25	
7556.3 22	1/2-		2802	10	
7560.2 22	1/2+		2806	110 11	
7569.0 22	(5/2+, 3/2+)		2815	5	
7578.9 22	1/2-		2825	165 17	
7581.8 22	1/2-		2828	25	
7583.8 22	1/2-		2830	115 12	
7588.7 22	1/2-		2835	25	
7608.4 22	(3/2-, 1/2-)		2855	10	
7631.0 22	(5/2+, 3/2+)		2878	10	
7636.9 22	1/2+		2884	160 16	
7638.9 22	(5/2+)		2886	20	
7647.7 22	1/2+		2895	70	
7657.6 22	(3/2-, 1/2-)		2905	15	
7662.5 22	(5/2+, 3/2+)		2910	5	
7672.3 22	(5/2+, 3/2+)		2920	5	
7681.2 22	1/2+		2929	45	
7702.1	3/2+		2950.3	55 8	
7702.7	(5/2+)		2950.9	12 6	
7705.3	(1/2-)		2953.5	45 15	
7722.5	(3/2+)		2971.0	65 10	
7728.7	(1/2-)		2977.3	45 15	
7743.9	1/2+		2992.8	250 30	
7746.0	(5/2+)		2994.9	11 5	

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⁶⁰Ni(p,p),(p,p'): Resonances 1989Ti01,1976FlZY,1970Br33 (continued)

⁶¹Cu Levels (continued)

E(level) [†]	J _π &	T _{1/2}	E(p)(Lab) keV	Γ(p) eV ^b	Comments
7762.0	(5/2+)		3011.2	23 7	
7767.4	1/2+		3016.7	400 35	
7781.9	(3/2-)		3031.4	15 5	
7785.1	(5/2+)		3034.7	28 8	
7805.8	3/2+		3055.7	56 15	
7806.7	1/2+		3056.7	115 10	
7837.5	(3/2+)		3088.0	35 10	
7842.6	1/2+		3093.2	110 10	
7848.7	3/2+		3099.4	80 10	
7849.5	(1/2-)	40 eV 10	3100.2	50 10	
7855.0	3/2-		3105.8	55 8	
7886.2	(1/2-)		3137.5	50 10	
7894.1	(1/2-)		3145.5	45 8	
7896.4	1/2+		3147.9	180 20	
7919.2	1/2+		3171.0	20 8	
7921.1	1/2-	0.25 keV 5	3173.0	340 35	
7931.2	(5/2+)		3183.2	12 6	
7943.6	1/2+		3195.9	270 20	
7946.9	3/2+		3199.2	45 6	
7950.9	1/2-	35 eV 7	3203.3	60 8	
7962.4	1/2+		3215.0	350 30	
7970.2	1/2+		3222.9	22 10	
7971.9	3/2-		3224.6	20 8	
7987.5	1/2+		3240.5	175 20	
7996.9	1/2+		3250.1	95 10	
8006.1	3/2-		3259.4	45 8	
8015.3	3/2+		3268.8	115 10	Γ(p')=16 eV 5.
8016.3	1/2-		3269.8	50 8	
8019.8	1/2-		3273.3	50 8	
8023.3	5/2+		3276.9	60 8	Γ(p')=7 eV 3.
8028.3	(5/2+)		3282.0	15 4	
8031.6	(5/2+)		3285.3	20 8	
8043.1	(5/2+)		3297.0	17 8	
8054.8	(1/2-)		3308.9	25 20	
8057.3	1/2+		3311.5	450 40	
8067.9	(5/2+)		3322.2	25 6	
8075.4	3/2-		3329.9	50 8	
8076.3	1/2+		3330.8	40 5	
8086.6	1/2+		3341.3	280 28	
8090.2	5/2+		3344.9	6 4	
8096.8	3/2-		3351.6	50 5	
8101.8	1/2+		3356.7	25 4	
8103.1	(1/2-)		3358.0	30 10	
8108.6	1/2+		3363.6	15 5	
8113.1	5/2+		3368.2	15 4	Γ(p')=5 eV 1.
8118.5	1/2-		3373.7	70 12	
8120.7	(5/2+)		3375.9	20 6	
8121.7	1/2+		3377.0	550 50	
8122.5	3/2-		3377.8	65 8	
8127.7	(5/2+)		3383.1	30 7	
8130.9	1/2+		3386.3	65 6	
8139.5	(1/2-)		3395.0	80 30	
8139.5	(5/2+)		3395.0	17 5	
8148.9	1/2+		3404.6	145 15	
8151.5	(5/2+)		3407.2	15 5	
8156.1	5/2+		3411.9	60 6	Γ(p')=2 eV 1.
8162.0	5/2+		3417.9	75 8	Γ(p')=6 eV 2.
8164.9	(1/2-)		3420.9	35 10	
8167.8	5/2+		3423.8	100 10	Γ(p')=7 eV 2.
8168.7	(1/2-)		3424.7	35 10	
8170.0	1/2-		3426.1	110 12	
8171.2	5/2+		3427.3	25 5	Γ(p')=7 eV 2.
8173.6	1/2+		3429.7	165 15	

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$^{60}\text{Ni}(\text{p},\text{p}),(\text{p},\text{p}')$: Resonances 1989Ti01,1976FlZY,1970Br33 (continued) **^{61}Cu Levels (continued)**

$E(\text{level})^\dagger$	$J\pi^\&$	$E(\text{p})(\text{Lab}) \text{ keV}$	$\Gamma(\text{p}) \text{ eV}^\text{b}$	Comments
8175.3	1/2+	3431.4	500 45	
8177.9	3/2-	3434.1	55 6	$\Gamma(\text{p}')=6 \text{ eV } 2.$
8181.2	1/2-	3437.5	90 10	
8187.5	(5/2+)	3443.9	35 6	
8194.3	(5/2+)	3450.8	10 5	
8222.4	1/2-	3479.3	40 10	
8250.3	1/2-	3507.7	40 10	
8272.4	1/2-	3530.2	40 10	
8290.1	3/2-	3548.2	20 10	
8307.6	1/2-	3566.0	40 10	
8361.0	1/2-	3620.3	60 12	
8364.6	1/2-	3623.9	40 10	
8415.3	1/2-	3675.5	109 11	
8426.8	1/2-	3687.2	56 8	
8448.3	3/2-	3709.0	80 16	
8449.2 §#	9/2+ ^a	3710.0	2	$\Gamma(\text{p}')=0.8 \text{ eV (1990Sz01).}$
8453.6 §#	9/2+ ^a	3714.4	3.9	$\Gamma(\text{p}')=3.7 \text{ eV (1990Sz01).}$
8456.1	3/2-	3717.0	60 12	
8456.5 §#	9/2+ ^a	3717.4	2.0	$\Gamma(\text{p}')=1.1 \text{ eV.}$
8460.1 §#	9/2+ ^a	3721.0	2.1	$\Gamma(\text{p}')=0.9 \text{ eV (1990Sz01).}$
8466.6 §#	9/2+ ^a	3727.6	14.9	$\Gamma(\text{p}')=10.1 \text{ eV (1990Sz01).}$
8467.8 §#	9/2+ ^a	3728.9	9.5	$\Gamma(\text{p}')=10.6 \text{ eV (1990Sz01).}$
8468.7	1/2-	3729.8	155 6	
8475.5 §#	9/2+ ^a	3736.7	11.9	$\Gamma(\text{p}')=2.7 \text{ eV (1990Sz01).}$
8477.6 §#	9/2+ ^a	3738.8	5.2	$\Gamma(\text{p}')=0.1 \text{ eV (1990Sz01).}$
8477.9	1/2-	3739.1	1222 54	
8480.3 §#	9/2+ ^a	3741.6	14.0	$\Gamma(\text{p}')=2.8 \text{ eV (1990Sz01).}$
8483.1 §#	9/2+ ^a	3744.4	2.5	$\Gamma(\text{p}')=3.4 \text{ eV (1990Sz01).}$
8487.1 §#	9/2+ ^a	3748.5	6.1	$\Gamma(\text{p}')=4.3 \text{ eV (1990Sz01).}$
8488.0	1/2-	3749.4	536 36	
8497.8	3/2-	3759.4	110 7	
8591.0	3/2-	3854.1	19 4	
8631.1	3/2-	3894.9	80 16	
8692.5	1/2-	3957.3	70 14	
8731.6	1/2-	3997.1	40 10	
8734.3	1/2-	3999.9	160 32	
8742.7	1/2-	4008.4	60 12	
10671.9@	1/2+@	5970	1750	

[†] From $E=S(\text{p})+E(\text{p})$, where $S(\text{p})=4800.3 \text{ } 10$ (2012Wa38) and $E(\text{p})$ is proton energy in the c.m. system. values of $E(\text{p})$ are from 1970Br33 ($E(\text{p})=1814-2929$), 1976FlZY ($E(\text{p})=2950.3-3450.8$), and 1976Ar01 ($E(\text{p})=3479.3-4008.4$), respectively. Additional 56 s-wave and 76 d-wave resonances in the energy range of 2.94–4.02 MeV are observed in 1976Ar01 but not listed. Values in 1970Br33 are systematically $\approx 2-3 \text{ keV}$ lower than in 1976FlZY.

[‡] From 1989Ti01.

§ From 1990Sz01.

$1g_{9/2}$ isobaric analog resonance fragments corresponding to 9/2+ 2122-keV excited state in ^{61}Ni .

@ From 1985AnZV.

& From $\sigma(E,\theta)$ and resonance analysis, except as noted.

a From analog resonance analysis (1990Sz01).

b Values of 1976FlZY are almost an order of magnitude higher than those of 1970Br33. Values are not given here.

⁶⁰Ni(d,n) 1969Ok01,1969Fu06

1969Fu06: E(d)=3.8 and 6 MeV. Neutron time of flight, $\sigma(\theta)$. Determined deuteron optical potential from sub-Coulomb stripping.

1969Ok01: E(d)=11.7 MeV. Neutron time of flight, $\sigma(\theta)$, FWHM $\approx$ 150 keV.

Data are from 1969Ok01. There is good agreement with 1969Fu06 at E(d)=6 MeV.

Others: 1965Ok01, 1966Ok01, 1966Ok02.

⁶¹Cu Levels

E(level)	(d(σ)/d(ω)) _{max}	L [†]	(2J+1)C ² S [†]	Comments
0.0	10.4	1	2.76	
480 50	6.2	1	1.52	
980 50	1.3	3	3.46	
1410 50	0.9	3	2.01	
1940 50	3.3	1	0.65	
2340 50				
2820 50	1.2	1	0.21	
3050 50	1.8	1	0.27	
3230 50	1.0			
3460 50	1.9	2	0.72	
3840 50	1.4 [‡]	0		
4470 50	2.0	2	0.66	
4900 50	3.3			
5240 50				
5580 50	2.5 [‡]	0		
6170 50				
6420 50	3.3	1	0.37	E(level): analog of 3/2-, g.s. in ⁶¹ Ni.
6680 50	2.6	1	0.29	E(level): analog of 1/2-, 283-keV in ⁶¹ Ni.
7130 50		1		E(level): analog of 1/2-, 656-keV in ⁶¹ Ni.
7370 50		3		E(level): analog of 5/2-, 909-keV in ⁶¹ Ni.
7620 50		1		E(level): analog of 3/2-, 1185-keV in ⁶¹ Ni.

[†] From comparisons with DWBA calculations.

[‡] Cross section for a neutron emission angle $\theta=10^\circ$.

⁶⁰Ni(³He,d) 1990Se03,1981Ki06,2013Sc06

2013Sc06, 2013ScZZ: E(³He)=18 MeV from WNSL-Yale tandem accelerator facility. Measured deuteron spectra, $\sigma(\theta)$, spectroscopic factor C²S using a split-pole spectrograph. FWHM $\approx$ 50 keV. Target=204 μ g/cm² thick, 99.7% enriched. Deduced levels, J, π . DWBA analysis. Comparison with shell-model calculations.

The main purpose of the neutron adding and neutron removal reaction studies by 2013Sc06 was to obtain occupancies of neutron orbitals, proton vacancies, and energy centroids of neutron, neutron-holes, proton-single particle excitations in ⁶⁰Ni and ⁶²Ni, and thereby investigate closure of 0f_{7/2} shell. Some data details of this study are supplied in 2013ScZZ.

1990Se03: E=33 MeV. Measured $\sigma(\theta)$, $\theta=12.5^\circ$ - 115° (lab.) in steps of 2.5° , with six ΔE -E telescopes, FWHM=55 keV.

Target enriched to 98.5% of ⁶⁰Ni. DWBA analysis.

1981Ki06: E=18 MeV. Measured $\sigma(\theta)$, $\theta=1.6^\circ$ - 40° . Magnetic spectrograph, FWHM=12-15 keV. Enriched target. J dependent effects at small angles.

1976Br36: E=18 MeV. Measured $\sigma(\theta)$, θ (c.m.)= 5° - 90° , magnetic spectrograph, FWHM=20 keV. Enriched target.

1968Pu03 (also 1966Ro13): E=16.4 MeV. Measured deuteron spectra, $\sigma(\theta)$, DWBA analysis. Magnetic spectrometer FWHM=19 keV.

Others:

1979Fi02, 1976Bo06: E=30.2 MeV. Measured $\sigma(\theta)$ with ΔE -E semi telescope, FWHM=50 keV. Data for seven analog states from 6450 to 9960 keV.

1975Ba63: E=6.5, 7 MeV. Magnetic spectrometer. Data for g.s. and 470 level.

1965Bl05: data for four isobaric analog states, FWHM=70 keV.

L values and spectroscopic factors are from comparisons with DWBA calculations with normalization factor =4.42 (1981Ki06).

Most data are from 1990Se03, except as noted. There is good agreement with the data of 1976Br36, if account is taken of the different DWBA normalization constant (N=3.2 from sum-rule limits) used in 1976Br36 and (N=4.42) in 1990Se03.

All data of E $\leq$ 3578 are from Adopted Levels rounded to nearest keV (1981Ki06). All data with E>3578 are from 1990Se03, except as noted.

Cross sections listed under comments are from 1968Pu03 corresponding to the value at first maximum in $\sigma(\theta)$ pattern.

Continued on next page (footnotes at end of table)

⁶⁰Ni(³He,d) 1990Se03,1981Ki06,2013Sc06 (continued)

dσ/dΩ in mb/sr (2013ScZZ)

Level	10° (³ He,d)	25° (³ He,d)
0	11.10	3.08
475	5.66	1.47
970	0.34	1.28
1311	0.11	0.25
1394	0.095	0.16
1933	1.48	0.43
2089	0.42	0.12
2203	0.10	0.23
2358	0.51	0.13
2472	0.081	0.007
2721	0.22	1.00
2840	1.48	0.50
2933	0.072	0.024
3019	0.31	0.15
3092	1.22	0.38
3406	2.33	1.57
3578	0.41	0.58
3863	0.68	0.28

2013Sc06 quote level energies from 1999-NDS for A=61 (1999Bh04);
these values are close to those in Adopted levels here

The uncertainties in cross sections are =4% for σ>1 mb/sr, =7% for
0.1<σ< 1.0 mb/sr, and =18% for σ< 0.1 mb/sr at their respective
maxima. The uncertainties arising from possible contaminants or
previously unidentified states for very weak transitions could be
≈0.02 mb/sr.

⁶¹Cu Levels

E(level) [†]	L [‡]	(2J+1)C ² S	Comments
0.0	1	2.16 ^c	dσ/dΩ=8.3 mb/sr. (2J+1)C ² S: 1.71 for J _π =3/2- (2013Sc06,2013ScZZ).
477	1	0.96 ^d	dσ/dΩ=3.5 mb/sr. (2J+1)C ² S: 0.82 for J _π =1/2- (2013Sc06,2013ScZZ).
972	3	3.26 ^e	dσ/dΩ=0.56 mb/sr.
1306 ^a	3	0.40 ^f	dσ/dΩ=0.13 mb/sr.
1390 ^a	3	0.36 ^e	dσ/dΩ=0.15 mb/sr.
1702			
1904	3	0.06 ^e	
1940	1	0.22 ^c	dσ/dΩ=1.0 mb/sr. (2J+1)C ² S: 0.19 for J _π =3/2- (2013Sc06,2013ScZZ).
2104	1	0.06 ^d	dσ/dΩ=0.32 mb/sr. (2J+1)C ² S: 0.054 for J _π =1/2- (2013Sc06,2013ScZZ).
2216	3	0.56 ^e	dσ/dΩ=0.08 mb/sr.
2368	1	0.07 ^c	dσ/dΩ=0.26 mb/sr. (2J+1)C ² S: 0.065 for J _π =3/2- (2013Sc06,2013ScZZ).
2390	3	0.08 ^f	dσ/dΩ=0.03 mb/sr.
2478	1	0.01 ^c	L: 1976Br36 obtain L=(2). dσ/dΩ=0.02 mb/sr. (2J+1)C ² S: 0.010 for J _π =3/2- (2013Sc06,2013ScZZ).
2629			dσ/dΩ=0.01 mb/sr.
2680	1	0.04 ^c	dσ/dΩ=0.05 mb/sr.
2711	4	2.80 ^g	dσ/dΩ=0.74 mb/sr.
2794	3	0.13 ^e	dσ/dΩ=0.3 mb/sr.
2846 ^{#a}	1 ^b	0.04 ^d	dσ/dΩ=1.6 mb/sr. (2J+1)C ² S: 0.38 for J _π =1/2-,3/2- (2013Sc06,2013ScZZ).
2857 ^{#a}	1 ^b		
2942	1	0.004	dσ/dΩ=0.04 mb/sr. (2J+1)C ² S: 0.009 for J _π =3/2- (2013Sc06,2013ScZZ).

Continued on next page (footnotes at end of table)

$^{60}\text{Ni}(^3\text{He},\text{d})$ 1990Se03,1981Ki06,2013Sc06 (continued) **^{61}Cu Levels (continued)**

E(level) [†]	L [‡]	(2J+1)C ² S	Comments
3019	1	0.06 ^c	dσ/dΩ=0.06 mb/sr. (2J+1)C ² S: 0.040 for Jπ=3/2- (2013Sc06,2013ScZZ).
3063 ^a	1	0.11 ^d	dσ/dΩ=0.09 mb/sr.
3094 ^a	1	0.08 ^d	dσ/dΩ=0.07 mb/sr.
3276	(4)	0.14 ^g	E(level), L and C ² S' from 1976Br36. C ² S' renormalized to N=4.42. dσ/dΩ=0.03 mb/sr.
3411	2	0.59 ^h	dσ/dΩ=1.92 mb/sr.
3526			
3588	2	0.20 ^h	dσ/dΩ=0.18 mb/sr.
3708			dσ/dΩ=0.09 mb/sr.
3790			dσ/dΩ=0.03 mb/sr.
3860	1	0.13 ^d	dσ/dΩ=0.12 mb/sr. (2J+1)C ² S: 0.093 for Jπ=1/2-,3/2- (2013Sc06,2013ScZZ).
3943	1	0.14 ^d	dσ/dΩ=0.02 mb/sr.
3970			
4013			dσ/dΩ=0.05 mb/sr.
4102			dσ/dΩ=0.03 mb/sr.
4273			dσ/dΩ=0.03 mb/sr.
4296			
4349	0	0.21	Configuration=(2s _{1/2}). dσ/dΩ=0.07 mb/sr.
4420	3	0.45 ^e	dσ/dΩ=0.04 mb/sr.
4477			dσ/dΩ=0.08 mb/sr.
4523			dσ/dΩ=0.05 mb/sr.
4581			dσ/dΩ=0.08 mb/sr.
4621	1	0.18 ^d	dσ/dΩ=0.06 mb/sr.
4738			
4790			dσ/dΩ=0.03 mb/sr.
4827	3	0.30 ^e	
4860			
4900			dσ/dΩ=0.06 mb/sr.
4925			dσ/dΩ=0.04 mb/sr.
4973			dσ/dΩ=0.05 mb/sr.
5042	4	0.29 ^g	dσ/dΩ=0.15 mb/sr.
5081			dσ/dΩ=0.03 mb/sr.
5111			dσ/dΩ=0.07 mb/sr.
5170			dσ/dΩ=0.07 mb/sr.
5235			
5329	4	0.60 ^g	dσ/dΩ=0.08 mb/sr.
5383	4	0.74 ^g	dσ/dΩ=0.06 mb/sr.
5433			dσ/dΩ=0.16 mb/sr.
5463			dσ/dΩ=0.15 mb/sr.
5532			dσ/dΩ=0.22 mb/sr.
5574			dσ/dΩ=0.17 mb/sr.
5624			
5669			dσ/dΩ=0.11 mb/sr.
5704	2	0.22 ^h	
5788	0	0.21	(2J+1)C ² S: for configuration=3s _{1/2} . dσ/dΩ=0.06 mb/sr.
5829			
5872			dσ/dΩ=0.05 mb/sr.
5937			dσ/dΩ=0.09 mb/sr.
6004			
6045			
6075			
6119			dσ/dΩ=0.20 mb/sr.
6149			
6216			dσ/dΩ=0.14 mb/sr.
6314			dσ/dΩ=0.13 mb/sr.
6350			
6402 ^{&}	1		dσ/dΩ=0.30 mb/sr.

Continued on next page (footnotes at end of table)

⁶⁰Ni(³He,d) 1990Se03,1981Ki06,2013Sc06 (continued)

⁶¹Cu Levels (continued)

E(level) [†]	L [‡]	(2J+1)C ² S	Comments
6457	1+3	1.58+2.28 ^c e	dσ/dΩ=0.36 mb/sr. E(level): probable analog of 3/2-, g.s. and 5/2-, 67-keV in ⁶¹ Ni. C ² S(2J+1)=2.28 for configuration=1f _{5/2} . May correspond to 6450 40 + 6520 40 (1976Bo06).
6543			dσ/dΩ=0.10 mb/sr.
6650&	1		dσ/dΩ=0.18 mb/sr.
6701	1	1.29 ^d	E(level): probable analog of 1/2-, 283-keV in ⁶¹ Ni. May correspond to 6740 40 (1976Bo06).
6712			dσ/dΩ=0.12 mb/sr.
6860@ 40			
6954			dσ/dΩ=0.15 mb/sr.
6980@ 40			
7192			
7401	3	0.90 ^e	
7520			dσ/dΩ=0.21 mb/sr.
7589			
7643	1+3	0.40+0.61 ^c e	dσ/dΩ=0.16 mb/sr. E(level): probable analogs of 3/2-, 1100-keV, 5/2-, 1132-keV, 3/2-, 1185-keV levels in ⁶¹ Ni.
8177			dσ/dΩ=0.10 mb/sr.
8504			dσ/dΩ=0.25 mb/sr.
8561	4	3.32 ^g	E(level): probable analog of 9/2+, 2122-keV level in ⁶¹ Ni.
8670@ 40			
9142	2+4	0.43+0.71 ^h	
9963	4	2.55 ^g	

[†] From 1990Se03 unless otherwise stated.

[‡] From DWBA analysis of σ(θ).

Jπ=(1/2)-, L=1, C²S=0.23 for unresolved doublet.

@ From 1976Bo06. For proton decay of some analog states, see 1979Fi02.

& Level from 1968Pu03, identified as an analog state.

a Rounded values from Adopted Levels, unresolved doublets at 1334, 2851, 3078 and 6457 keV.

b L=1 unresolved doublet (E=2851) (1990Se03).

c For configuration=2p_{3/2} for L=1.

d For configuration=2p_{1/2} for L=1.

e For configuration=1f_{5/2} for L=3.

f For configuration=1f_{7/2} for L=3.

g For configuration=1g_{9/2} for L=4.

h For configuration=2d_{5/2} for L=2.

⁶⁰Ni(α,t) 2013Sc06,1967Ar05

2013Sc06, 2013ScZZ: E(α)=38 MeV from WNSL-Yale tandem accelerator facility. Measured triton spectra, σ(θ), spectroscopic factor C²S using a split-pole spectrograph. FWHM ≈64 keV. Target=204 μg/cm² thick, 99.7% enriched. Deduced levels, J, π. DWBA analysis. Comparison with shell-model calculations.

The main purpose of the neutron adding and neutron removal reaction studies by 2013Sc06 was to obtain occupancies of neutron orbitals, proton vacancies, and energy centroids of neutron, neutron-holes, proton-single particle excitations in ⁶⁰Ni and ⁶²Ni, and thereby investigate closure of 0f_{7/2} shell. Some data details of this study are supplied in 2013ScZZ.

1967Ar05: E(α)=26.7 MeV. Measured σ(θ), θ(c.m.)=11°-48°.ΔE-E semi telescope with FWHM≈90 keV. Enriched target. Three groups are reported at 0, 470 and 970 keV.

L-values and spectroscopic factors are from comparisons with DWBA calculations with a DWBA normalization factor of 38.4.

dσ/dΩ in mb/sr (2013ScZZ)

Level	5° (α, t)
0	1.92
475	0.56
970	4.11

Continued on next page (footnotes at end of table)

⁶⁰Ni(α,t) 2013Sc06,1967Ar05 (continued)

1311	0.51
1394	0.43
1933	0.11
2203	0.42
2721	4.1
2840	0.26
3019	0.14
3092	0.041
3406	0.057
3578	0.12
3863	0.037

The uncertainties in cross sections are =4% for $\sigma > 1$ mb/sr, =7% for $0.1 < \sigma < 1.0$ mb/sr, and =18% for $\sigma < 0.1$ mb/sr at their respective maxima. The uncertainties arising from possible contaminants or previously unidentified states for very weak transitions could be =0.02 mb/sr.

All data are from 2013Sc06, 2013ScZZ unless otherwise stated.

⁶¹Cu Levels

E(level) [†]	J π	L ‡	C ² S	Comments
0.0	(3/2)- [§]	1 [#]	0.59 [#]	
475	(1/2)- [§]	1 [#]	0.99 [#]	
970	(5/2)- [§]	3	3.67	C ² S: 0.86 (1967Ar05).
1311		3	0.90	C ² S: for J π =7/2-.
1394		3	0.44	C ² S: for J π =5/2-.
1933				
2203		3	0.59	C ² S: for J π =5/2-.
2721		4	3.29	C ² S: for J π =9/2+.
2840				
3019				
3092				
3406				
3578				
3863				

[†] 2013Sc06 quote level energies from 1999-NDS for A=61 (1999Bh04); these values are close to those in Adopted levels here.

[‡] From DWBA analysis of $\sigma(\theta)$.

[§] From J-dependence of $\sigma(\theta)$ and S extraction (1967Ar05).

[#] From 1967Ar05. Because of poor fits to the data, large uncertainties are associated with the extraction of C²S.

⁶¹Ni(p,n): Resonances 1966Ri09

1966Ri09: E(p)=7.0-7.9 MeV. Measured proton resonances and σ .

⁶¹Cu Levels

E(level) [†]	E(p)(lab)	E(level) [†]	E(p)(lab)	E(level) [†]	E(p)(lab)
11768 7	7083	11994 7	7313	12303 7	7627
11798 7	7114	12054 7	7374	12314 7	7638
11822 7	7138	12084 7	7404	12356 7	7681
11831 7	7147	12102 7	7423	12394 7	7719
11852 7	7169	12121 7	7442	12409 7	7735
11881 7	7198	12148 7	7469	12452 7	7778
11902 7	7219	12166 7	7488	12478 7	7805
11919 7	7237	12189 7	7511	12494 7	7821
11935 7	7253	12215 7	7538	12506 7	7836
11946 7	7264	12253 7	7576	12520 7	7848
11969 7	7287	12273 7	7597		

[†] E(p)(c.m.)+S(p)(⁶¹Cu), where S(p)=4008.3 10 (2012Wa38). Uncertainty on E(p)(lab) is estimated as 7 keV.

⁶¹Ni(p,n),(p,n γ) 1970Ba64,1974Br34

1970Ba64: E(p)=5.5-6.3 MeV. Measured neutron time of flight, FWHM=10 keV. Enriched targets.
 1974Br34: E(p)=5.3 MeV. Measured DSA (centroid shift) with escape-suppression spectrometer.
 All data are from 1970Ba64, except as noted.

⁶¹Cu Levels

E(level) [†]	T _{1/2}	Comments
0.0		
477 1		
973 2		
1314 2		
1398 2		
1660.2 [‡]	193 fs 20	E(level): 1663 2 (1970Ba64).
1736 2		
1904.1 [‡]	178 fs 18	E(level): 1907 2 (1970Ba64).
1932.6 [‡]	84 fs 9	E(level): 1963 3 (1970Ba64).
1948 3		
2088.7 [‡]	28.4 fs § 35	E(level): 2091 2 (1970Ba64).
2206 2		
2296 2		
2338 2		
2360 3		
2401 3		
2474 3		
2575 3		

[†] From 1970Ba64 unless otherwise stated.

[‡] From γ -ray data (1974Br34).

§ From 1974Br34. The values are based on DSAM in 1974Br34 and stopping power corrections determined by using measured lifetimes in their (α ,p γ) study (1973Sa19).

$\gamma(^{61}\text{Cu})$

E γ	E(level)
1660.2	1660.2
1904.1	1904.1
1932.6	1932.6
2088.7	2088.7

⁶³Cu(p,t) 1972Iw02

1972Iw02: E(p)=51.9 MeV. Magnetic spectrograph, $\theta(\text{c.m.})=5^\circ-50^\circ$. $\sigma(\theta)$ compared to $\sigma(\theta)$ of ⁶²Ni(p,t). No L-transfer values are given, but transfer to ⁶¹Cu g.s. has L=0 and to the other states probably L=2.

1964Ba34: E=40 MeV. Measured $\sigma(\theta)$ for g.s., DWBA analysis.

J $\pi(^{63}\text{Cu g.s.})=3/2^-$.

⁶¹Cu Levels

E(level)	Relative σ
0.0	100
480	2.8
970	2.8
1310	15.7
1390	1.9

⁶⁴Zn(p,α) 1967Br10,1976Gu08

1967Br10: E(p)=11.5 MeV. Magnetic spectrograph, FWHM=20 keV, enriched target.

1976Gu08: E(p)=23.3-42.4 MeV. ΔE-E semi telescope, FWHM=120 keV, enriched target, studied energy dependence of σ(θ).

DWBA fits to σ(θ) rather poor. Data for g.s., 968 and 1306+1393 doublet.

⁶¹Cu Levels

E(level) [†]	L [‡]	E(level) [†]	E(level) [†]
0.0	(1)	2287 15	2834 15
478 15		2330 15	2849 15
968 15	(3)	2353 15	2917 15
1306 15	(3) §	2392 15	2994 15
1393 15	(3) §	2466 15	3010 15
1652 15		2574 15	3037 15
1726 15		2595 15	3056 15
1897 15		2615 15	3083 15
1927 15		2673 15	3191 15
1947 15		2706 15	3249 15
2081 15		2721 15	
2192 15		2785 15	

[†] From 1967Br10.

[‡] From DWBA analysis of σ(θ) (1976Gu08).

§ Combined value from analysis of 1306+1393 (listed as 1340 in 1976Gu08) unresolved doublet.

Adopted Levels, Gammas

Q(β⁻)=-9210 40; S(n)=10246 16; S(p)=5293 16; Q(α)=-2690 16 2012Wa38.

Q(εp)=835 16, S(2n)=25276 16, S(2p)=9771 16 (2012Wa38).

⁶¹Zn produced and identified by 1955Li39 in the bombardment of ⁵⁸Ni by 15-22 MeV α particles followed by chemical separation. An earlier abstract by Cumming (Phys. Rev. 99, 1645A (1955)) and a later full paper 1959Cu86 confirmed this isotope.

Theory, calculations:

2002Ca48: large-scale shell model calculations.

2004Ho08: the effective interaction GXPF1 for shell model in the pf shell.

⁶¹Zn Levels

Note that in 1999-NDS (1999Bh04), 88.2, 418.3, and 756.0 levels were erroneously assigned half-lives of <430 ms, 0.14 s 7 and <130 ms, respectively. These half-lives in 1999Oi01 simply refer to the half-life of the decaying ⁶¹Ga isotope.

For band configurations in terms of quasiparticle notation, see ²⁸Si(³⁶Ar,2pnγ) datasets.

Cross Reference (XREF) Flags

A ⁶¹Ga ε Decay (167 ms)

B ²⁸Si(³⁶Ar,2pnγ)

C ⁴⁰Ca(²⁴Mg,2pnγ)

D ⁵⁸Ni(α,nγ)

E ⁵⁸Ni(¹⁶O,¹³C)

F ⁵⁸Ni(⁶Li,t),(¹²C,⁹Be)

G ⁶⁴Zn(³He,⁶He)

E(level) [†]	Jπ [‡]	XREF	T _{1/2}	Comments
0.0 ^d	3/2-	ABCDEF	89.1 s 2	%ε+%β ⁺ =100. Jπ: allowed β transitions to 1/2- (log ft=5.96) and 5/2- (log ft=5.20) levels in ⁶¹ Cu from ⁶¹ Zn ε. T _{1/2} : from 1972Du09. Others: 88.8 s 18 (1955Li39), 88.5 s 10 (1959Cu86), 85.9 s 6 (1969Ho02).
88.55 ^e 19	1/2-	ABCD		Jπ: ΔJ=1, (M1+E2) γ to 3/2-; isotropic γ(θ).
123.84 ^c 9	5/2-	ABCDEF	≈5.5 ns	Jπ: ΔJ=1, M1+E2 γ to 3/2-.
418.80 ^f 14	3/2-	ABCDE G		T _{1/2} : γ(t) in (²⁴ Mg,2pnγ) (2006An31). Jπ: ΔJ=0, M1+E2 γ to 3/2-.
755.42 ^e 10	5/2-	ABCD		Jπ: ΔJ=1, M1+E2 γ to 3/2-.
938.5 3	(1/2-)	A DEFG		Jπ: γs to 1/2- and 3/2-.
996.66 ^d 10	7/2-	BCD		Jπ: stretched E2 996γ to 3/2-.
1239 9		FG		
1264.99 ^c 13	9/2-	BCDE		
1361.8 5	3/2-, 5/2-	A D		Jπ: M1+E2 γ to 3/2-.
1387 9		FG		
1402.64 ^f 18	7/2-	BCD		Jπ: ΔJ=1, M1 γ to 5/2-.
1636 20		G		
1657.8 6	5/2-, 7/2-	D		Jπ: M1+E2 γ to 5/2-.
1730		E		
2002.60 ^e 19	9/2-	BCD		Jπ: M1(+E2) γ to 7/2-; ΔJ=2 γ to 5/2-.
2030 10		EF		
2098.9 10		D		
2198 20		G		
2250 10		F		
2269.8 ^d 4	11/2-	BCD		
2399.0 ^h 5	9/2+	BCDEFG		XREF: G(2417).
2520 10		F		
2646 20		G		
2698.7 ^f 4	11/2-	BC		
2715 10		FG		
2798.7 ^c 4	(13/2-)	BCDE		Jπ: 1532γ(θ).
2804 9		FG		
3090 10		F		
3243.8 ^g 8	(11/2+)	BC		
3300 10		F		
3335.7 ^h 6	13/2+	BCD		
3345 20		G		
3380	(3/2-)	E		Jπ: T=3/2 analog of ⁶¹ Cu 3/2- g.s.
3460.8 ^e 7	(13/2-)	BC		
3494.0 10		BC		
3645 20		G		
3843.8 ^d 7	(15/2-)	BC		

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Adopted Levels, Gammas (continued)
⁶¹Zn Levels (continued)

E(level) [†]	Jπ [‡]	XREF	Comments
3880 80		EF	
4263.7g 7	15/2+	BC	
4308.8 11	(13/2)	BC	
4380 80		EF	
4414.6h 8	17/2+	BCD	
4644.2c 7	17/2-	BC	
4670 30		G	
4914.7 11		BC	
5100 30		EFG	
5194.6e 9	(17/2-)	BC	
5254.1 8		BC	
5320 30		G	
5467.8 13		BC	
5542.9d 8	(19/2-)	BC	
5552.2g 8	19/2+	BC	
5590 90		EF	
6090.3h 12	21/2+	BC	
6211.7 10		BC	
7283.7i 9	(21/2-)	BC	
7295.9g 10	(23/2+)	BC	
7486.3 15	25/2+	BC	
7628.5j 9	23/2-	BC	
8335.2a 11	(21/2-)	BC	
8496.4 12	(25/2+)	BC	
8775.1b 11	(23/2-)	BC	
8879.1i 12	(25/2-)	BC	
9036.5? 21		B	
9160.5j 12	27/2-	BC	
9303.1a 11	(25/2-)	B	
9367.2 11	(25/2-)	B	
9950.8b 11	(27/2-)	B	
9990 70	(3/2-)	E	T=5/2. Isobaric analog state.
10057.6i 12	29/2-	B	
10154.6j 13	31/2-	BC	
10664.6a 12	(29/2-)	B	
10871 6	(25/2+)	B	
11183 5	(27/2+)	B	
11261? 5	(25/2+)	B	
11368k 3	(25/2+)	B	
11505.4b 12	(31/2-)	B	
11527?l 5	(29/2-)	B	
11770 5	(29/2+)	B	
12042n 6	(29/2-)	B	
12232 4	(29/2+)	B	
12337& 4	(29/2-)	B	
12469.1a 13	(33/2-)	B	
12537§ 4	(29/2+)	B	
12665@ 3	(31/2-)	B	
12725.7 24	(33/2-)	B	
12761 5	(31/2-)	B	
12802k 3	(29/2+)	B	
12865# 4	(31/2-)	B	
13210 4	(33/2)	B	
13264l 5	(33/2-)	B	
13319.3b 15	(35/2-)	B	
13664n 6	(33/2-)	B	
13882§ 4	(33/2+)	B	
13886& 4	(33/2-)	B	
14061 6	(35/2-)	B	
14072 5	(35/2-)	B	
14114 5	(33/2)	B	
14144m 6	(35/2-)	B	

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Adopted Levels, Gammas (continued)

61Zn Levels (continued)

E(level) [†]	Jπ [‡]	XREF	E(level) [†]	Jπ [‡]	XREF	E(level) [†]	Jπ [‡]	XREF
14299.5 ^a 17	(37/2-)	B	17119 ^o 5	(37/2-)	B	21745 ^o 6	(45/2-)	B
14325 [@] 3	(35/2-)	B	17126 [#] 5	(39/2-)	B	22239 ⁿ 7	(49/2-)	B
14431 ^k 4	(33/2+)	B	17310 ^l 5	(41/2-)	B	22397 ^l 7	(49/2-)	B
14433 7	(31/2-)	B	17455 ⁿ 6	(41/2-)	B	22584 [@] 6	(47/2-)	B
14449 5	(35/2-)	B	17610 [§] 5	(41/2+)	B	22901 [#] 7	(47/2-)	B
14769 6		B	17987 ^{&} 5	(41/2-)	B	22965 [§] 7	(49/2+)	B
14817 [#] 4	(35/2-)	B	18196 ^P 5	(39/2-)	B	23180 ^P 6	(47/2-)	B
15020 6	(33/2-)	B	18363 ^k 5	(41/2+)	B	23222 ^k 6	(49/2+)	B
15206 ^l 5	(37/2-)	B	18471 ^m 6	(43/2-)	B	23856 ^m 7	(51/2-)	B
15224 ^o 4	(33/2-)	B	19149 [@] 5	(43/2-)	B	23900 ^{&} 6	(49/2-)	B
15261.3 ^b 25	(39/2-)	B	19270 ^o 5	(41/2-)	B	24604 ^o 7	(49/2-)	B
15293 6		B	19653 ⁿ 6	(45/2-)	B	25280 ^{?n} 8	(53/2-)	B
15475 ⁿ 5	(37/2-)	B	19690 ^l 6	(45/2-)	B	25449 ^{?l} 8	(53/2-)	B
15565 [§] 5	(37/2+)	B	19773 [#] 6	(43/2-)	B	26042 ^k 7	(53/2+)	B
15739 ^{&} 4	(37/2-)	B	20060 [§] 6	(45/2+)	B	26220 ^P 7	(51/2-)	B
16099 ^P 4	(35/2-)	B	20531 ^P 5	(43/2-)	B	26696 [§] 8	(53/2+)	B
16230 ^m 5	(39/2-)	B	20642 ^{&} 6	(45/2-)	B	27084 ^{?m} 8	(55/2-)	B
16280 ^k 4	(37/2+)	B	20674 ^k 5	(45/2+)	B	29171 ^k 7	(57/2+)	B
16438 [@] 4	(39/2-)	B	20999 ^m 6	(47/2-)	B			

[†] Level energies with ΔE<8 keV are deduced from least-squares fit to the Adopted Gammas (by evaluators). The others are weighted averages of all available data from (¹⁶O,¹³C),(⁶Li,t) and (³He,⁶He).

[‡] For states with J≥9/2, assignments are essentially as proposed in the high-spin studies by 2009An01 and 2006An31, which are based on γγ(θ) and γ(lin pol) data for selected transitions, band assignments, decay pattern of levels, and yrast nature of population of levels in heavy-ion γ-ray studies, except as noted. The parentheses in many cases have been added by the evaluators.

§ (A): Band based on (29/2+).

(B): Band based on (31/2-).

@ (C): Band based on (31/2-).

& (D): Band based on (29/2-).

a (E): Band based on (21/2-), α=+1/2.

b (F): Band based on (23/2-), α=-1/2.

c (G): Band based on 3/2-, α=+1/2.

d (H): Band based on 3/2-, α=-1/2.

e (I): Band based on 1/2-, α=+1/2.

f (J): Band based on 1/2-, α=-1/2.

g (K): Band based on 11/2+.

h (L): Band based on 9/2+.

i (M): Band based on 21/2-, α=+1/2.

j (N): Band based on 23/2-, α=-1/2.

k (O): SD-1 band, α=+1/2.

l (P): SD-2 band, α=+1/2.

m (Q): SD-3 band, α=-1/2.

n (R): SD-4 band, α=+1/2.

o (S): SD-5 band, α=+1/2.

P (T): SD-6 band, α=-1/2.

γ(61Zn)

E(level)	Eγ [†]	Iγ [†]	Mult. [‡]	δ	α	Comments
88.55	88.4 3	100	(M1+E2)	≈0.2	0.12 2	Eγ: unweighted average of 88.0 1 (1982Sm01), 88.4 1 (1984Th07) and 88.9 1 (2009An01,2006An31). Weighted average is the same but with a large χ ² value. α: assuming 25% uncertainty in δ. B(M1)(W.u.)=0.0021; B(E2)(W.u.)=0.62.
123.84	123.8 1	100	M1+E2	-0.05 2	0.0352 8	
418.80	295.4 2	5.7 7	(M1+E2)	-0.44 37	0.0051 19	
	330.5 4	14.3 4	(M1+E2)	+0.27 13	0.0032 4	Eγ: unweighted average of 330.4 3 (1982Sm01), 329.8 5 (1984Th07), 331.3 2 (2009An01,2006An31). Weighted average is 330.9 4 with a large χ ² value.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)
 $\gamma(^{61}\text{Zn})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\dagger}$	Mult. ‡	δ	α	Comments
418.80	419.0 3	100.0 20	M1+E2	-0.10 5		E γ : unweighted average of 418.4 1 (1982Sm01), 418.5 2 (1984Th07), 419.1 2 (2009An01,2006An31). Weighted average is 419.2 2 with a large χ^2 value.
755.42	338.2 6	5.0 6				E γ : unweighted average of 337.0 7 (1982Sm01), 338.6 2 (1984Th07), 339.0 2 (2009An01,2006An31). Weighted average is 338.7 3 with a large χ^2 value.
	631.7 3	6.1 6	D			
	666.6 3	10.0 6				
	755.55 13	100.0 19	M1+E2	-0.07 4		
938.5	520.0 4	30 13				I γ : unweighted average of 16 4 in (α , γ) (1982Sm01) and 43 10 in ϵ decay. Value of 232 43 from 1984Th07 in (α , γ) seems discrepant thus not used.
	849.8 7	26.8 24				
	938.2 4	100.0 16				
996.66	241.4 1	0.68 14				
	578.0 3	6.0 3	Q			
	872.7 1	100.0 16	M1+E2	-1.9 1		Mult.: from (α , γ).
	996.7 5	37 4	E2			I γ : unweighted average of values from (α , γ) (1982Sm01,1984Th07) and ⁴⁰ Ca(²⁴ Mg,2p γ) (2006An31).
1264.99	1141.1 1	100	E2			E γ : from (α , γ) (1982Sm01).
1361.8	606.0 5	13.9 14				
	944.0 10	33 6				
	1240 [#]	50				Questionable placement suggested in 1982Sm01, 50% relative branching from 1989Sc28 in (α , γ). Note that there is a 1239 γ from 1658 level proposed by 1984Th07. Evaluators consider the 1240 γ from 1362 level as suspect.
	1362.0 10	100 6	M1+E2			δ : -0.29 17 or +0.18 11 in (α , γ).
1402.64	647.1 2	100 3	M1			γ branching ratios are from (²⁴ Mg,2p γ) (2006An31). Corresponding values from (α , γ) (1982Sm01) are in reasonable agreement, but in sharp disagreements with those from 1984Th07 and 1989Sc28 in (α , γ).
	984.4 3	103 15				I γ : 100 in (α , γ) (1984Th07).
	1278.6 7	59 12	D			I γ : 30 8 in (α , γ) (1984Th07) seems discrepant.
	1401.9 5	156 91				I γ : 16 4 in (α , γ) (1984Th07) seems discrepant.
1657.8	1239.0 7	100				I γ : 32 7 in (α , γ) (1984Th07) seems discrepant.
	1534.0 10	38 7	M1+E2	-1.4 9		
2002.60	737.6 4	11.8 12				
	1006.0 2	100 8	M1(+E2)	-0.4 4		
	1247.0 4	86 8	Q			
2098.9	1975	100				
2269.8	1005 1	37 4	D			
	1273.6 4	100 4	E2			
2399.0	997.0 [#] 5	12 7				
	1403.4 7	100 12	E1			
	2273 1	5.6 2	(M2)			
2698.7	696.2 3	25.4 15	D			
	1433 1	100 3	D			
2798.7	529.4 3	1.7 2				
	1532 1	100 7	Q			
3243.8	1978 1	100	D			
3335.7	936.7 5	100 5	E2			
	1066 1	18 1	E1			
3460.8	1458 1	100 4	Q			
	2195 1	83 5	Q			
3494.0	2229 1	100	Q			
3843.8	1046 1	26 1				

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Adopted Levels, Gammas (continued) $\gamma(^{61}\text{Zn})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. [‡]	Comments
3843.8	1572 1	100 6	Q	E γ : level-energy difference=1574.
4263.7	1019 1	19 1	Q	
	1466 1	100 5	E1	
4308.8	2039 1	100	D	
4414.6	1079 1	100	E2	
4644.2	1847 1	100	E2	
4914.7	2116 1	100	D	
5194.6	1733 1	100	(Q)	
5254.1	839.2 4	100 3		
	990.9 5	45 10		
5467.8	1624 1	100		
5542.9	898.9 4	36 12		
	1698 1	100 5	Q	
5552.2	908.3 5	24 1	D	
	1289 1	100 9	E2	
6090.3	1675 3	100	E2	
6211.7	1799 1	100 26		
	1946 1	61 4		
7283.7	1733 1	57 14		
	2088 1	81 5	Q	
	2639 1	100 43		
7295.9	1743 1	100	Q	
7486.3	1396 1	100	E2	
7628.5	344.8 2	4.0 13		
	1538 1	100 9	E1	
8335.2	1039 1	86 19		
	2246 [#] 1	38 19		
	2785 2	29 15		
	3142 3	38 14		
	3691 3	100 24	Q	
8496.4	868 1	53 13		
	1200.4 12	100 27		
8775.1	439.9 4	100	D	
8879.1	1595 1	100	Q	
9036.5?	1408 2	100		
9160.5	1532 1	100 11	E2	
	1675 4	63 32		
9303.1	528.0 6	85 12		
	968 1	29 6		
	1676 2	82 21	D+Q	
	2006 2	100 18	D	
9367.2	592.0 4	100 16		
	2071 2	89 32	D	
9950.8	583.3 6	99 8	D+Q	
	647.6 5	80 9	D+Q	
	1175.9 4	100 10	Q	
10057.6	897			
	1178			
10154.6	994.1 5	100	E2	
10664.6	713.6 5	100 9	D+Q	
	1362 1	35 6		
10871	4780 5	100	Q	
11183	3697 4	100	D+Q	
11261?	5170 [#] 4	100		
11368	5278 [§] 5	100	Q	
11505.4	840.7 [§] 6	92 7	D+Q	
	1446 2	19 7		
	1555 1	100 11	Q	
11770	4284 4	100	Q	
12232	4745 5	100		
12469.1	963.6 6	100 7		
	1805 2	87 9	Q	
12537	3500 4	100 29		

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Adopted Levels, Gammas (continued) $\gamma(^{61}\text{Zn})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]
12537	5050 5	71 29	Q	16230	1024 1	67 11	
12665	3505§ 3	100	Q		2086 2	100 17	(Q)
12725.7	2571 2	100	D+Q		2169 3	44 11	(Q)
12761	3600 4	100	Q	16280	1849 2	100	Q
12802	1434 1	100 19	Q	16438	2113 2	100	Q
	1542§# 2	29 18	(Q)	17119	1020# 1	50 25	
	4305 5	53 12	Q		1895 2	100 20	
	5314 5	23 12	Q	17126	2309 3	100	
12865	3704# 4	100		17310	1080# 1	14 10	
13210	3055 3	100	D		2104 2	100 12	Q
13264	1736# 2			17455	1980 2	100	Q
	3109# 4	100	(D)	17610	2045 2	100	Q
13319.3	850§ 1	56 11	D+Q	17987	2248 2	100	Q
	1814 2	100 13	Q	18196	2097 2	100	Q
	3165 3	24 6		18363	2083 2	100	Q
13664	1622 2	100		18471	2241 2	100	
13882	1345 1	100	Q	19149	2711 3	100	Q
13886	1549 2	100 10	Q	19270	2151 2	100	
	3731 3	18 5	D+Q	19653	2198 2	100	Q
14072	3917 4	100	Q	19690	2380 2	100	
14114	3959 4	100	D	19773	2647 3	100	
14299.5	980 1	53 13		20060	2450 3	100	Q
	1831 2	100 13	Q	20531	2335 2	100	Q
14325	1660 2	100 26		20642	2655 3	100	Q
	4170 4	63 16	Q	20674	2311 2	100	Q
14431	1629 2	100 17	Q	20999	2528 3	100	
	1702# 2	11 6		21745	2475 3	100	
	2199 2	8 4		22239	2586 3	100	
14433	5272 6	100	Q	22397	2707 3	100	
14449	4294 4	100	Q	22584	3435 3	100	
14769	4614 5	100		22901	3128 4	100	
14817	1952 2	100 37		22965	2905 3	100	Q
	4662 5	100 37		23180	2649 3	100	Q
15020	4865 5	100	D+Q	23222	2548 3	100	Q
15206	1942 2	100	Q	23856	2857 3	100	
15224	4559# 5	100		23900	3258 3	100	Q
15261.3	1942 2	100		24604	2859 3	100	
15293	5138 5	100		25280?	3041# 4	100	
15475	1811 2	100		25449?	3052# 4	100	
15565	1683 2	100	Q	26042	2820 3	100	Q
15739	1853 2	100	Q	26220	3040 3	100	Q
16099	875 1	100 40		26696	3731 4	100	
	4593 5	70 30		27084?	3228# 4	100	
16230	755 1	50 17		29171	3129 3	100	Q

[†] Primarily From $^{28}\text{Si}(^{36}\text{Ar}, 2\text{pny})$ (2009An01) and/or $^{40}\text{Ca}(^{24}\text{Mg}, 2\text{pny})$ (2006An31), where in-beam γ -ray data are most comprehensive.

For low-lying levels (below 2.5 MeV), energy and intensity data from $(\alpha, \text{n}\gamma)$ (1984Th07, 1982Sm01) are also considered in the averaging procedure. Exceptions are noted.

[‡] From $\gamma\gamma(\theta)$ and $\gamma(\text{lin pol})$ data in high-spin studies.

§ Doublet structure.

Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas (continued)

Adopted Levels, Gammas (continued)

 (E) Band based on (21/2-), $\alpha=+1/2$.

 (F) Band based on (23/2-),
 $\alpha=-1/2$.

 (G) Band based on 3/2-,
 $\alpha=+1/2$.

 $^{61}_{30}\text{Zn}_{31}$

Adopted Levels, Gammas (continued)

 (H) Band based on $3/2-, \alpha=-1/2$.

 (I) Band based on $1/2-, \alpha=+1/2$.

 (J) Band based on $1/2-, \alpha=-1/2$.

 (K) Band based on $11/2+$.

Adopted Levels, Gammas (continued)

(L) Band based on 9/2+.

 (M) Band based on 21/2-,
 $\alpha=+1/2$.

 (N) Band based on 23/2-,
 $\alpha=-1/2$.

 $^{61}_{30}\text{Zn}_{31}$

Adopted Levels, Gammas (continued)

Adopted Levels, Gammas (continued)

 (S) SD-5 band, $\alpha=+1/2$.

 (T) SD-6 band, $\alpha=-1/2$.

^{61}Ga ϵ Decay (167 ms) 1999Oi01,2002We07

Parent ^{61}Ga : $E=0.0$; $J\pi=3/2^-$; $T_{1/2}=167$ ms 3; $Q(\text{g.s.})=9210$ 40; $\% \epsilon + \% \beta^+$ decay=100.

$^{61}\text{Ga}-J, T_{1/2}$: From ^{61}Ga Adopted Levels.

$^{61}\text{Ga}-Q(\epsilon)$: From 2012Wa38.

1999Oi01: ^{61}Ga source produced in fusion-evaporation reaction using a 121-MeV ^{36}Ar beam from the heavy-ion accelerator UNILAC at GSI and 1.9 mg/cm² natural Si-target. Evaporation residues were stopped in FEBIAD-B2-C ion source and mass separated by on-line mass separator. Using two Ge detectors, cylindrical plastic scintillator for detection positrons and 2 mm thick plastic scintillator in front of Ge detectors. Measured β -gated γ spectrum, $E\gamma$, $I\gamma$, $I\beta$, $\gamma(t)$, $\beta(t)$.

2002We07: isotopes were produced in spallation reactions induced by a pulsed beam of 1.4 GeV protons from the CERN PS-booster and impinging on a zirconium oxide target (8 g/cm² of Zr). Ionization of Ga atoms was performed using the Resonance Ionization Laser Ion Source (RILIS). Ions are accelerated by a 60 kV voltage and mass separated using the high-resolution mass separator (HRS). Measured $\beta(t)$, $\beta\gamma$ coin, half-life, deduced $Q(\epsilon)$ and $S(p)$. Beta Gamow-Teller strength calculations in large-scale shell-model using the Strasbourg code ANTOINE and the effective interaction KB3G.

Others:

2014Rol4: measured half-life of ^{61}Ga g.s.

1993Wi18: Using the A1200 (achromatic projectile fragment separator) radioactive beam facility at the NSCL of Michigan State University. The radioactive isotopes was produced by fragmentation of $E=75$ MeV/nucleon ^{78}Kr beam by 98% enriched ^{58}Ni target a thin (3 mg/cm²) aluminum backing. Using Si detector telescope and β segmented plastic scintillator, measured half-life.

From RADLIST code, deduced total decay energy is 9236 keV 98 agrees with 9210 keV 40 from $Q(\epsilon)$ value.

 ^{61}Zn Levels

Note that in 1999-NDS (1999Bh04), 88.2, 418.3, and 756.0 levels were erroneously assigned half-lives of <430 ms, 0.14 s 7 and <130 ms, respectively. These half-lives in 1999Oi01 simply refer to the half-life of the decaying ^{61}Ga isotope.

$E(\text{level})^\dagger$	$J\pi^\ddagger$
0.0	3/2-
88.2 7	1/2-
123.3 7	5/2-
418.3 6	3/2-
756.0 7	5/2-
938.2 7	1/2-
1362.0? 10	

† From a least-squares fit to the $E\gamma$ data.

‡ From Adopted Levels.

 β^+, ϵ Data

Experimental and theoretical Gamow-Teller (B(GT)) strengths listed here are from 2002We07.

$E\epsilon$	$E(\text{level})$	$I\beta^+^\dagger$	$I\epsilon^\dagger$	$\text{Log } ft$	$I(\epsilon+\beta^+)^\dagger$	Comments
(7850 ‡ 40)	1362.0?	≤ 0.010	$\leq 2 \times 10^{-5}$	≥ 7.3	≤ 0.01	
(8270 40)	938.2	0.68 18	0.0012 3	5.6	0.68 18	$(B(GT))_{\text{exp}}=0.2$ 1 $(B(GT))_{\text{theor}}=0.18$.
(8450 40)	756.0	0.86 24	0.0015 4	5.5	0.86 24	$(B(GT))_{\text{exp}}=0.02$ 1 $(B(GT))_{\text{theor}}=0.00033$.
(8790 40)	418.3	1.3 4	0.0019 6	5.4	1.3 4	$(B(GT))_{\text{exp}}=0.02$ 1 $(B(GT))_{\text{theor}}=0.0034$.
(9090 40)	123.3	1.2 4	0.0016 5	5.5	1.2 4	$(B(GT))_{\text{exp}}=0.02$ 1 $(B(GT))_{\text{theor}}=0.0012$.
(9120 40)	88.2	1.9 6	0.0025 8	5.4	1.9 6	$(B(GT))_{\text{exp}}=0.04$ 1 $(B(GT))_{\text{theor}}=0.0068$.
(9210 40)	0.0	93.9 10	0.120 2	3.7	94.0 10	$(B(GT))_{\text{exp}}=0.28$ 7 $(B(GT))_{\text{theor}}=0.35$.

† Absolute intensity per 100 decays.

‡ Existence of this branch is questionable.

 $\gamma(^{61}\text{Zn})$

$I\gamma$ normalization: Summed transition intensity=6 1, based on level scheme of 2002We07 with $I(\epsilon+\beta^+)(\text{g.s.})=94.0\%$ 10 and upper limit for the delayed proton emission probability of 0.25% (2002We07).

$E\gamma^\dagger$	$E(\text{level})$	$I\gamma^\dagger@$	Mult.#	$\delta^\#$	α	Comments
87.6 ‡ 10	88.2	100 16	(M1+E2)	≈ 0.2	0.126 21	α : assuming 25% uncertainty on $\delta(E2/M1)$. δ : 2002We07 suggest $\delta=0.2$ or 3.8 based on $A_2=-0.03$ 3 for the 88 γ in $\gamma(\theta)$ data from 1982Sm01. Lower value

Continued on next page (footnotes at end of table)

⁶¹Ga ε Decay (167 ms) 1999Oi01,2002We07 (continued)

 $\gamma(^{61}\text{Zn})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger@$	Mult.#	$\delta^\#$	α	Comments
						is adopted here, higher value will suggest a long lifetime for the level. δ: from Adopted Gammas.
122.9 [‡] 10	123.3	62 11	M1+E2	-0.05 2	0.0352 8	
295.5 ^{§&}	418.3	≤2 [§]	(M1+E2)	-0.44 37	0.0051 19	
330	418.3	4 1	(M1+E2)	+0.27 13	0.0032 4	
337.5 ^{§&}	756.0	≤2 [§]				
418.4 [‡] 8	418.3	72 12	M1+E2	-0.10 5		
520	938.2	9 2				
633 ^{§&}	756.0	≤1 [§]				
754.5 [‡] 12	756.0	44 8	M1+E2	-0.07 4		
850	938.2	6 2				
938	938.2	21 4				
1362 ^{§&}	1362.0?	≤0.5 [§]				

[†] From 2002We07 unless otherwise stated.

[‡] From 1999Oi01. The corresponding value in 2002We07 is given without uncertainty.

[§] 2002We07 quote energy from high-spin studies by 1982Sm01 and 1984Th07. This γ not observed in 2002We07, only an upper limit of intensity is given.

[#] From Adopted Gammas.

[@] For absolute intensity per 100 decays, multiply by 0.019 4.

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

Decay Scheme

Intensities: I(γ +e) per 100 parent decays

3/2- 0.0 167 ms
⁶¹Ga₃₀
 $\%e+\%\beta^+=100$
 $Q^+=9210^{40}$

28Si(36Ar,2pnγ) 2009An01

2009An01: E=142, 148 MeV beam provided by ATLAS-ANL facility. Measured E γ , I γ , $\gamma\gamma$, (particle) γ coin, angular distributions using GAMMASPHERE array of Ge detectors. The charged particles were detected using Microball array and ΔE -E telescopes. Comparisons with cranked Nilsson-Strutinsky calculations. See also 2006An31 from the same group using $^{40}\text{Ca}(^{24}\text{Mg},2\text{pn}\gamma)$ reaction. See also dataset for this reaction.

1999Yu10: E=143 MeV; also $^{40}\text{Ca}(^{29}\text{Si},2\alpha\gamma)$ E=130 MeV. Measured E γ , I γ , $\gamma\gamma$, particle- γ coin, $\gamma\gamma(\theta)$ (DCO) using GAMMASPHERE array of 82 and 100 Compton-suppressed Ge detectors and 95-element CsI Microball. Deduced SD-1 band and interconnecting transitions of 5172 and 5278 keV to normal band. Interband transition of 5278 keV is confirmed in 2009An01.

Level scheme below 8500-keV level shown in figure 1 of 2009An01 is taken from their previous work reported in 2006An31, which used $^{40}\text{Ca}(^{24}\text{Mg},2\text{pn}\gamma)$ reaction.

61Zn Levels

Nomenclature for configuration assignments is $[p_1p_2, n_1n_2]$, where p_1 and n_1 denote number of proton or neutron holes in the orbitals of high-j $1f_{7/2}$ shell; p_2 and n_2 denote the number of (proton or neutron) particles in the high-j $1g_{9/2}$ shell, relative to the closed ^{56}Ni core. Active orbitals for protons and neutrons are: $1f_{7/2}$, $1g_{9/2}$, $1f_{5/2}$, $2p_{3/2}$ and $2p_{1/2}$; the number of particles in the last three orbitals are denoted as p_3 or n_3 .

E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$
0.0 ^d	3/2-	10057.1 ⁱ 13	29/2-	15564 [§] 5	(37/2+)
88.77 ^e 9	1/2-	10154.2 ^j 13	31/2-	15738 ^{&} 4	(37/2-)
123.94 ^c 9	5/2-	10664.3 ^a 13	29/2-	16098 ^p 4	(35/2-)
419.42 ^f 10	3/2-	10870 6	(25/2+)	16229 ^m 5	(39/2-)
755.68 ^e 15	5/2-	11183 5	27/2+	16279 ^k 4	37/2+
997.07 ^d 16	7/2-	11260? 5	25/2+	16438 [@] 4	39/2-
1265.4 ^c 6	9/2-	11367 ^k 3	25/2+	17118 ^o 5	(37/2-)
1403.0 ^f 3	7/2-	11505.1 ^b 13	31/2-	17125 [#] 5	(39/2-)
2002.8 ^e 6	9/2-	11527? ^l 5	(29/2-)	17309 ^l 5	(41/2-)
2269.0 ^d 6	11/2-	11770 5	(29/2+)	17454 ⁿ 6	(41/2-)
2398.5 ^h 6	9/2+	12041 ⁿ 6	(29/2-)	17609 [§] 5	(41/2+)
2698.9 ^f 6	11/2-	12231 4	29/2+	17986 ^{&} 5	(41/2-)
2798.0 ^c 7	13/2-	12336 ^{&} 4	(29/2-)	18195 ^p 5	(39/2-)
3243.8 ^g 9	11/2+	12468.7 ^a 14	33/2-	18362 ^k 5	41/2+
3335.2 ^h 7	13/2+	12536 [§] 4	(29/2+)	18470 ^m 6	(43/2-)
3460.9 ^e 9	13/2-	12665 [@] 3	31/2-	19149 [@] 5	43/2-
3494.4 12		12725.2 24	33/2(-)	19269 ^o 5	(41/2-)
3843.1 ^d 9	15/2-	12760 5	(31/2-)	19652 ⁿ 6	(45/2-)
4263.2 ^g 8	15/2+	12801 ^k 3	29/2+	19689 ^l 6	(45/2-)
4308.1 12	13/2	12864 [#] 4	(31/2-)	19772 [#] 6	(43/2-)
4414.2 ^h 9	17/2+	13209 4	33/2	20059 [§] 6	(45/2+)
4643.7 ^c 9	17/2-	13263 ^l 5	(33/2-)	20530 ^p 5	(43/2-)
4914.0 12		13319.0 ^b 15	35/2-	20641 ^{&} 6	(45/2-)
5194.5 ^e 10	17/2-	13663 ⁿ 6	(33/2-)	20673 ^k 5	45/2+
5253.7 9		13881 [§] 4	(33/2+)	20998 ^m 6	(47/2-)
5467.2 13		13885 ^{&} 4	(33/2-)	21744 ^o 6	(45/2-)
5542.4 ^d 9	19/2-	14060 6	(35/2-)	22238 ⁿ 7	(49/2-)
5551.8 ^g 9	19/2+	14071 5	35/2-	22396 ^l 7	(49/2-)
6089.8 ^h 13	21/2+	14113 5	33/2	22584 [@] 6	(47/2-)
6211.2 11		14143 ^m 6	(35/2-)	22900 [#] 7	(47/2-)
7283.2 ^l 10	21/2-	14299.1 ^a 17	37/2-	22964 [§] 7	(49/2+)
7295.7 ^g 11	23/2+	14325 [@] 3	35/2-	23180 ^p 6	(47/2-)
7485.8 16	25/2+	14430 ^k 4	33/2+	23221 ^k 6	49/2+
7628.0 ^j 10	23/2-	14432 7	31/2-	23855 ^m 7	(51/2-)
8334.9 ^a 12	21/2-	14448 5	35/2-	23900 ^{&} 6	(49/2-)
8495.6 13	25/2+	14768 6		24604 ^o 7	(49/2-)
8774.8 ^b 12	23/2-	14816 [#] 4	(35/2-)	25280? ⁿ 8	(53/2-)
8878.7 ⁱ 13	25/2-	15019 6	33/2-	25449? ^l 8	(53/2-)
9036.0? 22		15205 ^l 5	(37/2-)	26041 ^k 7	53/2+
9160.1 ^j 13	27/2-	15223 ^o 4	(33/2-)	26220 ^p 7	(51/2-)
9302.8 ^a 12	25/2-	15261.0 ^b 25	39/2-	26695 [§] 8	(53/2+)
9366.9 12	25/2-	15292 6		27084? ^m 8	(55/2-)
9950.5 ^b 12	27/2-	15474 ⁿ 5	(37/2-)	29170 ^k 7	57/2+

[†] From least-squares fit to E γ data.

[‡] As proposed in 2009An01 and 2006An31 based on $\gamma\gamma(\theta)$ data for selected transitions and band associations. See also Adopted Levels for recommended values.

[§] (A): Band based on (29/2+). Configuration=[22,01].

28Si(36Ar,2pnγ) 2009An01 (continued)**61Zn Levels (continued)**

- # (B): Band based on (31/2-), 12864. Configuration=[21,11] or [11,11]. Population intensity=1%.
 @ (C): Band based on 31/2-, 12665. Configuration=[21,01] or [11,11].
 & (D): Band based on (29/2-). Configuration=[11,12].
 a (E): Band based on 21/2-, α=+1/2. Configuration=[11,01].
 b (F): Band based on 23/2-, α=-1/2. Configuration=[11,01].
 c (G): Band based on 3/2-, α=+1/2. Configuration=[00,00].
 d (H): Band based on 3/2-, α=-1/2. Configuration=[00,00].
 e (I): Band based on 1/2-, α=+1/2.
 f (J): Band based on 1/2-, α=-1/2.
 g (K): Band based on 11/2+. Configuration=[01,00].
 h (L): Band based on 9/2+. Configuration=[00,01].
 i (M): Band based on 21/2-, α=+1/2. Configuration=[01,01].
 j (N): Band based on 23/2-, α=-1/2. Configuration=[01,01].
 k (O): SD-1 band, α=+1/2. Configuration=[22,23]. Population intensity=5%.
 l (P): SD-2 band, α=+1/2. Configuration=[22,22]. Population intensity=2%.
 m (Q): SD-3 band, α=-1/2. Configuration=[22,22] or [22,12]. Population intensity=2%.
 n (R): SD-4 band, α=+1/2. Configuration=[22,22] or [22,12]. Population intensity=2%.
 o (S): SD-5 band, α=+1/2. Configuration=[11,23]. Population intensity=0.7%.
 p (T): SD-6 band, α=-1/2. Configuration=[11,23]. Population intensity=0.7%.

γ(61Zn)

R(30°-83°) is angular asymmetry ratio: expected ratio is ≈1.6-1.7 for ΔJ=2, quadrupole and ≈0.7-0.8 for ΔJ=1, dipole transition.

Eγ [†]	E(level)	I _γ	Mult. [‡]	Comments
88.9 1	88.77			
123.9 1	123.94	100		
241.4 1	997.07			
295.5 1	419.42			
331.3 2	419.42			Eγ: level-energy difference=330.6.
338	755.68			Eγ: from figure 1 of 2009An01.
344.8 2	7628.0			
419.1 2	419.42			
439.9 4	8774.8	3.0 5	D+Q	R(30°-83°)=0.98 11.
528.0 6	9302.8	2.9 4		
529.4 3	2798.0			
578.2 3	997.07			
583.3 6	9950.5	7.8 6	D+Q	R(30°-83°)=1.00 10.
592.0 4	9366.9	1.9 3		
631.7 3	755.68			
647.1 3	1403.0			
647.6 5	9950.5	6.3 7	D+Q	R(30°-83°)=0.93 11.
666.6 3	755.68			
696.2 3	2698.9			
713.6 5	10664.3	11 1	D+Q	R(30°-83°)=0.99 9.
737.6 4	2002.8			
755 1	16229	0.9 3		
755.7 4	755.68			
839.2 4	5253.7			
840.7 6	11505.1	6.6 5	D+Q	R(30°-83°)=0.95 8, for doublet structure.
850 1	13319.0	2.6 5	D+Q	R(30°-83°)=0.95 8, for doublet structure.
868 1	8495.6	0.8 2		
872.7 4	997.07			
875 1	16098	1.0 4		
897	10057.1			Eγ: from figure 1 of 2009An01.
898.9 4	5542.4			
908.3 5	5551.8			
936.7 5	3335.2			
963.6 6	12468.7	5.5 4		
968 1	9302.8	1.0 2		
980 1	14299.1	2.0 5		
984.3 5	1403.0			
990.9 5	5253.7			
994.1 5	10154.2			Eγ: from 2006An31.

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$^{28}\text{Si}(^{36}\text{Ar}, 2\text{pn}\gamma)$ 2009An01 (continued) $\gamma(^{61}\text{Zn})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma$	Mult. ‡	Comments
996.7 5	997.07			
997.0 § 5	2398.5			
1005 1	2269.0			
1006 1	2002.8			
1019 1	4263.2			
1020 § 1	17118	1.0 5		
1024 1	16229	1.2 2		
1039 1	8334.9	1.8 4		
1046 1	3843.1			
1066 1	3335.2			
1079 1	4414.2			
1080 § 1	17309	0.7 5		
1141 1	1265.4			
1175.9 4	9950.5	7.9 8	Q	R(30°-83°)=1.60 20.
1178	10057.1			E γ : from figure 1 of 2009An01.
1198 2	8495.6	1.5 4		
1246 1	2002.8			
1273 1	2269.0			
1278 1	1403.0			
1289 1	5551.8			
1345 1	13881	1.2 4	Q	R(30°-83°)=1.41 25.
1362 1	10664.3	3.8 6		
1396 1	7485.8			
1403 1	1403.0			
	2398.5			
1408 2	9036.0?	0.6 3		
1433 1	2698.9			
1434 1	12801	1.7 5	Q	R(30°-83°)=1.45 18.
1446 2	11505.1	1.4 5		
1458 1	3460.9			
1466 1	4263.2			
1531 1	2798.0			
1532 1	9160.1			E γ : from 2006An31.
1538 1	7628.0			
1542 § 2	12801	0.5 3	(Q)	R(30°-83°)=1.44 16, for doublet structure.
1549 2	13885	6.0 6	Q	R(30°-83°)=1.41 12.
1555 1	11505.1	7.2 8	Q	R(30°-83°)=1.41 12.
1572 1	3843.1			E γ : level-energy difference=1574.
1595 1	8878.7			E γ : from 2006An31.
1622 2	13663	3.1 5		
1624 1	5467.2			
1629 2	14430	4.7 8	Q	R(30°-83°)=1.35 11.
1660 2	14325	1.9 5		
1675 3	6089.8			
1675 4	9160.1			E γ : from 2006An31.
1676 2	9302.8	2.8 7	D+Q	R(30°-83°)=1.07 10.
1683 2	15564	4.0 5	Q	R(30°-83°)=1.29 10.
1698 1	5542.4			
1702 § 2	14430	0.5 3		
1733 1	5194.5			
	7283.2			
1736 § 2	13263			
1743 1	7295.7			
1799 1	6211.2			
1805 2	12468.7	4.8 5	Q	R(30°-83°)=1.37 14.
1811 2	15474	3.2 5		
1814 2	13319.0	4.6 6	Q	R(30°-83°)=1.42 10.
1831 2	14299.1	3.8 5	Q	R(30°-83°)=1.30 17.
1847 1	4643.7			
1849 2	16279	5.5 5	Q	R(30°-83°)=1.68 13.
1853 2	15738	6.5 7	Q	R(30°-83°)=1.30 12.
1895 2	17118	2.0 4		
1942 2	15205	3.0 6	Q	R(30°-83°)=1.30 21.

Continued on next page (footnotes at end of table)

$^{28}\text{Si}(^{36}\text{Ar}, 2\text{pn}\gamma)$ 2009An01 (continued) $\gamma(^{61}\text{Zn})$ (continued)

$E\gamma^{\dagger}$	E(level)	I_{γ}	Mult. ‡	Comments
1942 2	15261.0	2.4 6		
1946 1	6211.2			
1952 2	14816	0.8 3		
1978 1	3243.8			
1980 2	17454	2.9 4	Q	R(30°-83°)=1.35 25.
2006 2	9302.8	3.4 6	D	R(30°-83°)=0.94 11.
2039 1	4308.1			
2045 2	17609	4.3 5	Q	R(30°-83°)=1.75 15.
2071 2	9366.9	1.7 6	D	R(30°-83°)=1.18 20.
2083 2	18362	5.3 5	Q	R(30°-83°)=1.76 14.
2086 2	16229	1.8 3	(Q)	R(30°-83°)=1.3 4.
2088 1	7283.2			
2097 2	18195	3.0 7	Q	R(30°-83°)=1.7 3.
2104 2	17309	5.1 6	Q	R(30°-83°)=1.28 16.
2113 2	16438	2.5 5	Q	R(30°-83°)=1.9 3.
2116 1	4914.0			
2151 2	19269	2.5 5		
2169 3	16229	0.8 2	(Q)	R(30°-83°)=1.2 4.
2195 1	3460.9			
2198 2	19652	2.4 4	Q	R(30°-83°)=1.36 23.
2199 2	14430	0.4 2		
2229 1	3494.4			
2241 2	18470	3.8 7		
2246 $\S$ 2	8334.9	0.8 4		
2248 2	17986	6.4 8	Q	R(30°-83°)=1.52 17.
2273 1	2398.5			
2309 3	17125	1.2 2		
2311 2	20673	4.3 5	Q	R(30°-83°)=1.56 13.
2335 2	20530	2.0 4	Q	R(30°-83°)=1.8 3.
2380 2	19689	3.7 4		
2450 3	20059	3.8 4	Q	R(30°-83°)=1.21 12.
2475 3	21744	1.8 4		
2528 3	20998	2.9 4		
2548 3	23221	3.8 4	Q	R(30°-83°)=1.24 11.
2571 2	12725.2	3.3 4	D+Q	R(30°-83°)=0.59 8.
2586 3	22238	1.0 3		
2639 1	7283.2			
2647 3	19772	0.8 2		
2649 3	23180	1.5 5	Q	R(30°-83°)=1.5 3.
2655 3	20641	3.9 5	Q	R(30°-83°)=1.48 16.
2707 3	22396	2.1 4		
2711 3	19149	1.4 3	Q	R(30°-83°)=1.8 4.
2785 2	8334.9	0.6 3		
2820 3	26041	1.7 3	Q	R(30°-83°)=1.50 19.
2857 3	23855	1.1 4		
2859 3	24604	0.5 2		
2905 3	22964	3.0 4	Q	R(30°-83°)=1.37 17.
3040 3	26220	0.7 2	Q	R(30°-83°)=1.6 7.
3041 $\S$ 4	25280?	0.3 1		
3052 $\S$ 4	25449?	0.6 3		
3055 3	13209	1.5 4	D	R(30°-83°)=0.68 15. Mult.: $\Delta J=1$ transition.
3109 $\S$ 4	13263	0.6 3	(D)	R(30°-83°)=1.0 5.
3128 4	22900	0.5 1		
3129 3	29170	0.4 2	Q	R(30°-83°)=1.4 4.
3142 3	8334.9	0.8 3		
3165 3	13319.0	1.1 3		
3228 $\S$ 4	27084?	0.3 1		
3258 3	23900	1.5 5	Q	R(30°-83°)=1.5 4.
3435 3	22584	0.5 2		
3500 4	12536	0.7 2		
3505 3	12665	2.2 3	Q	R(30°-83°)=1.6 3, for doublet structure.
3600 4	12760	0.8 3	Q	R(30°-83°)=2.1 7.

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²⁸Si(³⁶Ar,2pn γ) 2009An01 (continued)

 $\gamma(^{61}\text{Zn})$ (continued)

$E\gamma^\dagger$	E(level)	I_γ	Mult. [‡]	Comments
3691 3	8334.9	2.1 5	Q	R(30°-83°)=1.3 4.
3697 4	11183	1.2 3	D+Q	R(30°-83°)=0.99 15.
3704 § 4	12864	0.1 1		
3731 3	13885	1.1 3	D+Q	R(30°-83°)=1.32 19.
3731 4	26695	0.6 2		
3917 4	14071	2.3 4	Q	R(30°-83°)=1.46 18.
3959 4	14113	0.6 3	D	R(30°-83°)=0.9 3.
				Mult.: $\Delta J=1$ transition.
4170 4	14325	1.2 3	Q	R(30°-83°)=1.42 22.
4284 4	11770	0.8 2	Q	R(30°-83°)=1.3 3.
4294 4	14448	0.8 3	Q	R(30°-83°)=1.56 23.
4305 5	12801	0.9 2	Q	R(30°-83°)=1.4 3.
4559 § 5	15223	0.4 2		
4593 5	16098	0.7 3		
4614 5	14768	0.7 2		
4662 5	14816	0.8 3		
4745 5	12231	0.9 3		
4780 5	10870	1.1 3	Q	R(30°-83°)=2.0 6.
4865 5	15019	0.7 3	D+Q	R(30°-83°)=0.9 3.
5050 5	12536	0.5 2	Q	R(30°-83°)=1.5 4.
5138 5	15292	0.6 2		
5170 § 4	11260?	0.7 2		
5272 6	14432	0.3 2	Q	R(30°-83°)=1.4 3 for doublet structure.
5278 5	11367	1.2 3	Q	R(30°-83°)=1.32 23, for doublet structure.
5314 5	12801	0.4 2	Q	R(30°-83°)=1.32 23.

[†] From 2006An31 for transitions from levels up to 8500 keV, all others are from 2009An01.

[‡] From $\gamma\gamma(\theta)$ data. The $\Delta J=2$, quadrupole transitions, multipolarity is most likely E2, and for interband transitions, $\Delta J=1,0$, D+Q is most likely M1+E2.

§ Placement of transition in the level scheme is uncertain.

⁴⁰Ca(²⁴Mg,2pn γ) 2006An31

2006An31 (also 2005An03,2005Ek01): E=104 MeV. Measured $E\gamma$, $\gamma\gamma$, I_γ , $\gamma(\theta)$ using the CLARION Ge detector array, and the Recoil Mass Spectrometer (RMS). The CLARION array was comprised of ten Ge Clover detectors placed in a three ring configuration at 90°, 132°, and 154° with respect to the beam direction. Comparison of experimental and theoretical branching ratios are given in Table 2 of 2006An31 and levels in Fig.6. using large-scale shell-model calculations (code ANTOINE with GXPF1).

2004Iz01: E=96 MeV ⁴⁰Ca beam provided by LNL Tandem accelerator, bombarding a ²⁴Mg target. Measured $E\gamma$, I_γ , $\gamma\gamma$, $\gamma\gamma(\theta)$ (DCO), $\gamma\gamma$ (lin pol) with the EUROBALL Ge-detector array consisting of 26 Clover detectors and 15 Cluster detectors. Evaporated charged particles were detected in the 40-element silicon ΔE -E array ISIS. A total of 27 γ rays are assigned in a level scheme up to 31/2. The level scheme is in agreement with that from 2006An31.

1999Vi12: E=65 MeV. Measured $E\gamma$, $\gamma\gamma$, I_γ (singles and $\gamma\gamma$), and $\gamma\gamma(\theta)$ (DCO) using the AYEBALL array with TESSA type detectors, eight EUROGAM detectors and one GAMMASPHERE detector. A total of 23 γ transitions were reported. There is disagreement in parity assignment for bands based on 124 level, as compared to results in 2006An31 and 2004Iz01. Also 1403-keV γ is a doublet, whereas only a single line is shown in 1999Vi12.

⁶¹Zn Levels

$E(\text{level})^\dagger$	$J\pi$	$T_{1/2}$	Comments
0.0 d	3/2-		
88.79 # 9	1/2-§		
123.90 e 8	5/2-‡	≈ 5.5 ns	$T_{1/2}$: γ -intensity balance at 124 level suggests that this level is long-lived, estimated mean lifetime ≈ 8 ns (2006An31).
419.19 @ 10	3/2-§		
756.44 # 13	5/2-§		
997.68 d 15	7/2-‡		
1266.0 e 5	9/2-‡		
1403.3 @ 3	7/2-§		

Continued on next page (footnotes at end of table)

$^{40}\text{Ca}(^{24}\text{Mg}, 2\text{pn}\gamma)$ 2006An31 (continued) ^{61}Zn Levels (continued)

E(level) [†]	J π	Comments
2003.4 [#] 5	9/2- [§]	
2269.7 ^d 6	11/2- [‡]	
2399.7 ^{&} 4	9/2+ [‡]	J=9/2- quoted in 1999Vi12.
2699.5 [@] 6	11/2-	
2798.7 ^e 6	13/2- [‡]	
3244.5 ^a 9	11/2+ [‡]	E(level),J π : from Fig. 3 (2004Iz01). (13/2-) quoted in 1999Vi12.
3336.2 ^{&} 6	13/2+ [‡]	J π : 13/2- quoted in 1999Vi12.
3461.6 [#] 8	13/2-	
3495.0 11		
3843.8 ^d 8	15/2- [‡]	E(level),J π : from Fig. 3 (2004Iz01).
4264.0 ^a 8	15/2+ [‡]	
4308.8 12	13/2	
4415.0 ^{&} 8	17/2+ [‡]	J=17/2- quoted in 1999Vi12.
4644.3 ^e 8	17/2- [‡]	
4914.7 12		
5195.3 [#] 10	17/2-	
5254.5 8		
5467.8 13		
5543.0 ^d 9	19/2- [‡]	E(level),J π : from Fig. 3 (2004Iz01).
5552.4 ^a 8	19/2+ [‡]	
6090.7 ^{&} 13	21/2+ [‡]	J π : (21/2-) quoted in 1999Vi12.
6212.0 10		
7284.0 ^c 9	21/2-	
7295.4 ^a 13	23/2+ [‡]	E(level),J π : from Fig. 3 (2004Iz01).
7486.6 ^{&} 16	25/2+ [‡]	
7628.8 ^b 10	23/2- [‡]	
8336.7 16		
8496.5 [?] ^a 16		
8777.3 16		
8879.0 ^c 14	25/2-	
9160.9 ^b 14	27/2- [‡]	
10155.0 ^b 15	31/2- [‡]	

[†] From least-squares fit to E γ data.[‡] Assignment from 2004Iz01.[§] Assignment supported in Adopted Levels.[#] (A): 1/2- band.[@] (B): 3/2- band.[&] (C): 9/2+ band.^a (D): 11/2+ band.^b (E): 23/2- band.^c (F): 21/2- band.^d (G): 3/2- band.^e (H): 5/2- band. $\gamma(^{61}\text{Zn})$

$R_{\text{DCO}} = [(I(158^\circ) \text{ gated at } I(79^\circ, 101^\circ, 134^\circ)) / (I(79^\circ, 101^\circ, 134^\circ) \text{ gated at } I(158^\circ))] \times \epsilon$, where I is the number of counts in a peak and ϵ is an efficiency multiplication factor (1999Vi12).

$R_{\text{DCO}} = I(\gamma_1 \text{ at } 156^\circ; \text{ gated with } \gamma_2 \text{ at } 77^\circ, 103^\circ) / I(\gamma_1 \text{ at } 77^\circ, 103^\circ; \text{ gated with } \gamma_2 \text{ at } 156^\circ)$, CLOVER detectors at 77° and 103° are equivalent as far as DCO ratios are concerned. Known stretched E2 transitions were used for gating, such the $R_{\text{DCO}}=1.0$ is expected for stretched quadrupole transitions and $R_{\text{DCO}}=0.6$ for stretched dipoles, $\Delta J=0$ transitions have values similar to stretched quadrupole transitions (2004Iz01).

$\text{POL} = [a\text{N}(\text{perpendicular}) - \text{N}(\text{parallel})] / [a\text{N}(\text{perpendicular}) + \text{N}(\text{parallel})]$, where $a(E\gamma)$ =normalization function determined from the ^{152}Eu source calibration. POL takes positive values for pure stretched electrical radiation and negative values for pure stretched magnetic radiation (2004Iz01).

$R_{154^\circ, 96^\circ} = \text{Yield at } 154^\circ / \text{Yield at } 96^\circ$. Typical values are 1.6–1.7 for $\Delta J=2$, quadrupole transitions and 0.7–0.8 for $\Delta J=1$, dipole transitions (2006An31).

E γ [†]	E(level)	I γ [†]	Mult.	Comments
88.9 1	88.79	3.0 1	(D)	$R_{154^\circ, 96^\circ}=1.08 \pm 7$.

Continued on next page (footnotes at end of table)

$^{40}\text{Ca}(^{24}\text{Mg}, 2\text{pn}\gamma)$ 2006An31 (continued) $\gamma(^{61}\text{Zn})$ (continued)

$E_{\gamma}^{\dagger}$	E(level)	$I_{\gamma}^{\dagger}$	Mult.	Comments
123.9 1	123.90	100 3	(M1+E2)	$R_{154^{\circ}, 96^{\circ}}=0.55$; corrected for the estimated level lifetime. $R_{\text{DCO}}=0.38$ 3 (2004Iz01), 0.82 7 (1999Vi12).
241.4 1	997.68	0.5 1		$R_{154^{\circ}, 96^{\circ}}=1.6$ 3.
295.5 1	419.19	0.6 1		E γ : poor fit, level-energy difference=330.7.
331.3 2	419.19	1.2 1	(D)	$R_{154^{\circ}, 96^{\circ}}=0.97$ 16.
339.0 2	756.44	0.9 1		E γ : poor fit, level-energy difference=336.3. This γ not used in the fitting procedure.
344.8 2	7628.8	0.3 1		$R_{154^{\circ}, 96^{\circ}}=1.20$ 24.
419.1 2	419.19	8.9 3		$R_{154^{\circ}, 96^{\circ}}=1.11$ 6. $R_{\text{DCO}}=0.89$ 23 (1999Vi12).
440.6 2	8777.3	0.5 1	D	$R_{154^{\circ}, 96^{\circ}}=0.71$ 18.
529.4 3	2798.7	0.8 1		
578.2 3	997.68	4.4 2	Q	$R_{154^{\circ}, 96^{\circ}}=1.40$ 9. $R_{\text{DCO}}=0.85$ 23 (1999Vi12).
631.7 3	756.44	1.1 1	D	$R_{154^{\circ}, 96^{\circ}}=0.72$ 16.
647.1 3	1403.3	3.4 1	D	$R_{154^{\circ}, 96^{\circ}}=0.66$ 6.
666.6 $\frac{5}{2}$ 3	756.44	1.8 1		
696.2 3	2699.5	1.7 1	D	$R_{154^{\circ}, 96^{\circ}}=0.70$ 13.
737.6 4	2003.4	1.0 1		
755.7 4	756.44	18 1	D	$R_{154^{\circ}, 96^{\circ}}=0.60$ 3.
839.2 4	5254.5	3.1 1		$R_{154^{\circ}, 96^{\circ}}=1.18$ 10.
872.7 4	997.68	73 2	M1+E2	$R_{154^{\circ}, 96^{\circ}}=0.64$ 3. $R_{\text{DCO}}=0.30$ 4. POL=+0.041 12 (2004Iz01).
898.9 4	5543.0	2.1 7		
908.3 5	5552.4	2.6 1	D	$R_{154^{\circ}, 96^{\circ}}=0.62$ 10.
936.7 5	3336.2	39 2	E2	$R_{154^{\circ}, 96^{\circ}}=1.70$ 7. $R_{\text{DCO}}=1.117$. POL=+0.087 12 (2004Iz01).
984.3 5	1403.3	3.5 5		
990.9 $\frac{3}{2}$ 5	5254.5	1.4 $\frac{3}{2}$ 3		$R_{154^{\circ}, 96^{\circ}}=1.32$ 13 for 990.9 γ +impurity γ .
994.1 $\frac{3}{2}$ 5	10155.0	3.4 $\frac{3}{2}$ 6	E2	$R_{154^{\circ}, 96^{\circ}}=1.48$ 7, combined for 996.7 γ +997.0 γ +994.1 γ . $R_{\text{DCO}}=0.99$ 6. POL=+0.13 4 (2004Iz01).
996.7 $\frac{3}{2}$ 5	997.68	27 $\frac{3}{2}$ 6	E2	$R_{154^{\circ}, 96^{\circ}}=1.48$ 7, combined for 996.7 γ +997.0 γ +994.1 γ . $R_{\text{DCO}}=0.99$ 6. POL=+0.07 6 (2004Iz01).
997.0 $\frac{3}{2}$ 5	2399.7	5 $\frac{3}{2}$ 3		$R_{154^{\circ}, 96^{\circ}}=1.48$ 7, combined for 996.7 γ +997.0 γ +994.1 γ .
1005 $\frac{3}{2}$ 1	2269.7	10 $\frac{3}{2}$ 1	D	$R_{154^{\circ}, 96^{\circ}}=0.37$ 2, combined for 1006 γ +1005 γ . $R_{\text{DCO}}=0.51$ 17 (1999Vi12).
1006 $\frac{3}{2}$ 1	2003.4	8.5 $\frac{3}{2}$ 10	D	$R_{154^{\circ}, 96^{\circ}}=0.37$ 2, combined for 1006 γ +1005 γ .
1019 1	4264.0	3.6 1	Q	$R_{154^{\circ}, 96^{\circ}}=1.73$ 13.
1046 1	3843.8	4.2 1		
1066 1	3336.2	6.9 2	E1	$R_{154^{\circ}, 96^{\circ}}=0.98$ 6. $R_{\text{DCO}}=0.45$ 6. POL=+0.14 5 (2004Iz01).
1079 1	4415.0	35 1	E2	$R_{154^{\circ}, 96^{\circ}}=1.76$ 7. $R_{\text{DCO}}=0.99$ 6. POL=+0.072 14 (2004Iz01).
1141 1	1266.0	83 3	E2	$R_{154^{\circ}, 96^{\circ}}=1.62$ 7. $R_{\text{DCO}}=1.15$ 9. POL=+0.096 25 (2004Iz01).
1201 $\frac{5}{2}$ 1	8496.5?	2.2 1		
1246 1	2003.4	8.1 3	Q	$R_{154^{\circ}, 96^{\circ}}=1.40$ 8.
1273 1	2269.7	27 1	E2	$R_{154^{\circ}, 96^{\circ}}=1.77$ 8. POL=+0.10 4 (2004Iz01). $R_{\text{DCO}}=1.2$ 3 (1999Vi12).
1278 1	1403.3	2.0 1	D	$R_{154^{\circ}, 96^{\circ}}=1.01$ 12.
1289 1	5552.4	11 1	E2	$R_{154^{\circ}, 96^{\circ}}=1.67$ 9. $R_{\text{DCO}}=0.88$ 7. POL=+0.10 3 (2004Iz01).
1396 1	7486.6	9.9 4	E2	$R_{154^{\circ}, 96^{\circ}}=1.93$ 10. $R_{\text{DCO}}=0.94$ 7. POL=+0.09 7 (2004Iz01).
1403 $\frac{3}{2}$ 1	1403.3	5.3 $\frac{3}{2}$ 31		
	2399.7	41 $\frac{3}{2}$ 5	E1	$R_{154^{\circ}, 96^{\circ}}=0.84$ 4 for 1403 doublet. $R_{\text{DCO}}=0.54$ 4. POL=+0.063 13 for doublet (2004Iz01).
1433 1	2699.5	6.7 2	D	$R_{154^{\circ}, 96^{\circ}}=1.01$ 6.
1458 1	3461.6	6.6 3	Q	$R_{154^{\circ}, 96^{\circ}}=1.51$ 9.
1466 1	4264.0	19 1	E1	$R_{154^{\circ}, 96^{\circ}}=0.73$ 4. $R_{\text{DCO}}=0.44$ 4. POL=+0.07 3 (2004Iz01).

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$^{40}\text{Ca}(^{24}\text{Mg}, 2\text{pn}\gamma)$ 2006An31 (continued) **$\gamma(^{61}\text{Zn})$ (continued)**

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger$	Mult.	Comments
1531 $\frac{1}{2}$	2798.7	46 $\frac{1}{2}$ 3	Q	$R_{154^\circ, 96^\circ}=1.70$ 7, combined for 1531 γ +1532 γ . $R_{\text{DCO}}=0.917$. POL=+0.03 8 (2004Iz01).
1532 $\frac{1}{2}$	9160.9	6.3 $\frac{1}{2}$ 7	E2	$R_{154^\circ, 96^\circ}=1.70$ 7, combined for 1531 γ +1532 γ . $R_{\text{DCO}}=0.95$ 7. POL=+0.039 22 (2004Iz01).
1538 1	7628.8	7.5 7	E1	$R_{154^\circ, 96^\circ}=0.60$ 6. $R_{\text{DCO}}=0.48$ 3. POL=+0.090 17 (2004Iz01).
1572 1	3843.8	16 1	Q	$R_{154^\circ, 96^\circ}=1.62$ 8.
1595 1	8879.0	1.9 1	Q	$R_{154^\circ, 96^\circ}=1.79$ 21.
1624 1	5467.8	3.6 1		
1675 $\frac{1}{2}$ 3	6090.7	22 $\frac{1}{2}$ 2	E2	$R_{154^\circ, 96^\circ}=1.69$ 8 for 1675 doublet. $R_{\text{DCO}}=0.91$ 6. POL=+0.059 20 (2004Iz01).
1675 $\frac{1}{2}$ 4	9160.9	4.0 $\frac{1}{2}$ 20		$R_{154^\circ, 96^\circ}=1.69$ 8 for 1675 doublet.
1698 1	5543.0	5.8 3	Q	$R_{154^\circ, 96^\circ}=1.57$ 10.
1733 $\frac{1}{2}$ 1	5195.3	3.5 $\frac{1}{2}$ 11	(Q)	$R_{154^\circ, 96^\circ}=1.49$ 10 for 1733 doublet.
	7284.0	1.2 $\frac{1}{2}$ 3		$R_{154^\circ, 96^\circ}=1.49$ 10 for 1733 doublet.
1743 1	7295.4	5.4 3	Q	$R_{154^\circ, 96^\circ}=1.47$ 10.
1799 1	6212.0	2.3 6		
1847 1	4644.3	11 1	E2	$R_{154^\circ, 96^\circ}=1.66$ 9. $R_{\text{DCO}}=1.00$ 12. POL=+0.12 5 (2004Iz01).
1946 $\frac{1}{2}$ 1	6212.0	1.4 1		
1978 1	3244.5	7.7 3	D	$R_{154^\circ, 96^\circ}=0.78$ 6. $R_{\text{DCO}}=0.8$ 5 (1999Vi12).
2039 1	4308.8	1.9 1	D	$R_{154^\circ, 96^\circ}=0.87$ 14.
2088 1	7284.0	1.7 1	Q	$R_{154^\circ, 96^\circ}=1.32$ 17.
2116 1	4914.7	3.4 1	D	$R_{154^\circ, 96^\circ}=0.81$ 9.
2195 1	3461.6	5.5 3	Q	$R_{154^\circ, 96^\circ}=1.60$ 11.
2229 1	3495.0	3.4 1	Q	$R_{154^\circ, 96^\circ}=1.40$ 12.
2246 1	8336.7	0.9 1		
2273 1	2399.7	2.3 1	Q	$R_{154^\circ, 96^\circ}=1.17$ 16. $R_{\text{DCO}}=1.6$ 7 (1999Vi12).
2639 1	7284.0	2.1 9		

 † From 2006An31. $\frac{1}{2}$ Multiply placed; intensity suitably divided. Doublet structure. $\frac{1}{2}$ Placement of transition in the level scheme is uncertain. **$^{58}\text{Ni}(\alpha, n\gamma)$ 1982Sm01, 1984Th07, 1989Sc28**

1982Sm01: $^{58}\text{Ni}(\alpha, n\gamma)$, E=10.75–16 MeV. Measured $E\gamma$, $\gamma\gamma$ coin, $\gamma(0)$, and γ -ray linear polarization in coin with neutrons detected near 0° .

1984Th07: $^{58}\text{Ni}(\alpha, n\gamma)$, E=10.3–14.5 MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ coin, $\gamma(0)$, $n\gamma$ coin, and $\gamma\gamma(0)$.

1989Sc28: $^{58}\text{Ni}(\alpha, n\gamma)$, E=11.5, 13.0, 15, 20 MeV; $^{58}\text{Ni}(^6\text{Li}, p2n\gamma)$, E=30 MeV; $^{54}\text{Fe}(^{10}\text{B}, p2n\gamma)$, E=45 MeV; $^{40}\text{Ca}(^{24}\text{Mg}, 2\text{pn}\gamma)$, E=65, 80 MeV; measured $E\gamma$, $I\gamma$, $\gamma\gamma$ coin, $n\gamma$ coin, $n\gamma\gamma$ coin, $\gamma(0)$ $\theta=0^\circ$ – 90° , $\gamma\gamma(0)$, $n\gamma(0)$, and DSA.

1978Wo01: $^{58}\text{Ni}(\alpha, n\gamma)$, E=18 MeV, 6 γ -rays observed.

The decay scheme is deduced from neutron- γ and $\gamma\gamma$ -coin data (1989Sc28).

From neutron spectrum taken with ^3He -filled detector at beam energy of 13 MeV, mass excess of -56.369 8 MeV was derived (1989Sc28).

 ^{61}Zn Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	Comments
0.0	3/2–	
88.21 10	1/2–	$J\pi$: 1/2– (1982Sm01), J=1/2, 3/2, 5/2 consistent with isotropic $\gamma(0)$ (1984Th07), 1/2– (1989Sc28).
123.66 9	5/2–	
418.09 14	3/2–	
756.05 18	5/2–	
937.7 3	1/2–	$J\pi$: (1/2, 3/2, 5/2) (1984Th07).
		γ -branching ratios in 1984Th07 seem incorrect especially for 519 γ . These are taken from 1982Sm01.
995.96 18	7/2–	$J\pi$: 7/2–, stretched E2 996 γ to 3/2– (1982Sm01), 7/2 (1984Th07), 7/2– (1989Sc28).

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⁵⁸Ni(α,nγ) 1982Sm01,1984Th07,1989Sc28 (continued)

⁶¹Zn Levels (continued)

E(level) [†]	Jπ [‡]	Comments
1264.67 22	9/2-	Jπ: 9/2- (1982Sm01), 9/2, however lower spins are not completely excluded (1984Th07), 9/2- (1989Sc28).
1362.3 4	3/2-, 5/2-	
1402.2 3	7/2-	
1657.3 6	5/2-, 7/2-	
2001.7 6	9/2-	Jπ: 9/2(+) (1982Sm01), 9/2- (1989Sc28).
2098.7 10		
2269.7 9	7/2-, 11/2-	Jπ: 7/2-, 11/2- proposed based on 1274γ(θ) (1989Sc28). 11/2- is inconsistent with negative A2 for 1274γ to 7/2-, but 11/2- is assigned in Adopted Levels based on E2 multipolarity of 1273.6γ.
2399.6 7	11/2-	
2796.7 10	(9/2-)	Jπ: 9/2, 13/2- proposed based on 1532γ(θ) (1989Sc28). 13/2- is inconsistent with negative A2 for 1532γ to 9/2-.
3336.6 12		E(level): Observed only in the heavy-ion reactions (1989Sc28).
4415.6 16		E(level): Observed only in the heavy-ion reactions (1989Sc28).

[†] From least-squares fit to Eγ data. Δ(Eγ) assumed as 1 keV when not given.

[‡] As proposed by (1989Sc28) based on their n-γ angular distribution measurements, except as noted.

γ(⁶¹Zn)

A₂ and A₄ values are from 1989Sc28, POL values are from 1982Sm01.

All placements of γ rays are from γγ coin data.

E(level)	Eγ [†]	Iγ [‡]	Mult. ^a	δ ^b	Comments
88.21	88.2 1	100	(M1+E2)		Eγ: average of 88.0 1 (1982Sm01), 88.4 1 (1984Th07). Eγ=88.0 1, Iγ=4.3 2 (1982Sm01). A ₂ =-0.07 6; A ₄ =-0.04 8. A ₂ =-0.03 3, A ₄ =-0.07 3 (1982Sm01). Eγ=123.6 1, Iγ=100 (1982Sm01). δ: other: -0.01 +11-7 or -3.2+17-11 (1982Sm01). A ₂ =-0.13 1, A ₄ =-0.02 1. A ₂ =-0.25 7, A ₄ =-0.05 9 (1982Sm01). Eγ=294.8 3, Iγ=2.6 3 (1982Sm01). A ₂ =+0.26 19, A ₄ =+0.20 26. Eγ=330.4 3 1, Iγ=6.5 2 (1982Sm01). A ₂ =+0.02 10, A ₄ =+0.12 20. POL=+0.01 20. Eγ=418.4 1, Iγ=45.2 9 (1982Sm01). δ: other: +0.04 +27-14 (1982Sm01). A ₂ =+0.15 4, A ₄ =+0.00 5. POL=+0.18 8. A ₂ =+0.24 3, A ₄ =+0.02 4 (1982Sm01). Eγ=337.0 7, Iγ=3.4 1 (1982Sm01). Eγ=632.0 7, Iγ=5.7 5 (1982Sm01). Eγ=755.6 1, Iγ=64.4 12 (1982Sm01). δ: other: -0.3 +1-2 (1982Sm01). A ₂ =-0.66 2, A ₄ =+0.10 2. POL=-0.17 8. A ₂ =-0.75 3, A ₄ =+0.08 4 (1982Sm01). Eγ=520.0 4, Iγ=2.6 6 (1982Sm01). Iγ: 232 based on data in 1984Th07. Eγ=850.2 7, Iγ=4.4 4 (1982Sm01). Iγ: 49 10 based on data in 1984Th07. Eγ=938.0 4, Iγ=16.4 10 (1982Sm01). POL=+0.8 3. Eγ=577.8 3, Iγ=3.8 4 (1982Sm01). Eγ=872.7 1, Iγ=49.0 8 (1982Sm01). δ: other: -1.7 +2-3 (1982Sm01). A ₂ =-0.77 3, A ₄ =-0.24 6. POL=+0.14 9. A ₂ =-0.73 5, A ₄ =-0.14 5 (1982Sm01). Eγ: 882 keV in table 1 of 1989Sc28 may be a misprint. Eγ=996.4 2, Iγ=21.8 10 (1982Sm01). δ: other: -0.09 -9+7 (1982Sm01). A ₂ =+0.19 5, A ₄ =-0.49 9. POL=+0.32 27. A ₂ =+0.31 5, A ₄ =-0.14 5 (1982Sm01).
123.66	123.7 1	100	(M1+E2)	-0.05 2	
418.09	294.9 4	13 2	(M1+E2)	-0.44 37	
	329.8 5	20 3	(M1+E2)	+0.27 13	
	418.5 2	100	M1+E2	-0.10 5	
756.05	338.6 2	100			
	631.0 10	5 1			
	755.0 3	72 3	M1+E2	-0.07 4	
937.7	519.0 5	16 4			
	849.0 10	26.8 24			
	938.4 5	100.0 ^{&} 16			
995.96	578.0 10	<5			
	872.2 6	100	M1+E2	-1.9 1	
	995.9 2	30 4	E2		

Continued on next page (footnotes at end of table)

$^{58}\text{Ni}(\alpha, n\gamma)$ 1982Sm01, 1984Th07, 1989Sc28 (continued) $\gamma(^{61}\text{Zn})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\ddagger}$	Mult. ^a	δ^b	Comments
1264.67	1141.0 2	100	E2		$E\gamma=1141.1$ 1, $I\gamma=63.9$ 10 (1982Sm01). δ : other: +0.02 +1-3 (1982Sm01). $A_2=+0.35$ 6, $A_4=-0.28$ 8. POL=+0.42 14. $A_2=+0.42$ 2, $A_4=+0.15$ 2 (1982Sm01). $E\gamma=606.0$ 5, $I\gamma=1.0$ 1 (1982Sm01). $E\gamma$: 406 keV in table 1 of 1989Sc28 may be a misprint. $E\gamma=944.0$ 10, $I\gamma=2.4$ 4 (1982Sm01). $E\gamma=1237$ keV in 1989Sc28. Questionable placement in 1982Sm01, no intensity is given. $E\gamma=1362.0$ 10, $I\gamma=7.2$ 4 (1982Sm01). δ : -0.29 17 or +0.18 11 (1989Sc28). $A_2=-0.02$ 16, $A_4=+0.25$ 20. POL=-0.55 6. $E\gamma=646.7$ 3, $I\gamma=7.1$ 5 (1982Sm01). Branching ratio=2% (1989Sc18). $E\gamma=984.4$ 3, $I\gamma=8.8$ 7 (1982Sm01). Branching ratio=12% (1989Sc18). $E\gamma=1278.6$ 7, $I\gamma=6.1$ 6 (1982Sm01). Branching ratio=17% (1989Sc18). γ not reported in 1982Sm01. Branching ratio=69% (1989Sc18). γ not reported in 1982Sm01; a 1240 γ questionable placement shown from 1362 level. $E\gamma=1534.0$ 10, $I\gamma=20.9$ 21 (1982Sm01). $A_2=-0.39$ 13, $A_4=-0.98$ 21. $E\gamma=1006.1$ 2, $I\gamma=17.8$ 14 (1982Sm01). $A_2=-0.77$ 11, $A_4=+0.13$ 18. POL=+0.9 3. $A_2=-0.53$ 5, $A_4=+0.05$ 6 (1982Sm01). Mult.: ; (D+Q) (1982Sm01); $\delta=-0.1$ 1. $E\gamma=1247.4$ 4, $I\gamma=12.9$ 9 (1982Sm01). $A_2=+0.33$ 11, $A_4=-0.58$ 16.
1362.3	606.0 [#] 5	14 [§] 2			
	944.0 [#] 10	34 [§] 6			
	1240 ^{#c}	50 [@]			
	1362.0 [#] 10	100 [§]	(M1+E2)		
1402.2	646.8 5	100	M1		
	984.0 10	30 8			
	1279.0 10	16 4			
	1401.7 4	32 7			
1657.3	1239.0 7	100			
	1534.0 10	38 7	(M1+E2)	-1.4 9	
2001.7	1004.7 9	89 24	M1 (+E2)	-0.4 4	
	1246.3 7	100	Q		
2098.7	1975 [@]	100 [@]			
2269.7	1005 [@]	6 [@]			
	1273.6 18	100			$E\gamma=1273.7$ 4, $I\gamma=12.5$ 5 (1982Sm01). $A_2=-0.26$ 10, $A_4=-0.51$ 14. POL=+0.4 4. Mult.: $\gamma(\theta)$ data in 1984Th07 suggesting (M1+E2) with $\delta=+1.9$ 4 are in conflict with those from 2006An31, the latter assigned E2 based on $\gamma\gamma(\theta)$ (DCO), asymmetry ratios and $\gamma(\text{lin pol})$ data. $E\gamma=1403.6$ 7, $I\gamma=34.7$ 15; POL=-0.1 2 (1982Sm01) (this γ may be contaminated by a possible 1403-keV g.s. transition). $A_2=-0.26$ 12, $A_4=-0.47$ 18.
2399.6	1403.6 [#] 7	100 [§]			
2796.7	1532 [@]	100 [@]	(M1+E2)	-2 1	
3336.6	937 [@]	100 [@]			
4415.6	1079 [@]	100 [@]			

[†] From 1984Th07, except as noted.[‡] Relative branchings from each level. Values are from 1984Th07, except as noted. For corresponding values available from 1982Sm01 and 1989Sc28, disagreements (for example for 1402 level) are found in many cases.[§] From $\gamma(\theta)$ in coin with neutrons at $E\alpha=15$ MeV (1982Sm01).[#] From 1982Sm01.[@] From 1989Sc28.[&] From 1982Sm01.^a From $n\gamma(\theta)$ (1989Sc28, 1982Sm01) and $\text{pol}(\theta)$ data (1982Sm01).^b From 1989Sc28. Values from 1982Sm01 are listed under comments.^c Placement of transition in the level scheme is uncertain.

$^{58}\text{Ni}(^{16}\text{O}, ^{13}\text{C})$ 1983OkZY, 1985OkZX, 1986OkZV

E=80 MeV, measured spectra and angular distributions by $\Delta\text{E-E}$ silicon detector telescopes. Isobaric analog state analysis of $\text{ISPIN}_z=1/2, 3/2, 5/2$. Deduced reaction Q value=-11.5040 MeV.

All data are from 1983OkZY, except as noted.

 ^{61}Zn Levels

E(level)	$\text{J}\pi^\dagger$	$\text{L}^\ddagger$	S	Comments
0.0	3/2-	1	1	T=1/2.
120	5/2-			
390	1/2-#	1@	0.95	
940	5/2-#	3@	0.20	
1300	7/2-#		0.15	L=4 in table 3 (1983OkZY).
1730				
2030				
2440	7/2-			L=4 in table 3 (1983OkZY).
2770	9/2+#	4		
3380	3/2-§	1		T=3/2 analog g.s. ^{61}Cu 3/2-.
3880				
4380				
5130				
5590				
9990§ 70	3/2-§	1		T=5/2 analog g.s. ^{61}Ni 3/2-.

† From 1983OkZY, except as noted.

‡ From DWBA analysis of $\sigma(\theta)$. Values from 1985OkZX, except as noted.

§ From 1985OkZX.

From 1986OkZV.

@ From 1983OkZY.

 $^{58}\text{Ni}(^6\text{Li}, t), (^{12}\text{C}, ^9\text{Be})$ 1978Wo01, 1979We02

1978Wo01: E(^6Li)=34 MeV. Magnetic spectrograph, $\theta=10^\circ-20^\circ$, FWHM=50-100 keV.

1979We02: E(^{12}C)=77 MeV. Magnetic spectrograph, $\sigma(\theta)$, $\theta=5^\circ-30^\circ$, FWHM=150-250 keV. $\sigma(\theta)$ is rather structureless and not sensitive to L-transfer.

Data are from 1978Wo01, except as noted.

 ^{61}Zn Levels

E(level)	$\text{d}\sigma/\text{d}\Omega(\mu\text{b}/\text{sr})$	E(level)	$\text{d}\sigma/\text{d}\Omega(\mu\text{b}/\text{sr})$	E(level)	$\text{d}\sigma/\text{d}\Omega(\mu\text{b}/\text{sr})$
0.0 †	0.9	2030 † 10		2800 † 10	
120 † 10		2250 10		3090 10	7.4
940 † 10		2400 † 10	5.5	3300 † 10	4.0
1240 10		2520 10		3880 ‡ 60	
1390 † 10		2710 10	2.0		

† Level also observed in the ($^{12}\text{C}, ^9\text{Be}$) reaction (1979We02).

‡ From 1979We02.

⁶⁴Zn(³He,⁶He) 1979We02

1979We02: E(³He)=70 MeV. Magnetic spectrograph, θ=7° and 9°, FWHM=60–100 keV.

⁶¹Zn Levels

<u>E(level)</u>	<u>E(level)</u>	<u>E(level)</u>
0 . 0	1636 20	3345 20
123 20	2198 20	3645 20
390 30	2417 20	4670 30
967 20	2646 20	5100 30
1230 30	2735 20	5320 30
1374 20	2820 20	

Adopted Levels, Gammas

Q(β^-)=-13410 SY; S(n)=15420 SY; S(p)=250 40; Q(α)=-2250 40 2012Wa38.
 Estimated uncertainties (2012Wa38): 300 for Q(β^-), 200 for S(n).
 Q(ϵ p)=3920 40, S(2n)=29310 170 (syst), S(2p)=5350 40 (2012Wa38).
 1987Ho01 (also:1979ViZY,1978ViZT thesis): first evidence of population of excited state in ^{61}Ga from ^{61}Ge decay.
 1991Mo10: ^{61}Ga first identified in the bombardment of enriched ^{58}Ni target by a 65 MeV/nucleon ^{78}Kr beam followed by A-1200 mass separator at NSCL facility .
 1993Wi18 (also 1993Wi03): ^{61}Ga produced in fragmentation of ^{78}Kr beam at 75 MeV/nucleon with ^{58}Ni target using A1200 fragment separator at NSCL facility. Measured half-life.
 1999Oi01: ^{61}Ga produced in Si(^{36}Ar ,X) reaction at E=121 MeV at GSI facility.
 2002We07: ^{61}Ga produced in ZrO(p,X) using RILIS source at ISOLDE- CERN facility. Measured half-life and Q(ϵ) value.
 2002Lo13 (also 2002B117): ^9Be (^{78}Kr ,X) E=73 MeV/nucleon; LISE3 spectrometer at GANIL facility. Measured half-life from timing of correlated beta-delayed protons and implanted nuclei.
 Structure calculations: 2001Pa02.
 2005An03 (also 2005Ru06,2005Ek01): ^{24}Mg (^{40}Ca ,p2n γ) E=104 MeV. Measured prompt γ rays in the yrast structure.
 Mass measurement using storage ring CSRe in Lanzhou: 2011Tu09.

 ^{61}Ga Levels**Cross Reference (XREF) Flags**

A ^{61}Ge ϵ Decay (44 ms)
 B ^{24}Mg (^{40}Ca ,p2n γ)

E(level) [†]	J $\pi^{\ddagger}$	XREF	T _{1/2}	Comments
0.0	3/2-	AB	167 ms 3	% ϵ +% β^+ =100; % ϵ p<0.25 (2002We07). J π : log ft=5.3 to 1/2-, and 5.6 to 5/2- levels in ^{61}Zn from ^{61}Ga ϵ decay. T _{1/2} : weighted average of 162 ms 10 (timing of β (implant) correlations, 2014Ro14); 168 ms 3 (timing of β or β -delayed proton events correlated with implanted ^{61}Ga nuclei,2002We07); 148 ms 19 (2002Lo13,2002B117) and 0.15 s 3 (1993Wi18,1993Wi03). Other: 167.3 ms 29 (2008Se10 evaluation).
220? 1	(1/2-)	B		
271 [§] 1	(5/2-)	B		
1397 [§] 1	(9/2-)	B		
2903? [§] 2	(13/2-)	B		
3420 50	(3/2-)	A		%p=100 (1987Ho01,2007B109). T=3/2. J π : isobaric analog state, T=3/2 g.s. in ^{61}Ge .

[†] From E γ data, except for the 3420 level which is from ϵ decay.

[‡] From mirror symmetry arguments with ^{61}Zn nuclide (2005An03).

[§] (A): γ -cascade based on 5/2-.

 $\gamma(^{61}\text{Ga})$

E(level)	E γ	I γ	Mult.
220?	220 [†] 1	100	
271	271 1	100	D+Q
1397	1126 1	100	
2903?	1506 [†] 1	100	

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

**(A) γ -cascade
based on 5/2-**

^{61}Ge ϵ Decay (44 ms) 2007B109,1987Ho01

Parent ^{61}Ge : $E=0.0$; $J\pi=(3/2-)$; $T_{1/2}=44$ ms 6; $Q(g.s.)=13410$ syst; $\% \epsilon + \% \beta^+$ decay=100.

$^{61}\text{Ge}-Q(\epsilon)$: 13410 300 (syst,2012Wa38).

$^{61}\text{Ge}-J, T_{1/2}$: From ^{61}Ge Adopted Levels.

Source produced by $^{40}\text{Ca}(^{24}\text{Mg}, 3n)$ (1987Ho01,1978ViZT,1979ViZY).

1987Ho01 (also 1979ViZY,1978ViZT thesis): $E=77-120$ MeV ^{40}Ca pulsed beam on ^{24}Mg target. $\Delta E-E$ silicon detector telescope shielded system. Observed ϵ -delayed proton group with $E=3110$ 30 and $T_{1/2}=40$ ms 15. The proton decay mainly feeds ^{60}Zn g.s. (<10% to first excited state). A and Z identification is not certain, but it is supported by Coulomb displacement energy systematics. Measured mass excess=-47.73 MeV 3.

2007B109: ^{61}Ge nuclei produced in a fragmentation of $^{70}\text{Ge}+^{28}$ beam at an energy of 71.6 MeV using LISE3 facility at GANIL. A nickel target was used. Measured delayed proton events by implanting nuclei in a double-sided silicon strip detector (DSSSD) and isotopic $T_{1/2}$.

From RADLIST code, deduced total decay energy is 5500 keV 400 compared to 13360 keV 300 from $Q(\epsilon)$ value. The decay scheme is poorly known.

 ^{61}Ga Levels

E(level)	$J\pi^\dagger$	$T_{1/2}$	Comments
0.0	3/2-	167 ms 3	$T_{1/2}$: from Adopted Levels.
3420 50	(3/2-)		$\% p=100$. E(level): from $E(p)(c.m.)=3170$ 30 (2007B109) (weighted average of $E(p)(c.m.)=3162$ 30 (from $E(p)_{\text{lab}}=3110$ 30 (1987Ho01))) and $E(p)(c.m.)=3220$ 60 (2007B109)) and $S(p)(^{61}\text{Ga})=250$ 40 (2012Wa38).

† From Adopted Levels.

 β^+, ϵ Data

$E\epsilon$	E(level)	$I\beta^+^\dagger$	$I\epsilon^\dagger$	Log ft	$I(\epsilon+\beta^+)^\dagger$	Comments
(9990)	3420	55 6	0.061 9	3.52 11	55 6	$I(\epsilon+\beta^+)$: measured by 2007B109. Other: ≈ 80 (1987Ho01) from assumed $\log ft=3.3$.

† Absolute intensity per 100 decays.

 $^{24}\text{Mg}(^{40}\text{Ca}, p2n\gamma)$ 2005An03

2005An03 (also 2005Ru06,2005Ek01): $E=104$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, (recoil) $\gamma\gamma$ coin with the CLARION detector array, composed of ten Clover detectors and recoil spectrometer. The relative cross sections of the three $A=61$ isotopes ^{61}Cu , ^{61}Zn , and ^{61}Ga were estimated from the known or presumed ground state transitions to be 420:110:1, respectively. Comparison with structure of mirror nuclide ^{61}Zn and shell-model calculations.

Level scheme is proposed by 2005An03 based on mirror symmetry arguments with the ^{61}Zn nuclide, in particular 1532-1141-124 cascade in ^{61}Zn .

 ^{61}Ga Levels

E(level) †	$J\pi^\ddagger$	Comments
0.0	3/2-	$J\pi$: from Adopted Levels.
220? 1	(1/2-)	
271§ 1	5/2-	
1397§ 1	(9/2-)	
2903?§ 2	(13/2-)	

† From $E\gamma$ data.

‡ As assigned by 2005An03 based on mirror symmetry arguments with ^{61}Zn nuclide.

§ (A): γ -cascade based on 5/2-.

$^{24}\text{Mg}(^{40}\text{Ca},\text{p}2\text{n}\gamma)$ 2005An03 (continued)

$\gamma(^{61}\text{Ga})$

$R_{154-90} = Y(154^\circ)/Y(90^\circ)$, where $Y(\theta)$ represents the γ -ray yield at one of the detector rings of CLARION. Ratios for known stretched $\Delta J=2$ reference transitions is expected as 1.6–1.7, while stretched $\Delta J=1$ transitions have $R_{154-90}=0.7-0.8$.

$E\gamma^\dagger$	E(level)	$I\gamma$	Mult.	Comments
220 $\frac{5}{2}^-$ 1	220?	15 7		E γ : possible counterpart of 89-keV 1/2- to 3/2- transition in ^{61}Zn . Mult.: $\Delta J=1$, D+Q from $R_{154^\circ-90^\circ}=1.15$ 16.
271 1	271	100 10	D+Q	
1126 1	1397	64 16		
^x 1231 1		22 12		
1506 $\frac{5}{2}^-$ 1	2903?	39 14		

† The placement and order of the 1506–1126–271 cascade has been inferred from mirror symmetry arguments with ^{61}Zn nuclide.

$\frac{5}{2}$ Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

Adopted Levels

$Q(\beta^-) = -16140$ SY; $S(n) = 14190$ SY; $S(p) = 1230$ SY; $Q(\alpha) = -3610$ SY 2012Wa38.
 Estimated uncertainties (2012Wa38): 420 for $Q(\beta^-)$, 360 for $S(n)$, $S(p)$ and $Q(\alpha)$.
 $Q(\epsilon p) = 13160$ 300, $S(2n) = 33560$ 420, $S(2p) = 1090$ 300 (syst, 2012Wa38).
 1987Ho01 (also 1979ViZY, 1978ViZT, thesis): production and identification of ⁶¹Ge in ⁴⁰Ca(²⁴Mg, 3n) E=77–120 MeV and Ca(²⁸Si, X) reactions. Measured beta-delayed proton spectra, half-life.
 2002Lo13 (also 2002B117): ⁹Be(⁷⁸Kr, X) E=73 MeV/nucleon; LISE3 spectrometer at GANIL facility. Measured half-life from timing of correlated beta-delayed protons and implanted nuclei.
 2005St29 (also 2005St34): ⁹Be(⁷⁸Kr, X) E=140 MeV/nucleon; A1900 fragment separator at NSCL facility. Measured production σ .
 2007B109: ⁶¹Ge nuclei produced in a fragmentation of ⁷⁰Ge+²⁸ beam at an energy of 71.6 MeV using LISE3 facility at GANIL. A nickel target was used. Measured delayed proton events by implanting nuclei in a double-sided silicon strip detector (DSSSD) and isotopic $T_{1/2}$.
 Calculated $Q(\beta^-)$ and $S(p)$: 1997Or04.

⁶¹Ge Levels

E(level)	J π	T _{1/2}	Comments
0.0	(3/2-)	44 ms 6	$\% \epsilon + \% \beta^+ = 100$; $\% \epsilon p > 62$ (2007B109). $\% \epsilon p$: %listed as $\epsilon p > 62$ 4 (2007B109). Other: =80 (1987Ho01). $J\pi$: $T_z = -3/2$ mirror state of ⁶¹ Cu g.s. $T_{1/2}$: weighted average of 45 ms 6 (delayed proton timing, 2007B109) and 40 ms 15 (1987Ho01, pulsed beam). Other: 36 ms 21 (2002Lo13, same group as 2007B109).

NUCLEAR DATA SHEETS

REFERENCES FOR A=61

- 1937Ri01 L.N.Ridenour, W.J.Henderson – Phys.Rev. 52, 889 (1937)
 1937Th01 R.L.Thornton – Phys.Rev. 51, 893 (1937)
 1938Al02 L.W.Alvarez – Phys.Rev. 54, 486 (1938)
 1945Br02 H.Bradt, P.C.Gugelot, O.Huber, H.Medicus, P.Preiswerk, P.Scherrer – Helv.Phys.Acta 18, 252 (1945)
 1948Co08 C.S.Cook, L.M.Langer – Phys.Rev. 74, 227 (1948)
 1948Ku01 D.N.Kundu, M.L.Pool – Phys.Rev. 73, 22 (1948)
 1949Bo16 R.Bouchez, G.Kayas – J.Phys.Radium 10, 110 (1949)
 1949Hu21 O.Huber, R.Ruetschi, P.Scherrer – Helv.Phys.Acta 22, 375 (1949)
 1949Pa01 T.J.Parmley, B.J.Moyer, R.C.Lilly – Phys.Rev. 75, 619 (1949)
 1950Bo34 R.Bouchez, S.R.de Groot, R.Nataf, H.A.Tolhoek – J.Phys.Radium 11, 105 (1950)
 1950Co05 C.S.Cook, C.H.Chang – Phys.Rev. 78, 171 (1950)
 1950Ku05 D.N.Kundu, M.L.Pool – Phys.Rev. 78, 488 (1950)
 1950Ow03 G.E.Owen, C.S.Cook, P.H.Owen – Phys.Rev. 78, 686 (1950)
 1951Sm64 L.A.Smith, R.N.H.Haslam, J.G.V.Taylor – Phys.Rev. 84, 842 (1951)
 1953En06 T.C.Engelder – Phys.Rev. 90, 259 (1953)
 1954Be84 A.I.Berman, K.L.Brown – Phys.Rev. 96, 83 (1954)
 1955Li39 L.Lindner, G.A.Brinkman – Physica 21, 747 (1955)
 1956Nu02 R.H.Nussbaum, A.H.Wapstra, W.A.Bruil, M.J.Sterk, G.J.Nijgh, N.Grobbe – Phys.Rev. 101, 905 (1956)
 1956Ru45 G.Rudstam – Thesis, University of Uppsala (1956)
 1957Bu64 J.W.Butler, C.R.Gossett – Phys.Rev. 108, 1473 (1957)
 1957Ku57 M.I.Kuznetsova, V.N.Mekhedov – Izvest.Akad.Nauk SSSR, Ser.Fiz. 21, 1020 (1957); Columbia Tech.Transl. 21, 1021 (1958)
 1957Ni09 W.A.Nierenberg, H.A.Shugart, H.B.Silsbee – Bull.Am.Phys.Soc. 2, No.4, 200, KA11 (1957)
 1957Ri10 E.Ricci, J.P.Campa, N.Nussis – Publs.com.nacl.energia atomica (Buenos Aires) Ser.quim. 1, No.11, 129 (1957)
 1958Bu07 J.W.Butler, C.R.Gossett – Phys.Rev. 109, 863 (1958)
 1958Re10 J.B.Reynolds, R.L.Christensen, D.R.Hamilton, W.M.Hooke, H.H.Stroke – Phys.Rev. 109, 465 (1958)
 1958Wo52 H.H.Woodbury, G.W.Ludwig – Phys.Rev.Letters 1, 16 (1958)
 1959Cu86 J.B.Cummings – Phys.Rev. 114, 1600 (1959)
 1960Pr05 I.L.Preiss, R.W.Fink – Nuclear Phys. 15, 326 (1960)
 1961Sa09 J.Saudinos, R.Beurtey, P.Catillon, R.Chaminade, M.Crut, H.Faraggi, A.Papineau, J.Thirion – Compt.Rend. 252, 3776 (1961)
 1962Co02 B.L.Cohen, R.H.Fulmer, A.L.McCarthy – Phys.Rev. 126, 698 (1962)
 1962Jo05 R.K.Jolly, E.K.Lin, B.L.Cohen – Phys.Rev. 128, 2292 (1962)
 1962Ri09 R.C.Ritter, P.H.Stelson, F.K.McGowan, R.L.Robinson – Phys.Rev. 128, 2320 (1962)
 1962Va23 A.K.Valter, V.Y.Gonchar, I.I.Zalyubovskii, G.D.Latyshev, G.P.Chursin – Izvest.Akad.Nauk SSSR, Ser.Fiz. 26, 1079 (1962); Columbia Tech.Transl. 26, 1086 (1963)
 1964Ba34 G.Bassani, N.M.Hintz, C.D.Kavaloski – Phys. Rev. 136, B1006 (1964)
 1964Co13 R.E.Cote, H.E.Jackson, Jr., L.L.Lee, Jr., J.P.Schiffer – Phys.Rev. 135, B52 (1964)
 1964Cr07 W.G.Cross – Phys.Canada 20, No.2, 36, Abstr.7.5 (1964); Priv.Comm. (June 1967)
 1964Dr02 L.E.Drain – Phys.Lett. 11, 114 (1964)
 1964Fu04 R.H.Fulmer, A.L.McCarthy, B.L.Cohen, R.Middleton – Phys.Rev. 133, B955 (1964)
 1964Za02 Z.Zamori – Nucl.Phys. 52, 269 (1964)
 1965Bl05 A.G.Blair, D.D.Armstrong – Phys.Letters 16, 57 (1965)
 1965Fu06 R.H.Fulmer, W.W.Daehnick – Phys.Rev. 139, B579 (1965)
 1965Go02 C.R.Gossett, L.S.August – Phys.Rev. 137, B381 (1965)
 1965Le05 L.L.Lee, Jr., A.Marinov, C.Mayer-Borick, J.P.Schiffer, R.H.Bassel, R.M.Drisko, G.R.Satchler – Phys.Rev.Lett. 14, 261 (1965)
 1965Ok01 V.V.Okorokov, D.L.Tolchenkov – Yad.Fiz. 1, 448 (1965); Sov.J.Nucl.Phys. 1, 320 (1965)
 1965Sh06 R.Sherr, B.F.Bayman, E.Rost, M.E.Rickey, C.G.Hoot – Phys.Rev. 139, B1272 (1965)
 1966Bl15 A.G.Blair, D.D.Armstrong – Phys.Rev. 151, 930 (1966)
 1966Do01 B.M.Dodsworth, H.A.Shugart – Phys.Rev. 142, 638 (1966)
 1966Le19 V.N.Levkovskii, I.V.Kazachevskii, V.V.Sokolskii, G.P.Vinitskaya – Yad.Fiz. 4, 1258 (1966); Sov.J.Nucl.Phys. 4, 904 (1967)
 1966Ok01 V.V.Okorokov, V.M.Serezhin, V.A.Smotryaev, D.L.Tolchenkov, I.S.Trostin, Y.N.Cheblukov – Phys.Lett. 20, 676 (1966)
 1966Ok02 V.V.Okorokov, V.M.Serezhin, V.A.Smotryaev, D.L.Tolchenkov, I.S.Trostin, Y.N.Cheblukov – Yad.Fiz. 4, 975 (1966); Soviet J.Nucl.Phys. 4, 697 (1967)
 1966Ri09 G.Rickards, B.E.Bonner, G.C.Phillips – Nucl.Phys. 86, 167 (1966)
 1966Ro13 B.Rosner, C.H.Holbrow, D.J.Pullen – Isobaric Spin in Nucl.Phys., J.D.Fox and D.Robson, Eds., Academic Press, p.595 (1966)
 1966St11 J.E.Strain, W.J.Ross – J.Inorg.Nucl.Chem. 28, 2075 (1966); Erratum Quoted by 1967Gr15
 1967Ar05 D.D.Armstrong, A.G.Blair, H.C.Thomas – Phys.Rev. 155, 1254 (1967)
 1967Ba79 G.A.Bartholomew, A.Doveika, K.M.Eastwood, S.Monaro, L.V.Groshev, A.M.Demidov, V.I.Pelekhov, L.L.Sokolovskii – Nuclear Data A3, 367 (1967)
 1967Be12 R.Beraud, I.Berkes, J.Daniere, M.Levy, G.Marest, R.Rougny – Nucl.Phys. A99, 577 (1967)
 1967Bo01 H.H.Bolotin, H.J.Fischbeck – Phys.Rev. 158, 1069 (1967)
 1967Br10 G.Brown, J.G.B.Haigh, F.R.Hudson, A.E.Macgregor – Nucl.Phys. A101, 163 (1967)
 1967Co27 E.R.Cosman, D.N.Schramm, H.A.Enge, A.Sperduto, C.H.Paris – Phys.Rev. 163, 1134 (1967)
 1967Eh02 D.Ehrlich – Z.Phys. 207, 268 (1967)

NUCLEAR DATA SHEETS

REFERENCES FOR A=61 (CONTINUED)

- 1967Gr15 H.A.Grench, K.L.Coop, H.O.Menlove – Phys.Rev. 161, 1118 (1967)
 1967Gu06 S.C.Gujrathi, S.K.Mukherjee – Phys.Rev. 159, 909 (1967)
 1967Hj01 S.A.Hjorth – Ark.Fys. 33, 147 (1967)
 1967Sc02 R.Schoneberg, A.Flammersfeld – Z.Phys. 200, 205 (1967)
 1967Te02 R.G.Tee, A.Aspinall – Nucl.Phys. A98, 417 (1967)
 1967Wa04 A.H.Wapstra, L.G.R.Mathot, J.E.J.Oberski, H.J.Pfalzgaf, S.A.De Wit – Priv.Comm. (May 1967)
 1968A118 B.J.Allen, M.J.Kenny, R.J.Sparks – Nucl.Phys. A122, 220 (1968)
 1968An22 A.E.Antropov, V.P.Bochin, P.P.Zarubin, B.N.Orlov, A.V.Plavko, A.I.Sorokin – Izv.Akad.Nauk SSSR, Ser.Fiz. 32, 1741 (1968); Bull.Acad.Sci.USSR, Phys.Ser. 32, 1605 (1969)
 1968Ch10 W.J.Childs, L.S.Goodman – Phys.Rev. 170, 136 (1968)
 1968Co01 E.R.Cosman, D.N.Schramm, H.A.Engel – Nucl.Phys. A109, 305 (1968)
 1968Ka21 I.V.Kazachevskii, V.N.Levkovskii – Izv.Akad.Nauk SSSR, Ser.Fiz. 32, 235 (1968); Bull.Acad.Sci.USSR, Phys.Ser. 32, 213 (1969)
 1968Ka22 I.V.Kazachevskii, V.N.Levkovskii – Izv.Akad.Nauk SSSR, Ser.Fiz. 32, 322 (1968); Bull.Acad.Sci.USSR, Phys.Ser. 32, 295 (1969)
 1968Na15 L.Nauclear, I.Bergqvist, B.Lundberg, L.Nilsson – Nucl.Phys. A122, 113 (1968)
 1968Pu03 D.J.Pullen, B.Rosner – Phys.Rev. 170, 1034 (1968)
 1968Ru01 D.E.Rundquist, M.K.Brussel, A.I.Yavin – Phys.Rev. 168, 1287 (1968)
 1968Ru02 D.E.Rundquist, M.K.Brussel, A.I.Yavin – Phys.Rev. 168, 1296 (1968)
 1969Ar20 K.P.Artemov, V.Z.Goldberg, B.I.Islamov, V.P.Rudakov – Yad.Fiz. 10, 911 (1969); Sov.J.Nucl.Phys. 10, 526 (1970)
 1969Co05 K.L.Coop, I.G.Graham, J.M.Poate, E.W.Titterton – Nucl.Phys. A130, 223 (1969)
 1969Da09 W.W.Daehnick, Y.S.Park – Phys.Rev. 180, 1062 (1969)
 1969Fu06 H.Fuchs, K.Grabisch, G.Roschert – Nucl.Phys. A133, 385 (1969)
 1969Ga25 L.N.Galperin, A.Z.Ilyasov, I.K.Lemberg, G.A.Firsanov – Yad.Fiz. 9, 225 (1969); Sov.J.Nucl.Phys. 9, 133 (1969)
 1969Gu07 B.Y.Guzhovskii, I.M.Borkin, A.G.Zvenigorodskii, V.S.Rudnev, A.P.Solodovnikov, S.V.Trusillo – Izv.Akad.Nauk SSSR, Ser.Fiz. 33, 129 (1969); Bull.Acad.Sci.USSR, Phys.Ser. 33, 119 (1970)
 1969Ho02 E.J.Hoffman, D.G.Sarantites – Phys.Rev. 177, 1647 (1969)
 1969Ki09 B.G.Kiselev, V.N.Levkovskii – Yad.Fiz. 9, 1113 (1969); Sov.J.Nucl.Phys. 9, 651 (1969)
 1969Ok01 V.V.Okorokov, D.L.Tolchenkov, Y.N.Cheblukov – Yad.Fiz. 9, 710 (1969); Sov.J.Nucl.Phys. 9, 411 (1969)
 1969Ri04 J.C.Ritter, R.E.Larson – Nucl.Phys. A127, 399 (1969)
 1969Sh12 E.N.Shipley, R.E.Holland, F.J.Lynch – Phys.Rev. 182, 1165 (1969)
 1970An32 A.E.Antropov, S.I.Vasilev, P.P.Zarubin, B.N.Orlov, A.V.Plavko, A.I.Sorokin – Izv.Akad.Nauk SSSR, Ser.Fiz. 34, 400 (1970); Bull.Acad.Sci. USSR, Phys.Ser. 34, 348 (1971)
 1970Ba64 W.T.Bass, P.H.Stelson – Phys.Rev. C2, 2154 (1970)
 1970Br33 J.C.Browne, H.W.Newson, E.G.Bilpuch, G.E.Mitchell – Nucl.Phys. A153, 481 (1970)
 1970Co21 K.L.Coop, I.G.Graham, E.W.Titterton – Nucl.Phys. A150, 346 (1970)
 1970GaZQ J.-J.Gardien – Thesis, Univ.Paris (1970); FRNC-TH-37 (1970)
 1970Ho29 E.J.Hoffman, D.G.Sarantites – Nucl.Phys. A157, 584 (1970)
 1971AzZZ S. A. A z i m o v , M . G u l y a m o v , T . I s k h a k o v , M . M . K h o d z h a e v – Program and Theses, Proc.21st Ann.Conf.Nucl.Spectrosc.Struct.At.Nuclei, Moscow, Abstr., p.45 (1971)
 1971Go31 J.Goring – Z.Naturforsch. 26a, 1931 (1971)
 1971He14 B.Heusch, B.Cujec, R.Dayras, J.N.Mo, I.M.Szogy – Nucl.Phys. A169, 145 (1971)
 1971He17 B.Heusch, B.Cujec, R.Dayras – Nucl.Phys. A172, 395 (1971)
 1971Ho21 E.J.Hoffman, D.G.Sarantites, N.-H.Lu – Nucl.Phys. A173, 146 (1971)
 1971Ho22 E.J.Hoffman, D.G.Sarantites – Nucl.Phys. A173, 177 (1971)
 1971Hu01 F.R.Hudson, R.N.Glover – Nucl.Phys. A160, 482 (1971)
 1971Ki29 A.Kiuru, P.Holmberg, M.Viitasalo – Commentat.Phys.-Math. 41, 55 (1971)
 1971VoZX M. A . V o r o n i n , L . M . D a u t o v , D . K . K a i p o v , Y u . K . S h u b n y i – Program and Theses, Proc.21st Ann.Conf.Nucl.Spectrosc.Struct.At.Nuclei, Moscow, Abstr., p.205 (1971)
 1972Bu17 D.Bucurescu, M.Ivascu, G.Semenescu, M.Titirici – Nucl.Phys. A189, 577 (1972)
 1972Ca20 B.Castel, I.P.Johnstone, B.P.Singh, K.W.C.Stewart – Can.J.Phys. 50, 1630 (1972)
 1972Cr02 D.F.Crisler, H.B.Eldridge, R.Kunselman, C.S.Zaidins – Phys.Rev. C5, 419 (1972)
 1972Du09 G.H.Dulfer, B.O.ten Brink, T.J.Ketel, A.W.B.Kalshoven, H.Verheul – Z.Phys. 251, 416 (1972)
 1972GeZG R.J.Gehrke – ANCR-1088, p.392 (1972)
 1972Iw02 Y.Iwasaki, M.Sekiguchi, F.Soga, N.Takahashi – Phys.Rev.Lett. 29, 1528 (1972)
 1972Ko15 J.Kopecky, K.Abrahams, F.Stecher-Rasmussen – Nucl.Phys. A188, 535 (1972)
 1972Sz01 I.Szentpetery, J.Szucs – Phys.Rev.Lett. 28, 378 (1972)
 1973Ay03 J.A.Aymar, H.R.Hiddleston, E.D.Berners, A.A.Rollefson – Nucl.Phys. A213, 125 (1973)
 1973Bi11 J.R.Bird, B.J.Allen, I.Bergqvist, J.A.Biggerstaff – Nucl.Data Tables 11, 433 (1973)
 1973Ho21 E.J.Hoffman, D.M.Van Patter, D.G.Sarantites, J.H.Barker – Nucl.Instrum.Methods 109, 3 (1973)
 1973Ma38 M.T.Magda, I.Lukas, M.Nistor, A.Chevarier, N.Chevarier, A.Demeyer, G.Hollinger, Tran Minh Duc – Lett.Nuovo Cim. 8, 396 (1973)
 1973Ne02 D.A.Newton, S.Sarkar, L.Yaffe, R.B.Moore – J.Inorg.Nucl.Chem. 35, 361 (1973)
 1973Sa19 D.G.Sarantites, J.H.Barker, N.-H.Lu, E.J.Hoffman, D.M.Van Patter – Phys.Rev. C8, 629 (1973)
 1973Sc09 K.P.Schmidt, R.Coussement, G.Langouche, J.P.Lafaut – Nucl.Phys. A204, 279 (1973)
 1973Tr06 J.P.Trentelman, J.R.Leslie, W.McLatchie – Nucl.Phys. A206, 393 (1973)
 1974Ad06 M.Adachi, T.Hattori, E.Arai, M.Ogawa, H.Sato – J.Phys.Soc.Jap. 36, 1266 (1974)

NUCLEAR DATA SHEETS

REFERENCES FOR A=61 (CONTINUED)

- 1974An17 D.S.Andreev, I.K.Lemberg, S.A.Petrov, K.K.Revyuk, I.N.Chugunov – *Izv.Akad.Nauk SSSR, Ser.Fiz.* 38, 721 (1974); *Bull.Acad.Sci.USSR, Phys.Ser.* 38, No.4, 48 (1974)
- 1974An20 D.S.Andreev, K.I.Erokhina, V.S.Zvonov, I.K.Lemberg, A.S.Mishin – *Izv.Akad.Nauk SSSR, Ser.Fiz.* 38, 1661 (1974); *Bull.Acad.Sci.USSR, Phys.Ser.* 38, No.8, 86 (1974)
- 1974Br34 R.A.Braga, D.G.Sarantites – *Phys.Rev.* C10, 2109 (1974)
- 1974Br39 P.H.Brown, R.C.Block, J.R.Tatarczuk – *Nucl.Phys.* A236, 45 (1974)
- 1974BrYF R.Braga – *COO-1530-43*, p.31 (1974)
- 1974Ko32 D.H.Kong-A-Siou, W.S.Chien – *Phys.Lett.* 52B, 175 (1974)
- 1974Kr26 O.E.Kraft, Y.V.Naumov, I.V.Sizov – *Yad.Fiz.* 20, 1081 (1974); *Sov.J.Nucl.Phys.* 20, 567 (1975)
- 1974Le34 I.K.Lemberg, A.A.Pasternak – *Izv.Akad.Nauk SSSR, Ser.Fiz.* 38, 1600 (1974); *Bull.Acad.Sci.USSR, Phys.Ser.* 38, No.8, 35 (1974)
- 1974Sa01 D.G.Sarantites, J.H.Barker, N.-H.Lu – *Phys.Rev.* C9, 603 (1974)
- 1974Tr03 J.P.Trentelman, J.R.Leslie, W.McLatchie – *Z.Phys.* 266, 69 (1974)
- 1974WiZR J.R.Williams, Jr. – Thesis, North Carolina State University (1974)
- 1974YoZT Y.Yoshizawa, H.Noma, T.Horiguchi, H.Kushiyama, T.Katoh, M.Itoh, K.Chida, K.Hisatake, M.Sekikawa – *Inst.Nucl.Study, Univ.Tokyo, Ann.Rept.*, 1973, p.27 (1974)
- 1975Au05 R.L.Auble – *Nucl.Data Sheets* 16, 1 (1975)
- 1975Ba28 A.Baghdadi, R.Seltz, D.Magnac-Valette, G.Bonneaud, C.Gerardin – *J.Phys.(Paris), Suppl.Lett.* 36, L-181 (1975)
- 1975Ba63 A.Baghdadi, R.Seltz, D.Magnac-Valette, G.Bonneaud, C.Gerardin – *Nucl.Phys.* A253, 20 (1975)
- 1975Br04 J.Bron, H.W.Jongsma, H.Verheul – *Phys.Rev.* C11, 966 (1975)
- 1975Kr05 O.E.Kraft, Y.V.Naumov, I.V.Sizov – *Yad.Fiz.* 21, 919 (1975); *Sov.J.Nucl.Phys.* 21, 472 (1976)
- 1975Kr06 O.E.Kraft, Y.V.Naumov, I.V.Sizov – *Izv.Akad.Nauk SSSR, Ser.Fiz.* 39, 70 (1975); *Bull.Acad.Sci.USSR, Phys.Ser.* 39, No.1, 59 (1975)
- 1975Ro25 S.Roodbergen, H.Visser, W.Molendijk, H.S.Bedet, H.Verheul – *Z.Phys.* A275, 45 (1975)
- 1975SeZB V.A.Sergienko, P.P.Zarubin, Yu.A.Aleksandrov, A.A.Bykov, M.Aprelev, V.A.Larionova – Program and Theses, Proc.25th Ann.Conf.Nucl.Spectrosc.Struct.At.Nuclei, Leningrad, p.59 (1975)
- 1975Wi06 W.M.Wilson, G.E.Thomas, H.E.Jackson – *Phys.Rev.* C11, 1477 (1975)
- 1975Wi28 J.R.Williams, C.R.Gould, R.O.Nelson, D.R.Tilley, D.G.Rickel, N.R.Roberson – *Nucl.Phys.* A253, 365 (1975)
- 1976Ar01 E.Arai, M.Ogawa, H.Sato – *Nucl.Phys.* A256, 127 (1976)
- 1976Be30 G.Bergdolt, A.M.Bergdolt, H.V.Klapdor, M.Schrader – *Nucl.Phys.* A263, 477 (1976)
- 1976Bo06 A.Boudard, G.Brüge, A.Chaumeaux, G.Finkel, D.Ashery, A.I.Yavin – *Phys.Rev.* C13, 1123 (1976)
- 1976Br36 R.M.Britton, D.L.Watson – *Nucl.Phys.* A272, 91 (1976); Erratum *Nucl.Phys.* A292, 536 (1977)
- 1976Ch34 R.Chapman, J.N.Mo, J.L.Durell, N.H.Merrill – *J.Phys.(London)* G2, 951 (1976)
- 1976FlZY D.S.Flynn – Thesis, Duke University (1976)
- 1976Fu06 G.H.Fuller – *J.Phys.Chem.Ref.Data* 5, 835 (1976)
- 1976Gu08 P.Guazzoni, M.Ippanelli, E.Colombo, F.Crescentini – *Phys.Rev.* C13, 1424 (1976)
- 1976Hu06 G.A.Huttlin, J.A.Aymar, J.A.Bieszk, S.Sen, A.A.Rollefson – *Nucl.Phys.* A263, 445 (1976)
- 1976Ko06 D.H.Koang, W.S.Chien, H.Rossner – *Phys.Rev.* C13, 1470 (1976)
- 1976Kr19 O.E.Kraft, Y.V.Naumov, S.S.Parzhitskii, I.V.Sizov – *Izv.Akad.Nauk SSSR, Ser.Fiz.* 40, 1182 (1976); *Bull.Acad.Sci.USSR, Phys.Ser.* 40, No.6, 73 (1976)
- 1976Ma24 J.F.Mateja, J.A.Bieszk, J.T.Meek, J.D.Goss, A.A.Rollefson, P.L.Jolivet, C.P.Browne – *Phys.Rev.* C13, 2269 (1976)
- 1976Mo02 P.J.Moffa, C.B.Dover, J.P.Vary – *Phys.Rev.* C13, 147 (1976)
- 1976Ob01 F.E.Obenshain, J.C.Williams, L.W.Houk – *J.Inorg.Nucl.Chem.* 38, 19 (1976)
- 1977Co08 J.D.Cossairt, R.E.Tribble, R.A.Kenefick – *Phys.Rev.* C15, 1685 (1977)
- 1977Ho29 M.D.Hossain – *Nuovo Cim.* 39A, 594 (1977)
- 1977Is01 A.F.M.Ishaq, A.Robertson, W.V.Prestwich, T.J.Kennett – *Z.Phys.* A281, 365 (1977)
- 1977Pa06 P.N.Patrawale, R.G.Kulkarni – *J.Phys.(London)* G3, 401 (1977)
- 1977St07 P.Staub, E.Baumgartner, J.X.Saladin, H.Schar, D.Trautmann – *Helv.Phys.Acta* 50, 9 (1977)
- 1977Wa03 R.Wadsworth, A.Kogan, P.R.G.Lornie, M.R.Nixon, H.G.Price, P.J.Twin – *J.Phys.(London)* G3, 35 (1977)
- 1977Wa07 R.Wadsworth, G.D.Jones, A.Kogan, P.R.G.Lornie, T.Morrison, O.Mustaffa, H.G.Price, D.Simister, P.J.Twin – *J.Phys.(London)* G3, 833 (1977)
- 1977Wa15 R.Wadsworth, G.D.Jones, A.Kogan, P.R.G.Lornie, T.Morrison, O.Mustaffa, H.G.Price, D.N.Simister, P.J.Twin – *J.Phys.(London)* G3, 1377 (1977)
- 1978Be04 H.Beer, R.R.Spencer, F.Kappeler – *Z.Phys.* A284, 173 (1978)
- 1978Jo08 P.L.Jolivet, C.P.Browne – *Phys.Rev.* C18, 1590 (1978)
- 1978LeZA C.M.Lederer, V.S.Shirley, E.Browne, J.M.Dairiki, R.E.Doebler, A.A.Shihab-Eldin, L.J.Jardine, J.K.Tuli, A.B.Buyn – Table of Isotopes, 7th Ed., John Wiley and Sons, Inc., New York (1978)
- 1978Me10 R.A.Meyer, A.L.Prindle, W.A.Myers, P.K.Hopke, D.Dieterly, J.E.Koops – *Phys.Rev.* C17, 1822 (1978)
- 1978Na14 H.Nann, E.R.Flynn, D.L.Hanson, S.Raman – *Phys.Rev.* C18, 2511 (1978)
- 1978ViZT D.J.Vieira – Thesis, Univ.California (1978); LBL-7161 (1978)
- 1978Wa09 E.K.Warburton, J.W.Olness, A.M.Nathan, A.R.Poletti – *Phys.Rev.* C18, 1637 (1978)
- 1978Wo01 C.W.Woods, N.Stein, J.W.Sunier – *Phys.Rev.* C17, 66 (1978)
- 1979An26 V.A.Anufriev, S.I.Babich, A.G.Kolesov, V.N.Nefedov, V.V.Tikhomirov, V.S.Artamonov, R.I.Ivanov, S.M.Kalebin – *At.Energ.* 46, 54 (1979); *Sov.At.Energ.* 46, 57 (1979)
- 1979Bo09 S.Bokharee, K.Rimawi, J.B.Garg – *Nucl.Phys.* A320, 385 (1979)
- 1979El06 F.M.El Ashri, O.V.Chubinskii, L.I.Vinogradov, Y.F.Andronov, L.V.Gustova – *Yad.Fiz.* 30, 13 (1979); *Sov.J.Nucl.Phys.* 30, 6 (1979)
- 1979Fi02 G.Finkel, D.Ashery, A.I.Yavin, A.Boudard, G.Brüge, A.Chaumeaux, M.Rouger – *Phys.Rev.* C19, 1782 (1979)

NUCLEAR DATA SHEETS

REFERENCES FOR A=61 (CONTINUED)

- 1979Ik04 H.Ikegami, T.Yamazaki, S.Morinobu, I.Katayama, M.Fujiwara, Y.Fujita, H.Taketani, M.Adachi, T.Matsuzaki, N.Koori, M.Matoba – Nucl.Phys. A329, 84 (1979)
- 1979Sm03 J.W.Smits, R.H.Siemssen, S.Y.van der Werf, A.van der Woude – Nucl.Phys. A319, 29 (1979)
- 1979ViZY D.J.Vieira – Diss.Abst.Int. 40B, 238 (1979)
- 1979We02 D.J.Weber, G.M.Crawley, W.Benenson, E.Kashy, H.Nann – Nucl.Phys. A313, 385 (1979)
- 1981Bu26 N.T.Burtebaev, A.D.Duisebaev, G.N.Ivanov, V.I.Kanashevich, V.A.Lichman – Izv.Akad.Nauk SSSR, Ser.Fiz. 45, 2176 (1981)
- 1981By03 A.A.Bykov, O.E.Kraft, Yu.V.Naumov, B.F.Petrov, V.M.Sigalov, I.V.Sizov – Izv.Akad.Nauk SSSR, Ser.Fiz. 45, 822 (1981)
- 1981Ca10 Y.Cauchois, H.Ben Abdelaziz, R.Kherouf, C.Schloesing-Moller – J.Phys.(London) G7, 1539 (1981)
- 1981Ki06 J.E.Kim, W.W.Daehnick – Phys.Rev. C24, 1461 (1981)
- 1982Gr10 A.Grutter – Int.J.Appl.Radiat.Isotop. 33, 533 (1982)
- 1982Ma41 M.N.Martins, E.Wolynec, M.C.A.Campos – Phys.Rev. C26, 1936 (1982)
- 1982Sm01 P.J.Smith, L.P.Ekstrom, F.Kearns, P.J.Twin, N.J.Ward – J.Phys.(London) G8, 281 (1982)
- 1983Ek01 L.P.Ekstrom, J.Lyttkens – Nucl.Data Sheets 38, 463 (1983)
- 1983OkZY Y.Okuma, T.Yanabu, T.Motobayashi, K.Takimoto, S.Matsuki, K.Ogino, T.Shimoura, M.Fukada, T.Suehiro – RCNP (Osaka), Ann.Rept., 1982, p.88 (1983)
- 1983Os08 A.Osman, S.A.Saleh – Acta Phys.Acad.Sci.Hung. 54, 25 (1983)
- 1983Si06 V.M.Sigalov, A.A.Bykov, O.E.Kraft, Yu.V.Naumov, S.S.Parzhitsky, B.F.Petrov, I.V.Sizov – Izv.Akad.Nauk SSSR, Ser.Fiz. 47, 66 (1983)
- 1984Em01 A.Emsalle, M.Asghar, P.D'Hondt, C.Wagemans – Z.Phys. A315, 201 (1984)
- 1984Ma60 A.Marinov, W.Oelert, S.Gopal, G.P.A.Berg, J.Bojowald, W.Hurlimann, I.Katayama, S.A.Martin, C.Mayer-Boricke, J.Meissburger, J.G.M.Romer, M.Rogge, J.L.Tain, P.Turek, L.Zemlo, R.B.M.Mooy, P.W.M.Glaudemans, S.Brant, V.Paar, M.Vouk, V.Lopac – Nucl.Phys. A431, 317 (1984)
- 1984Qa04 S.M.Qaim, R.Wolfe, M.M.Rahman, H.Ollig – Nucl.Sci.Eng. 88, 143 (1984)
- 1984So16 V.G.Soloviev – Yad.Fiz. 40, 1163 (1984)
- 1984Th07 J.M.Thirion, G.Chouragui, Th.Muller, M.Port – Z.Phys. A317, 329 (1984)
- 1985AnZV A.E.Antropov, V.P.Gusev, P.P.Zarubin, A.A.Kolozhvari, Yu.V.Khrisanfov – Program and Theses, Proc.35th Ann.Conf.Nucl.Spectrosc.Struct.At.Nuclei, Leningrad, p.273 (1985)
- 1985Fo02 H.T.Fortune, M.Carchidi, H.Banu, H.M.Sen Gupta – Phys.Rev. C31, 392 (1985)
- 1985Gu14 D.Guillemaud-Mueller, A.C.Mueller, D.Guerreau, F.Pougheon, R.Anne, M.Bernas, J.Galin, J.C.Jacmart, M.Langevin, F.Naulin, E.Quiniou, C.Detraz – Z.Phys. A322, 415 (1985)
- 1985OkZX Y.Okuma, T.Motobayashi, K.Takimoto, S.Shimoura, M.Fukada, T.Suehiro, T.Yanabu – RCNP (Osaka) Ann.Rept., 1984, p.108 (1985)
- 1985OkZY Y.Okuma, T.Motobayashi, K.Takimoto, S.Shimoura, M.Fukada, T.Suehiro, T.Yanabu – RCNP (Osaka), Ann.Rept., 1984, p.104 (1985)
- 1985Ru05 E.Runte, K.-L.Gippert, W.-D.Schmidt-Ott, P.Tidemand-Petersson, L.Ziegeler, R.Kirchner, O.Klepper, P.O.Larsson, E.Roeckl, D.Schardt, N.Kaffrell, P.Peuser, M.Bernas, P.Dessagne, M.Langevin, K.Ryckaczewski – Nucl.Phys. A441, 237 (1985)
- 1985Vi01 F.Videbaek, O.Hansen, B.S.Nilsson, E.R.Flynn, J.C.Peng – Nucl.Phys. A433, 441 (1985)
- 1985Wo01 P.J.Woods, R.Chapman, J.L.Durell, J.N.Mo, N.E.Sanderson, R.A.Cunningham, B.R.Fulton – Phys.Lett. 150B, 79 (1985)
- 1986Iz01 I.N.Izosimov, O.E.Kraft, Yu.V.Naumov, V.M.Sigalov – Izv.Akad.Nauk SSSR, Ser.Fiz. 50, 1952 (1986); Bull.Acad.Sci.USSR, Phys.Ser. 50, No.10, 80 (1986)
- 1986OkZV Y.Okuma, T.Motobayashi, K.Takimoto, S.Shimoura, M.Fukada, T.Suehiro – Proc.Intern.Nuclear Physics Conference, Harrogate, U.K., p.233 (1986)
- 1986TaZV D.C.Tayal, C.Singh, K.P.Singh, H.S.Hans – Bull.Am.Phys.Soc. 31, No.8, 1303, P2.50 (1986)
- 1987Ho01 M.A.C.Hotchkis, J.E.Reiff, D.J.Vieira, F.Blomnigen, T.F.Lang, D.M.Moltz, X.Xu, J.Cerny – Phys.Rev. C35, 315 (1987)
- 1988Iz01 I.N.Izosimov, O.E.Kraft, S.S.Parzhitsky, V.M.Sigalov, I.V.Sizov – Izv.Akad.Nauk SSSR, Ser.Fiz. 52, 72 (1988); Bull.Acad.Sci.USSR, Phys.Ser. 52, No.1, 67 (1988)
- 1988Le02 H.Lerchner, M.Rosenberg – Hyperfine Interactions 39, 51 (1988)
- 1988Sa26 G.Satyanarayana, N.Venkateswara Rao, G.S.Sri Krishna, M.V.S.Chandrasekhar Rao, S.Bhuloka Reddy, D.L.Sastry, S.N.Chintalapudi, V.V.Rao – Nuovo Cim. 99A, 309 (1988)
- 1989Gr24 D.Gryffroy, R.E.Vandenbergh, E.de Grave, R.M.Persoons – Hyperfine Interactions 50, 631 (1989)
- 1989Iz01 I.N.Izosimov – Izv.Akad.Nauk SSSR, Ser.Fiz. 53, 2451 (1989); Bull.Acad.Sci.USSR, Phys.Ser. 53, No.12, 175 (1989)
- 1989IzZZ I.N.Izosimov – Program and Thesis, Proc.39th Ann.Conf.Nucl.Spectrosc.Struct.At.Nuclei, Tashkent, p.285 (1989)
- 1989Ko54 Yu.G.Kosyakov, D.K.Kaipov, L.V.Chekushina – Izv.Akad.Nauk SSSR, Ser.Fiz. 53, 2130 (1989); Bull.Acad.Sci.USSR, Phys.Ser. 53, No.11, 68 (1989)
- 1989Sc18 A.Scalia – Nuovo Cim. 101A, 781 (1989)
- 1989Sc28 R.B.Schubank, J.A.Cameron, V.P.Janzen – Phys.Rev. C40, 2310 (1989)
- 1989Si25 V.M.Sigalov – Izv.Akad.Nauk SSSR, Ser.Fiz. 53, 2055 (1989); Bull.Acad.Sci.USSR, Phys.Ser. 53, No.10, 185 (1989)
- 1989Ti01 C.I.W.Tingwell, V.Y.Hansper, S.G.Tims, A.F.Scott, A.J.Morton, D.G.Sargood – Nucl.Phys. A496, 127 (1989)
- 1990Ku08 R.Kunselman, J.D.Zumbro, E.B.Shera, M.V.Hoehn – Nucl.Phys. A514, 589 (1990)
- 1990Se03 H.M.Sen Gupta, J.B.A.England, F.Khazaie, E.M.E.Rawas, G.T.A.Squier – Nucl.Phys. A512, 97 (1990)
- 1990Sz01 J.Sziklai, T.Vass, J.A.Cameron, I.M.Szogy – Phys.Rev. C41, 849 (1990)
- 1990Tu01 X.L.Tu, X.G.Zhou, D.J.Vieira, J.M.Wouters, Z.Y.Zhou, H.L.Seifert, V.G.Lind – Z.Phys. A337, 361 (1990)
- 1991Mo10 M.F.Mohar, D.Bazin, W.Benenson, D.J.Morrissey, N.A.Orr, B.M.Sherill, D.Swan, J.A.Winger, A.C.Mueller, D.Guillemaud-Mueller – Phys.Rev.Lett. 66, 1571 (1991)
- 1991Ul01 S.Ulbig, K.P.Lieb, H.G.Borner, B.Krusche, S.J.Robinson, J.G.L.Booten – Z.Phys. A338, 397 (1991)
- 1991We07 E.Wesolowski, A.Saganek, E.Gierlik, V.Meyer, M.Sieminski, A.Turowiecki, Z.Wilhelmi – J.Phys.(London) G17, 955 (1991)

NUCLEAR DATA SHEETS

REFERENCES FOR A=61 (CONTINUED)

- 1992Ku17 A.Kuronen, J.Keinonen, H.G.Borner, J.Jolie, S.Ulbig – Nucl.Phys. A549, 59 (1992)
- 1992We04 M.Weber, C.Donzaud, J.P.Dufour, H.Geissel, A.Grewe, D.Guillemaud-Mueller, H.Keller, M.Lewitowicz, A.Magel, A.C.Mueller, G.Munzenberg, F.Nickel, M.Pfutzner, A.Piechaczek, M.Pravikoff, E.Roeckl, K.Rykaczewski, M.G.Saint-Laurent, I.Schall, C.Stephan, K.Summerer, L.Tassan-Got, D.J.Vieira, B.Voss – Z.Phys. A343, 67 (1992)
- 1992Zh31 C.Zhou – Nucl.Data Sheets 67, 271 (1992)
- 1993Ca12 J.A.Cameron – Phys.Rev. C47, 2517 (1993)
- 1993Ha05 A.Harder, S.Michaelsen, K.P.Lieb, A.P.Williams – Z.Phys. A345, 143 (1993)
- 1993HaZV A.Harder, S.Michaelsen, A.Jungclaus, K.P.Lieb, A.P.Williams, H.G.Borner – Proc.6th Intern.Conf.on Nuclei Far from Stability + 9th Intern.Conf.on Atomic Masses and Fundamental Constants, Bernkastel-Kues, Germany, 19–24 July, 1992, R.Neugart, A.Wohr, Eds., p.69 (1993)
- 1993Wi03 J.A.Winger, D.P.Bazin, W.Benenson, G.M.Crawley, D.J.Morrissey, N.A.Orr, R.Pfaff, B.M.Sherrill, M.Steiner, M.Thoennessen, S.J.Yennello, B.M.Young – Phys.Lett. 299B, 214 (1993)
- 1993Wi18 J.A.Winger, D.P.Bazin, W.Benenson, G.M.Crawley, D.J.Morrissey, N.A.Orr, R.Pfaff, B.M.Sherrill, M.Thoennessen, S.J.Yennello, B.M.Young – Phys.Rev. C48, 3097 (1993)
- 1994Se12 H.L.Seifert, J.M.Wouters, D.J.Vieira, H.Wollnik, X.G.Zhou, X.L.Tu, Z.Y.Zhou, G.W.Butler – Z.Phys. A349, 25 (1994)
- 1995Ri05 W.A.Richter, M.G.Van der Merwe, B.Brown – Nucl.Phys. A586, 445 (1995); Erratum Nucl.Phys. A596, 716 (1996)
- 1996Ma11 M.Matoba, K.Kurohmaru, O.Iwamoto, A.Nohtomi, Y.Uozumi, T.Sakae, N.Koori, H.Ohgaki, H.Ijiri, T.Maki, M.Nakano, H.M.Sen Gupta – Phys.Rev. C53, 1792 (1996)
- 1996Re18 P.H.Regan, J.W.Arrison, U.J.Huttmeier, D.P.Balamuth – Phys.Rev. C54, 1084 (1996)
- 1997Ba98 T.J.Bastow, M.E.Smith, G.W.West – J.Phys.Condens.Matter 9, 6085 (1997)
- 1997Be70 M.Bernas, C.Engelmann, P.Armbruster, S.Czajkowski, F.Ameil, C.Bockstiegel, Ph.Dessagne, C.Donzaud, H.Geissel, A.Heinz, Z.Janas, C.Kozhuharov, Ch.Miehe, G.Munzenberg, M.Pfutzner, W.Schwab, C.Stephan, K.Summerer, L.Tassan-Got, B.Voss – Phys.Lett. 415B, 111 (1997)
- 1997Ha45 Y.Hatsukawa, T.Hayakawa, K.Furutaka, H.Nakada, M.Kidera, T.Ishii, M.Matsuda, M.Oshima, S.Mitarai, M.Sugawara, H.Kusakari, T.Tomatsubara, K.Furuno – Z.Phys. A359, 3 (1997)
- 1997Mo25 P.Moller, J.R.Nix, K.-L.Kratz – At.Data Nucl.Data Tables 66, 131 (1997)
- 1997Or04 W.E.Ormand – Phys.Rev. C55, 2407 (1997)
- 1997Ve03 L.Venturini, B.R.S.Pecequilo – Appl.Radiat.Isot. 48, 493 (1997)
- 1998Am04 F.Ameil, M.Bernas, P.Armbruster, S.Czajkowski, P.Dessagne, H.Geissel, E.Hanelt, C.Kozhuharov, C.Miehe, C.Donzaud, A.Grewe, A.Heinz, Z.Janas, M.de Jong, W.Schwab, S.Steinhauser – Eur.Phys.J. A 1, 275 (1998)
- 1998Gr14 R.Grzywacz, R.Beraud, C.Borcea, A.Emsallem, M.Glogowski, H.Grawe, D.Guillemaud-Mueller, M.Hjorth-Jensen, M.Houry, M.Lewitowicz, A.C.Mueller, A.Nowak, A.Plochocki, M.Pfutzner, K.Rykaczewski, M.G.Saint-Laurent, J.E.Sauvestre, M.Schaefer, O.Sorlin, J.Szerypo, W.Trinder, S.Viteritti, J.Winfield – Phys.Rev.Lett. 81, 766 (1998)
- 1999Bh04 M.R.Bhat – Nucl.Data Sheets 88, 417 (1999)
- 1999Ha05 M.Hannawald, T.Kautzsch, A.Wohr, W.B.Walters, K.-L.Kratz, V.N.Fedoseyev, V.I.Mishin, W.Bohmer, B.Pfeiffer, V.Sebastian, Y.Jading, U.Koster, J.Letry, H.L.Ravn, and the ISOLDE Collaboration – Phys.Rev.Lett. 82, 1391 (1999)
- 1999Le67 S.Leenhardt, F.Azaiez, O.Sorlin, M.Belleguic, C.Bourgeois, C.Donzaud, J.Duprat, S.Grevy, D.Guillemaud-Mueller, A.C.Mueller, F.Pougheon, I.Deloncle, J.Kiener, M.G.Porquet, J.M.Daugas, M.Lewitowicz, F.de Oliveira, M.G.Saint-Laurent, J.Winfield, J.C.Angelique, N.Orr, A.Gillibert, F.Marie, C.Borcea, Yu.-E.Penionzhkevich, Yu.Sobolev, R.Beraud, G.Canchel, E.Chabanat, A.Emsallem, C.Longour, J.E.Sauvestre – Nucl.Phys. (Supplement) A654, 683c (1999)
- 1999Oi01 M.Oinonen, P.Baumann, P.Dendooven, Y.Fujita, M.Gorska, H.Grawe, Z.Hu, Z.Janas, A.Jokinen, R.Kirchner, O.Klepper, A.Knipper, W.Liu, H.Penttila, A.Plochocki, M.Ramdhane, E.Roeckl, G.Walter, J.Aysto – Eur.Phys.J. A 5, 151 (1999)
- 1999So20 O.Sorlin, C.Donzaud, L.Axelsson, M.Belleguic, R.Beraud, C.Borcea, G.Canchel, E.Chabanat, J.M.Daugas, A.Emsallem, D.Guillemaud-Mueller, K.-L.Kratz, S.Leenhardt, M.Lewitowicz, C.Longour, M.J.Lopez, F.de Oliveira Santos, L.Petizon, B.Pfeiffer, F.Pougheon, M.G.Saint-Laurent, J.E.Sauvestre – Nucl.Phys. A660, 3 (1999); Erratum Nucl.Phys. A669, 351 (2000)
- 1999Vi07 S.M.Vincent, P.H.Regan, S.Mohammadi, W.Gelletly, D.Blumenthal, M.P.Carpenter, C.N.Davids, R.V.F.Janssens, C.J.Lister, C.J.Pearson, J.Simpson, D.Seweryniak, J.Schwartz, D.D.Warner – J.Phys.(London) G25, 941 (1999)
- 1999Vi12 S.M.Vincent, P.H.Regan, S.Mohammadi, D.Blumenthal, M.Carpenter, C.N.Davids, W.Gelletly, S.S.Ghugre, D.J.Henderson, R.V.F.Janssens, M.Hjorth-Jensen, B.Kharraja, C.J.Lister, C.J.Pearson, D.Seweryniak, J.Schwartz, J.Simpson, D.D.Warner – Phys.Rev. C60, 064308 (1999)
- 1999Yu10 C.-H.Yu, C.Baktash, J.Dobaczewski, J.A.Cameron, C.Chitu, M.Devlin, J.Eberth, A.Galindo-Uribarri, D.S.Haslip, D.R.LaFosse, T.J.Lampman, I.-Y.Lee, F.Lerma, A.O.Macchiavelli, S.D.Paul, D.C.Radford, D.Rudolph, D.G.Sarantites, C.E.Svensson, J.C.Waddington, J.N.Wilson – Phys.Rev. C60, 031305 (1999)
- 2000HaZL M.W.Hannawald – Thesis, Univ.Johannes Gutenberg, Mainz (2000)
- 2001Ny01 K.Nybo, H.Helstrup, T.F.Thorsteinsen, G.Lovhoiden – Phys.Scr. 63, 181 (2001)
- 2001Pa02 S.K.Patra, M.Del Estal, M.Centelles, X.Vinas – Phys.Rev. C63, 024311 (2001)
- 2001So07 O.Sorlin – Nucl.Phys. A682, 183c (2001)
- 2002B117 B.Blank – Eur.Phys.J. A 15, 121 (2002)
- 2002Ca48 E.Caurier, F.Nowacki, A.Poves – Eur.Phys.J. A 15, 145 (2002)
- 2002Lo13 M.J.Lopez Jimenez, B.Blank, M.Chartier, S.Czajkowski, P.Dessagne, G.de France, J.Giovinazzo, D.Karamanis, M.Lewitowicz, V.Maslov, C.Miehe, P.H.Regan, M.Stanoiu, M.Wiescher – Phys.Rev. C66, 025803 (2002)
- 2002MaZN I.Matea – Thesis, Universite de Caen, France (2002); GANIL T 03 05 (2002)
- 2002We07 L.Weissman, J.Cederkall, J.Aysto, H.Fynbo, L.Fraile, V.Fedoseyev, S.Franchoo, A.Jokinen, U.Koster, G.Martinez-Pinedo, T.Nilsson, M.Oinonen, K.Perajarvi, M.D.Seliverstov, and the ISOLDE Collaboration – Phys.Rev. C65, 044321 (2002)
- 2003Bb02 T.J.Bastow, G.W.West – J.Phys.Condens.Matter 15, 8389 (2003)

REFERENCES FOR A=61 (CONTINUED)

- 2003So02 O.Sorlin, C.Donzaud, F.Nowacki, J.C.Angelique, F.Azaiez, C.Bourgeois, V.Chiste, Z.Dlouhy, S.Grevy, D.Guillemaud-Mueller, F.Ibrahim, K.-L.Kratz, M.Lewitowicz, S.M.Lukyanov, J.Mrazek, Yu.-E.Penionzhkevich, F.de Oliveira Santos, B.Pfeiffer, F.Pougheon, A.Poves, M.G.Saint-Laurent, M.Stanoiu – *Eur.Phys.J. A* 16, 55 (2003)
- 2004Ho08 M.Honma, T.Otsuka, B.A.Brown, T.Mizusaki – *Phys.Rev. C* 69, 034335 (2004)
- 2004Iz01 O.Izotova, D.Rudolph, J.Ekman, C.Fahlander, A.Algora, C.AndreoIU, R.Cardona, C.Chandler, G.de Angelis, E.Farnea, A.Gadea, J.Garces Narro, J.Nyberg, M.Palacz, Zs.Podolyak, T.Steinhardt, O.Thelen – *Phys.Rev. C* 69, 037303 (2004)
- 2004Ma80 I.Matea, G.Georgiev, J.M.Daugas, M.Hass, G.Neyens, R.Astabytan, L.T.Baby, D.L.Balabanski, G.Belie, D.Borremans, G.Goldring, H.Goutte, P.Himpe, M.Lewitowicz, S.Lukyanov, V.Meot, F.de Oliveira Santos, Yu.E.Penionzhkevich, O.Roig, M.Sawicka – *Phys.Rev.Lett.* 93, 142503 (2004)
- 2004Ra23 S.Raman, X.Ouyang, M.A.Islam, J.W.Starner, E.T.Jurney, J.E.Lynn, G.Martinez-Pinedo – *Phys.Rev. C* 70, 044318 (2004)
- 2005An03 L.-L.Andersson, E.K.Johansson, J.Ekman, D.Rudolph, R.du Rietz, C.Fahlander, C.J.Gross, P.A.Hausladen, D.C.Radford, G.Hammond – *Phys.Rev. C* 71, 011303 (2005)
- 2005Ek01 J.Ekman, L.-L.Andersson, C.Fahlander, E.K.Johansson, R.du Rietz, D.Rudolph – *Eur.Phys.J. A* 25, Supplement 1, 363 (2005)
- 2005Ga01 L.Gaudefroy, O.Sorlin, C.Donzaud, J.C.Angelique, F.Azaiez, C.Bourgeois, V.Chiste, Z.Dlouhy, S.Grevy, D.Guillemaud-Mueller, F.Ibrahim, K.-L.Kratz, M.Lewitowicz, S.M.Lukyanov, I.Matea, J.Mrazek, F.Nowacki, F.de Oliveira Santos, Yu.-E.Penionzhkevich, B.Pfeiffer, F.Pougheon, M.G.Saint-Laurent, M.Stanoiu – *Eur.Phys.J. A* 23, 41 (2005)
- 2005Ru06 D.Rudolph, E.K.Johansson, L.-L.Andersson, J.Ekman, C.Fahlander, R.du Rietz – *Nucl.Phys. A* 752, 241c (2005)
- 2005St29 A.Stolz, T.Baumann, N.H.Frank, T.N.Ginter, G.W.Hitt, E.Kwan, M.Mocko, W.Peters, A.Schiller, C.S.Sumithrarachchi, M.Thoennessen – *Phys.Lett. B* 627, 32 (2005)
- 2005St34 A.Stolz, T.Baumann, N.H.Frank, T.N.Ginter, G.W.Hitt, E.Kwan, M.Mocko, W.Peters, A.Schiller, C.S.Sumithrarachchi, M.Thoennessen – *Eur.Phys.J. A* 25, Supplement 1, 335 (2005)
- 2006Ab30 K.Abbas, J.Kozempel, M.Bonardi, F.Groppi, A.Alfarano, U.Holzwarth, F.Simonelli, H.Hofman, W.Horstmann, E.Menapace, L.Leseticky, N.Gibson – *Appl.Radiat.Isot.* 64, 1001 (2006)
- 2006An31 L.-L.Andersson, D.Rudolph, J.Ekman, C.Fahlander, E.K.Johansson, R.du Rietz, C.J.Gross, P.A.Hausladen, D.C.Radford, G.Hammond – *Eur.Phys.J. A* 30, 381 (2006)
- 2006MuZX S.F.Mughabghab – *Atlas of Neutron Resonances*, 5ed., Resonance Parameters and Thermal Cross Sections, Z = 1–100, Elsevier, Amsterdam (2006)
- 2007B109 B.Blank, C.Borcea, G.Canchel, C.-E.Demonchy, F.de Oliveira Santos, C.Dossat, J.Giovinazzo, S.Grevy, L.Hay, P.Hellmuth, S.Lebanc, I.Matea, J.-L.Pedroza, L.Perrot, J.Pibernat, A.Rebii, L.Serani, J.C.Thomas – *Eur.Phys.J. A* 31, 267 (2007)
- 2007ChZX H.D.Choi, R.B.Firestone, R.M.Lindstrom, G.L.Molnar, S.F.Mughabghab, R.Paviotti Corcuera, Z.Revay, A.Trkov, V.Zerkin, C.Zhou – *IAEA-STI/PUB/1263* (2007)
- 2007Lu13 S.Lunardi, S.M.Lenzi, F.Della Vedova, E.Farnea, A.Gadea, N.Marginean, D.Bazzacco, S.Beghini, P.G.Bizzeti, A.M.Bizzeti-Sona, D.Bucurescu, L.Corradi, A.N.Deacon, G.de Angelis, E.Fioreto, S.J.Freeman, M.Ionescu-Bujor, A.Iordachescu, P.Mason, D.Mengoni, G.Montagnoli, D.R.Napoli, F.Nowacki, R.Orlandi, G.Pollarolo, F.Recchia, F.Scarlassara, J.F.Smith, A.M.Stefanini, S.Szilner, C.A.Ur, J.J.Valiente-Dobon, B.J.Varley – *Phys.Rev. C* 76, 034303 (2007)
- 2007Ve05 N.Vermeulen, S.K.Chamoli, J.M.Daugas, M.Hass, D.L.Balabanski, J.P.Delaroche, F.de Oliveira-Santos, G.Georgiev, M.Girod, G.Goldring, H.Goutte, S.Grevy, I.Matea, P.Morel, B.S.Nara Singh, Yu.-E.Penionzhkevich, L.Perrot, O.Perru, S.Peru, O.Roig, F.Sarazin, G.S.Simpson, Yu.Sobolev, I.Stefan, C.Stodel, D.T.Yordanov, G.Neyens – *Phys.Rev. C* 75, 051302 (2007)
- 2008An06 L.-L.Andersson, D.Rudolph, E.K.Johansson, D.A.Torres, B.G.Carlsson, I.Ragnarsson, C.AndreoIU, C.Baktash, M.P.Carpenter, R.J.Charity, C.J.Chiera, J.Ekman, C.Fahlander, C.Hoel, O.L.Pechenaya, W.Reviol, R.du Rietz, D.G.Sarantites, L.G.Sobotka, C.H.Yu, S.Zhu – *Eur.Phys.J. A* 36, 251 (2008)
- 2008Ho05 N.Hoteling, W.B.Walters, R.V.F.Janssens, R.Broda, M.P.Carpenter, B.Fornal, A.A.Hecht, M.Hjorth-Jensen, W.Krolas, T.Lauritsen, T.Pawlat, D.Seweryniak, J.R.Stone, X.Wang, A.Wohr, J.Wrzesinski, S.Zhu – *Phys.Rev. C* 77, 044314 (2008)
- 2008Ki07 T.Kibedi, T.W.Burrows, M.B.Trzhaskovskaya, P.M.Davidson, C.W.Nestor, Jr. – *Nucl.Instrum.Methods Phys.Res. A* 589, 202 (2008)
- 2008Py02 P.Pyykko – *Molecular Physics* 106, 1965 (2008)
- 2008Se10 N.Severijns, M.Tandeki, T.Phalet, I.S.Towner – *Phys.Rev. C* 78, 055501 (2008)
- 2008Va08 J.J.Valiente-Dobon, S.M.Lenzi, S.J.Freeman, S.Lunardi, J.F.Smith, A.Gottardo, F.Della Vedova, E.Farnea, A.Gadea, D.R.Napoli, M.Axiotis, S.Aydin, D.Bazzacco, P.G.Bizzeti, A.M.Bizzeti-Sona, G.Benzoni, D.Bucurescu, L.Corradi, A.N.Deacon, G.De Angelis, E.Fioreto, B.Guiot, M.Ionescu-Bujor, A.Iordachescu, S.Leoni, N.Marginean, R.Marginean, P.Mason, R.Menegazzo, D.Mengoni, B.Million, G.Montagnoli, R.Orlandi, F.Recchia, E.Sahin, F.Scarlassara, R.P.Singh, A.M.Stefanini, D.Steppenbeck, S.Szilner, C.A.Ur, B.J.Varley, O.Wieland – *Phys.Rev. C* 78, 024302 (2008)
- 2009An01 L.-L.Andersson, I.Ragnarsson, D.Rudolph, E.K.Johansson, D.A.Torres, C.AndreoIU, M.P.Carpenter, R.J.Charity, C.J.Chiera, J.Ekman, C.Fahlander, C.Hoel, O.L.Pechenaya, W.Reviol, R.du Rietz, D.G.Sarantites, D.Seweryniak, L.G.Sobotka, S.Zhu – *Phys.Rev. C* 79, 024312 (2009)
- 2009Cr02 H.L.Crawford, P.F.Mantica, J.S.Berryman, R.Broda, B.Fornal, C.R.Hoffman, N.Hoteling, R.V.F.Janssens, S.M.Lenzi, J.Pereira, J.B.Stoker, S.L.Tabor, W.B.Walters, X.Wang, S.Zhu – *Phys.Rev. C* 79, 054320 (2009)
- 2009Ta05 O.B.Tarasov, D.J.Morrissey, A.M.Amthor, T.Baumann, D.Bazin, A.Gade, T.N.Ginter, M.Hausmann, N.Inabe, T.Kubo, A.Nettleton, J.Pereira, M.Portillo, B.M.Sherrill, A.Stolz, M.Thoennessen – *Phys.Rev.Lett.* 102, 142501 (2009)
- 2009Ta24 O.B.Tarasov, M.Portillo, A.M.Amthor, T.Baumann, D.Bazin, A.Gade, T.N.Ginter, M.Hausmann, N.Inabe, T.Kubo, D.J.Morrissey, A.Nettleton, J.Pereira, B.M.Sherrill, A.Stolz, M.Thoennessen – *Phys.Rev. C* 80, 034609 (2009)

REFERENCES FOR A=61 (CONTINUED)

- 2009Va16 J. Van de Walle, V. Bildstein, N. Bree, J. Cederkall, P. Delahaye, J. Diriken, A. Ekstrom, V.N. Fedosseev, R. Gernhauser, A. Gustafsson, A. Herlert, M. Huyse, O. Ivanov, T. Kroll, R. Krucken, B. Marsh, N. Partronis, P. Van Duppen, D. Voulot, N. Warr, F. Wenander, K. Wimmer, S.M. Lenzi – *Eur. Phys. J. A* 42, 401 (2009)
- 2010Ch51 C.J. Chiara, I. Stefanescu, N. Hoteling, W.B. Walters, R.V.F. Janssens, R. Broda, M.P. Carpenter, B. Fornal, A.A. Hecht, W. Krolas, T. Lauritsen, T. Pawlat, D. Seweryniak, X. Wang, A. Wöhr, J. Wrzesinski, S. Zhu – *Phys. Rev. C* 82, 054313 (2010)
- 2010Gu19 K.H. Guber, H. Derrien, L.C. Leal, G. Arbanas, D. Wiarda, P.E. Koehler, J.A. Harvey – *Phys. Rev. C* 82, 057601 (2010)
- 2010Sr02 P.C. Srivastava, I. Mehrotra – *Phys. Atomic Nuclei* 73, 1656 (2010)
- 2010Vi07 P. Vingerhoets, K.T. Flanagan, M. Avgoulea, J. Billowes, M.L. Bissell, K. Blaum, B.A. Brown, B. Cheal, M. De Rydt, D.H. Forest, Ch. Geppert, M. Honma, M. Kowalska, J. Kramer, A. Krieger, E. Mane, R. Neugart, G. Neyens, W. Nortershauser, T. Otsuka, M. Schug, H.H. Stroke, G. Tungate, D.T. Yordanov – *Phys. Rev. C* 82, 064311 (2010)
- 2011Da08 J.M. Daugas, I. Matea, J.-P. Delaroche, M. Pfutzner, M. Sawicka, F. Becker, G. Belier, C.R. Bingham, R. Borcea, E. Bouchez, A. Buta, E. Dragulescu, G. Georgiev, J. Giovinnazzo, M. Girod, H. Grawe, R. Grzywacz, F. Hammache, F. Ibrahim, M. Lewitowicz, J. Libert, P. Mayet, V. Meot, F. Negoita, F. de Oliveira Santos, O. Perru, O. Roig, K. Rykaczewski, M.G. Saint-Laurent, J.E. Sauvestre, O. Sorlin, M. Stanoiu, I. Stefan, Ch. Stodel, Ch. Theisen, D. Verney, J. Zylicz – *Phys. Rev. C* 83, 054312 (2011)
- 2011Es06 A. Estrade, M. Matos, H. Schatz, A.M. Amthor, D. Bazin, M. Beard, A. Beceril, E.F. Brown, R. Cyburt, T. Elliot, A. Gade, D. Galaviz, S. George, S.S. Gupta, W.R. Hix, R. Lau, G. Lorusso, P. Moller, J. Pereira, M. Portillo, A.M. Rogers, D. Shapira, E. Smith, A. Stolz, M. Wallace, M. Wiescher – *Phys. Rev. Lett.* 107, 172503 (2011)
- 2011Pr03 B. Pritychenko, E. Betak, M.A. Kellelt, B. Singh, J. Totans – *Nucl. Instrum. Methods Phys. Res. A* 640, 213 (2011)
- 2011Sr04 P.C. Srivastava, V.K.B. Kota – *Phys. Atomic Nuclei* 74, 971 (2011)
- 2011TrZZ A. Trzcinska, W. Czarnacki, P. Decowski, M. Kisielinski, P. Koczon, A. Kordasz, E. Koshchiy, M. Kowalczyk, B. Lommel, E. Piasecki, K. Rusek, I. Strojek, A. Stolarz, K. Zerva – *Proc. 5th International Conference of Fusion11: Saint-Malo, France, May 2–6, 2011*, Ch. Schmitt, et al. Eds. p.05006 (2011); EPJ Web Conf. v.17 (2011)
- 2011Tu09 X.L. Tu, M. Wang, Yu.A. Litvinov, Y.H. Zhang, H.S. Xu, Z.Y. Sun, G. Audi, K. Blaum, C.M. Du, W.X. Huang, Z.G. Hu, P. Geng, S.L. Jin, L.X. Liu, Y. Liu, B. Mei, R.S. Mao, X.W. Ma, H. Suzuki, P. Shuai, Y. Sun, S.W. Tang, J.S. Wang, S.T. Wang, G.Q. Xiao, X. Xu, J.W. Xia, J.C. Yang, R.P. Ye, T. Yamaguchi, X.L. Yan, Y.J. Yuan, Y. Yamaguchi, Y.D. Zang, H.W. Zhao, T.C. Zhao, X.Y. Zhang, X.H. Zhou, W.L. Zhan – *Nucl. Instrum. Methods Phys. Res. A* 654, 213 (2011)
- 2011Vi03 P. Vingerhoets, K.T. Flanagan, J. Billowes, M.L. Bissell, K. Blaum, B. Cheal, M. De Rydt, D.H. Forest, Ch. Geppert, M. Honma, M. Kowalska, J. Kramer, K. Kreim, A. Krieger, R. Neugart, G. Neyens, W. Nortershauser, J. Papuga, T.J. Procter, M.M. Rajabali, R. Sanchez, H.H. Stroke, D.T. Yordanov – *Phys. Lett. B* 703, 34 (2011)
- 2012Au07 G. Audi, F.G. Kondev, M. Wang, B. Pfeiffer, X. Sun, J. Blachot, M. MacCormick – *Chin. Phys. C* 36, 1157 (2012)
- 2012He13 A. Herlert, S. Van Gorp, D. Beck, K. Blaum, M. Breitenfeldt, R.B. Cakirli, S. George, U. Hager, F. Herfurth, A. Kellerbauer, D. Lunney, R. Savreux, L. Schweikhard, C. Yazidjian – *Eur. Phys. J. A* 48, 97 (2012)
- 2012Na15 S. Naimi, G. Audi, D. Beck, K. Blaum, Ch. Bohm, Ch. Borgmann, M. Breitenfeldt, S. George, F. Herfurth, A. Herlert, A. Kellerbauer, M. Kowalska, D. Lunney, E. Minaya-Ramirez, D. Neidherr, M. Rosenbusch, L. Schweikhard, R.N. Wolf, K. Zuber – *Phys. Rev. C* 86, 014325 (2012)
- 2012PeZX T. Petrovic, M. Vencelj, M. Lipoglavsek, J. Gajevic, P. Pelicon – *Proc. Intern. Conf. on Nuclear Structure and Dynamics*, 12, Opatija, Croatia, 9–13 July, 2012, T. Niksic, M. Milin, D. Vretenar, S. Szilner, Eds., p.137 (2012); AIP Conf. Proc. 1491 (2012)
- 2012Re11 F. Recchia, S.M. Lenzi, S. Lunardi, E. Farnea, A. Gadea, N. Marginean, D.R. Napoli, F. Nowacki, A. Poves, J.J. Valiente-Dobon, M. Axiotis, S. Aydin, D. Bazzacco, G. Benzoni, P.G. Bizzeti, A.M. Bizzeti-Sona, A. Bracco, D. Bucurescu, E. Caurier, L. Corradi, G. de Angelis, F. Della Vedova, E. Fioretto, A. Gottardo, M. Ionescu-Bujor, A. Iordachescu, S. Leoni, R. Marginean, P. Mason, R. Menegazzo, D. Mengoni, B. Million, G. Montagnoli, R. Orlandi, G. Pollarolo, E. Sahin, F. Scarlassara, R.P. Singh, A.M. Stefanini, S. Szilner, C.A. Ur, O. Wieland – *Phys. Rev. C* 85, 064305 (2012)
- 2012Re16 F. Recchia, S.M. Lenzi, S. Lunardi, E. Farnea, A. Gadea, N. Marginean, J.J. Valiente-Dobon, M. Axiotis, S. Aydin, D. Bazzacco, G. Benzoni, P.G. Bizzeti, A.M. Bizzeti-Sona, A. Bracco, D. Bucurescu, F. Camera, L. Corradi, G. de Angelis, F. Della Vedova, E. Fioretto, M. Ionescu-Bujor, A. Iordachescu, S. Leoni, R. Marginean, P. Mason, R. Menegazzo, D. Mengoni, B. Million, G. Montagnoli, D.R. Napoli, F. Nowacki, R. Orlandi, G. Pollarolo, A. Poves, E. Sahin, K. Sieja, F. Scarlassara, R.P. Singh, A.M. Stefanini, S. Szilner, C.A. Ur, O. Wieland – *Phys. Scr.* T150, 014034 (2012)
- 2012VoZZ A.V. Voinov, S.M. Grimes, C.R. Brune, T. Massey, A. Schiller – *Proc. 3rd International Workshop on Compound-Nuclear Reactions and Related Topics*, Prague, Czech Republic, September 19–23, 2011, M. Krťicka, F. Becvar, J. Kroll, Eds. p.05001 (2012)
- 2012Wa38 M. Wang, G. Audi, A.H. Wapstra, F.G. Kondev, M. MacCormick, X. Xu, B. Pfeiffer – *Chin. Phys. C* 36, 1603 (2012)
- 2013An02 I. Angeli, K.P. Marinova – *At. Data Nucl. Data Tables* 99, 69 (2013)
- 2013Ji04 H. Jin, Y. Sun, K. Kaneko, S. Tazaki – *Phys. Rev. C* 87, 044327 (2013)
- 2013Ra17 D. Radulov, C.J. Chiara, I.G. Darby, H. De Witte, J. Diriken, D.V. Fedorov, V.N. Fedosseev, L.M. Fraile, M. Huyse, U. Koster, B.A. Marsh, D. Pauwels, L. Popescu, M.D. Seliverstov, A.M. Sjoedin, P. Van den Bergh, P. Van Duppen, M. Venhart, W.B. Walters, K. Wimmer – *Phys. Rev. C* 88, 014307 (2013)
- 2013Sc06 J.P. Schiffer, C.R. Hoffman, B.P. Kay, J.A. Clark, C.M. Deibel, S.J. Freeman, M. Honma, A.M. Howard, A.J. Mitchell, T. Otsuka, P.D. Parker, D.K. Sharp, J.S. Thomas – *Phys. Rev. C* 87, 034306 (2013)
- 2013ScZZ J.P. Schiffer, C.R. Hoffman, B.P. Kay, J.A. Clark, C.M. Deibel, S.J. Freeman, M. Honma, A.M. Howard, A.J. Mitchell, T. Otsuka, P.D. Parker, D.K. Sharp, J.S. Thomas – *Priv. Comm.* (2013)
- 2013StZZ N.J. Stone – *REPT INDC(NDS)-0650* (2013)
- 2014Pa50 P. Papka, J.F. Sharpey-Schafer, B.A. Brown, T.S. Dinoko, E.A.M.A. Khaleel, E.A. Lawrie, J.J. Lawrie, K.C.W. Li, S.N.T. Majola, W.A. Richter, O. Shirinda, M.A. Stankiewicz, P. Vymers, M. Wiedeking – *Eur. Phys. J. A* 50, 158 (2014)
- 2014Ro14 A.M. Rogers, J. Giovinnazzo, C.J. Lister, B. Blank, G. Canchel, J.A. Clark, G. de France, S. Grevy, S. Gros, E.A. McCutchan, F. de Oliveira Santos, G. Savard, D. Seweryniak, I. Stefan, J.-C. Thomas – *Nucl. Data Sheets* 120, 41 (2014)
- 2014StZZ N.J. Stone – *REPT INDC(NDS)-0658* (2014)

REFERENCES FOR A=61 (CONTINUED)

- 2014Su07 S.Suchyta, S.N.Liddick, C.J.Chicara, W.B.Walters, M.P.Carpenter, H.L.Crawford, G.F.Grinyer, G.Gurdal, A.Klose,
E.A.McCutchan, J.Pereira, S.Zhu – Phys.Rev. C 89, 034317 (2014)
- 2015Wi02 K.Wimmer, D.Barofsky, D.Bazin, L.M.Fraile, J.Lloyd, J.R.Tompkins, S.J.Williams – Nucl.Instrum.Methods Phys.Res.
A769, 65 (2015)