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Basunia, M Shamsuzzoha

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Peer reviewed

Nuclear Structure and Decay Data for A=169 Isobars*

M. Shamsuzzoha Basunia

*Nuclear Science Division
MS 88R0192
Lawrence Berkeley Laboratory
1 Cyclotron Road
Berkeley, California 94720*

Abstract: Experimental data pertaining to all nuclei with mass number A=169 (Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, W, Re, Os, Ir, Pt) have been evaluated. Level schemes from both radioactive decay and reaction studies are presented, along with associated tables of experimental data and adopted properties for levels and γ rays. The present evaluation for A=169 supersedes the 2008 evaluation, [2008Ba31](#), by C.M. Baglin.

A few highlights of this evaluation:

More extensive work on ε decay from ^{169}W is needed and new experimental work will be required to resolve a discrepancy between the J^π values deduced for a 180-keV level in ^{169}Ta based on extensive band structure from (HI,xn γ) work ($J^\pi=1/2^-$) and TDPAD measurements ($J=5/2$).

Low lying states of ^{169}Os were studied via fine structure of ^{173}Pt α decay in [2014ThZZ](#). The Eas feeding the g.s. of ^{169}Os in [2008Ba31](#) are separated well into two consistent groups to feed the g.s. and the newly proposed state at 34.84 keV. Based on the studies of [2014ThZZ](#) and [2021Zh52](#), the g.s. spin-parity assignment of ^{169}Os has been proposed to be $(7/2^-)$ from $(5/2^-)$.

The ^{169}Ir g.s. half-life and alpha emission branching reported in [2012Th13](#) from ^{173}Au α decay measurements are preferred over the values in [2005Sc22](#). The reported half-life value in [2005Sc22](#) for ^{169}Ir g.s. is discrepant and the research work was carried out in the same lab of [2012Th13](#).

Cutoff Date: All data received by 1 October 2025 have been evaluated.

General Policies and Organization of Material: See the April 2026 issue of the *Nuclear Data Sheets* or <https://www.nndc.bnl.gov/nds/docs/NDSPolicies.pdf>.

General Comments: The internal conversion coefficients (α) presented in this evaluation have been calculated using the computer code BrIcc ([2008Ki07](#)) based on Band-Raman tables of conversion coefficients. For Log ft and related data, Betashape code ([2023Mo21](#)) was used. In cases of weighted averaging of the data, the assigned uncertainty in the result is generally not lower than the lowest uncertainty amongst the input data points, assuming that the contribution of the systematic uncertainty was significant.

Throughout this evaluation, rotational band parameters are calculated from the standard energy equation:

$$E(J,K)=E_0+A[J(J+1)+\delta_{K,1/2}(-1)^{J+1/2}a(J+1/2)]+BJ^2(J+1)^2$$

where **A** is given in keV, **B** is given in eV, and the decoupling constant **a** is dimensionless. When not explicitly stated, **B** is assumed to be 0. The minimum number possible of the lowest energy levels was used to calculate each set of parameters, unless noted otherwise.

Acknowledgements: This evaluation benefits from earlier evaluations by C.M. Baglin ([2008Ba31](#)), V.S. Shirley ([1991Sh18](#), [1982Sh35](#)), B. Harmatz ([1973Ha76](#)), and the ENSDF updates of ^{169}Eu by B. Singh (Dated 31-Jan-2021), ^{169}Gd , ^{169}Tb by F.G. Kondev (Dated 20-Feb-2017), and ^{169}Dy by E.A. McCutchan (Dated 2-Jun-2021). The contribution of the XUNDL dataset compilers is deeply acknowledged. The evaluator is grateful to Dr. Caroline D. Nesaraja (ORNL) for a critical review of the manuscript. The editorial comments of Dr. E.A. McCutchan (BNL) and the follow-up processes of Dr. C. Morse (BNL) to publish the manuscript are deeply acknowledged.

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Skeleton Scheme for A=169

S(p) 11310 *syst*

S(n) 4480 *syst*
S(α) 3420 *syst*

S(p) 11930 *syst*

0.0
389 ms +92-88
¹⁶⁹₆₃Eu₁₀₆

Q⁻=8230 *syst* 100%

S(n) 3810 *syst*
S(α) 2810 *syst*

S(p) 9620 *syst*

0.0
0.90 s 10
¹⁶⁹₆₄Gd₁₀₅

Q⁻=6590 *syst* 100%

S(n) 5770 *syst*
S(α) 2180 *syst*

S(p) 10100 300

0.0
5.13 s 32
¹⁶⁹₆₅Tb₁₀₄
Q⁻=5120 *syst* 100%

S(n) 5110 330
S(α) 1500 300

S(p) 7530 140
S(n) 6810 40

S(p) 8150 30

S(n) 8033.6 15

S(n) 6003.25 15

S(p) 5574.4 8

(1/2⁻)
(5/2⁻)
39 s 8
¹⁶⁹₆₆Dy₁₀₃
Q⁻=3200 300

(19/2⁺)
S(α) 1386.4 4
S(α) 632 20

7/2⁻
4.7 min 1
¹⁶⁹₆₇Ho₁₀₂
Q⁻=2125 20

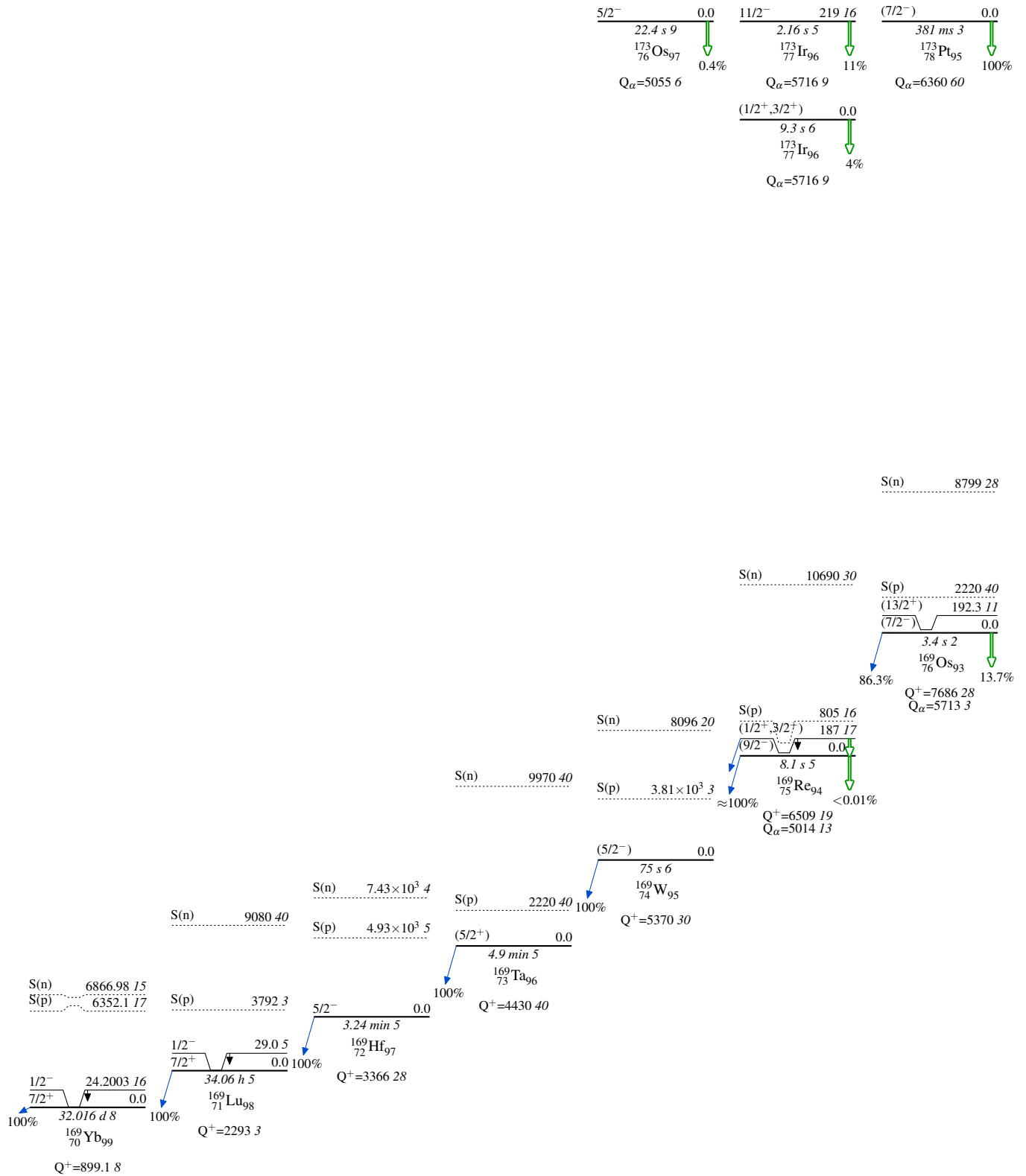
7/2⁺
(5/2⁻)
1/2⁻
9.39 d 2
¹⁶⁹₆₈Er₁₀₁

243.66 16
92.01 9
0.0

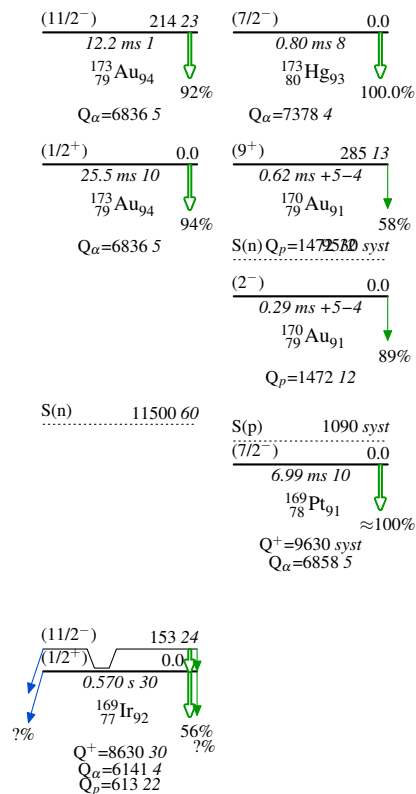
Q⁻=353.5 8

7/2⁺
1/2⁺
316.14633 5
0.0
stable
¹⁶⁹₆₉Tm₁₀₀

Skeleton Scheme for A=169 (continued)



Skeleton Scheme for A=169 (continued)



Ground-State and Isomeric-Level Properties				
Nuclide	Level	J^{π}	$T_{1/2}$	Decay Mode
^{169}Eu	0.0		389 ms +92-88	$\% \beta^- = 100$; $\% \beta^- n = 14.6 + 58-51$
^{169}Gd	0.0		0.90 s 10	$\% \beta^- = 100$; $\% \beta^- n \leq 0.7$
^{169}Tb	0.0		5.13 s 32	$\% \beta^- = 100$; $\% \beta^- n = ?$
^{169}Dy	0.0	(5/2) ⁻	39 s 8	$\% \beta^- = 100$
^{169}Dy	166.1	(1/2) ⁻	1.26 μ s 17	$\% IT = 100$
^{169}Ho	0.0	7/2 ⁻	4.7 min 1	$\% \beta^- = 100$
^{169}Ho	1386.4	(19/2) ⁺	118 μ s 6	
^{169}Er	0.0	1/2 ⁻	9.39 d 2	$\% \beta^- = 100$
^{169}Er	92.01	(5/2) ⁻	285 ns 20	
^{169}Er	243.66	7/2 ⁺	200 ns 10	
^{169}Tm	0.0	1/2 ⁺	stable	
^{169}Tm	316.14633	7/2 ⁺	660 ns 3	
^{169}Yb	0.0	7/2 ⁺	32.016 d 8	$\% \epsilon = 100$
^{169}Yb	24.2003	1/2 ⁻	46 s 2	$\% IT = 100$
^{169}Lu	0.0	7/2 ⁺	34.06 h 5	$\% \epsilon + \% \beta^+ = 100$
^{169}Lu	29.0	1/2 ⁻	160 s 10	$\% IT = 100$
^{169}Hf	0.0	5/2 ⁻	3.24 min 5	$\% \epsilon + \% \beta^+ = 100$
^{169}Ta	0.0	(5/2) ⁺	4.9 min 5	$\% \epsilon + \% \beta^+ = 100$
^{169}W	0.0	(5/2) ⁻	75 s 6	$\% \epsilon + \% \beta^+ = 100$
^{169}Re	0.0	(9/2) ⁻	8.1 s 5	$\% \epsilon + \% \beta^+ \approx 100$; $\% \alpha < 0.01$
^{169}Re	187	(1/2 ⁺ , 3/2 ⁺)	15.1 s 15	$\% \alpha \approx 0.2$; $\% \epsilon + \% \beta^+ = ?$; $\% IT = ?$
^{169}Os	0.0	(7/2) ⁻	3.4 s 2	$\% \epsilon + \% \beta^+ = 86.3$ 8; $\% \alpha = 13.7$ 8
^{169}Os	192.3	(13/2) ⁺	17.3 μ s 12	
^{169}Ir	0.0	(1/2) ⁺	0.570 s 30	$\% \alpha = 56$ 9; $\% \epsilon + \% \beta^+ = ?$; $\% p = ?$
^{169}Ir	153	(11/2) ⁻	0.280 s 1	$\% \alpha = 79$ 6; $\% \epsilon + \% \beta^+ = ?$; $\% p = ?$
^{169}Pt	0.0	(7/2) ⁻	6.99 ms 10	$\% \alpha \approx 100$
^{173}Os	0.0	5/2 ⁻	22.4 s 9	$\% \alpha = 0.4$ 2
^{173}Ir	219	11/2 ⁻	2.16 s 5	$\% \alpha = 11$ 2
^{173}Ir	0.0	(1/2 ⁺ , 3/2 ⁺)	9.3 s 6	$\% \alpha = 4$ 2
^{173}Pt	0.0	(7/2) ⁻	381 ms 3	$\% \alpha = 100$ 5
^{173}Au	214	(11/2) ⁻	12.2 ms 1	$\% \alpha \approx 92$
^{173}Au	0.0	(1/2) ⁺	25.5 ms 10	$\% \alpha \approx 94$
^{173}Hg	0.0	(7/2) ⁻	0.80 ms 8	$\% \alpha = 100.0$
^{170}Au	285	(9 ⁺)	0.62 ms +5-4	$\% p = 58$ 5
^{170}Au	0.0	(2 ⁻)	0.29 ms +5-4	$\% p = 89$ 10

Adopted Levels

$Q(\beta^-)=8230$ syst; $S(n)=4480$ syst; $S(p)=11310$ syst; $Q(\alpha)=-3420$ syst [2021Wa16](#)

$\Delta Q(\beta^-)=640$, $\Delta S(n)=640$, $\Delta S(p)=580$, $\Delta Q(\alpha)=710$ (syst,[2021Wa16](#)).

$S(2n)=8030$ 640, $Q(\beta^-n)=4420$ 580 (syst,[2021Wa16](#)).

Edited/Adapted the XUNDL datasets of [2018Fu08](#) and [2022Ki23](#), compiled by B. Singh (McMaster); September 5, 2018 and May 04, 2023, respectively, and the ENSDF update, January 31, 2021.

[2018Fu08](#): ^{169}Eu nuclide was produced and identified at the RIBF-RIKEN facility using the $^9\text{Be}(^{238}\text{U},\text{F})$ reaction with a $^{238}\text{U}^{86+}$ beam of $E=345$ MeV/nucleon produced by the RIBF accelerator complex. Target= ^9Be with a thickness of 2.92 mm. Nuclidic identification (PID) was made by determining the atomic number Z and mass-to-charge (A/Q) ratio of the ions using magnetic rigidity, time-of-flight, and energy loss (tof- $B\rho$ - ΔE method) using the BigRIPS fragment separator. The time-of-flight was measured using thin plastic scintillators placed at foci of the BigRIPS. The $B\rho$ values were deduced from trajectory reconstruction of measured position and angle of fragments at each focus using parallel plate avalanche counters (PPACs). For ΔE values, separated fragments were transported to an achromatic focus and implanted in a Si stack with 14 layers of Si PIN detectors, surrounded by four HPGe clovers for isomer tagging by detecting delayed gamma rays from known isomeric states in fission fragments. Comparison of measured cross sections with theoretical calculations using LISE⁺ abrasion-fission (AF) model.

[2022Ki23](#): ^{169}Eu nuclide was produced at the RIBF-RIKEN facility using the $^9\text{Be}(^{238}\text{U},\text{F})$, $E(^{238}\text{U})=345$ MeV/nucleon, followed by separation of fission fragments by measuring the energy loss (ΔE), magnetic rigidity ($B\rho$) and time-of-flight (tof) of the ions using the BigRIPS separator, multisampling ionization chambers (MUSIC), and parallel-plate avalanche counters (PPACs), and plastic scintillators. The radioactive ions were implanted in the Advanced Implantation Detector Array (AIDA) consisting of a stack of six double-sided silicon strip detectors (DSSSDs), and centered in the BRIKEN neutron detector consisting of 140 ^3He -filled proportional counters embedded in a large polyethylene moderator matrix. For γ and $n\gamma$ -coin detection, two CLARION-type clover HPGe detectors were used, but γ data were not analyzed in the present experiment. Measured (implanted ions)(β^-) correlations, and (implanted ions)(β^-)(neutron) correlations. Deduced half-life and $\% \beta^-n$ for the decay of ^{169}Eu .

 ^{169}Eu Levels

E(level)	$T_{1/2}$	Comments
0.0	389 ms +92–88	$\% \beta^- = 100$; $\% \beta^-n = 14.6 +58-51$ (2022Ki23) $T_{1/2}$: from binned maximum likelihood fitting of the (implant)β correlated decay curve, using Bateman equations to account for the activities of the parent, daughter, grand-daughter, and great-grand-daughter, and the β^--delayed neutron branch of the decay chain (2022Ki23). Other: >550 ns, from time-of-flight of 550 ns in 2018Fu08. $\% \beta^-n$ deduced from neutron-gated β^--decay events, fitted by an exponential function of the background subtracted time distribution of (implants)(β^-)(neutron)-correlations (2022Ki23). For further details of the analysis method, consult 2020ToZY (Thesis, Univ. of Valencia (2020)). A total of 15 counts were assigned to ^{169}Eu for spectrometer setting on Pr, and 13 counts for setting on Gd (2018Fu08). Production $\sigma=25$ pb +17–11 for Pr setting, and 28 pb +10–8 for Gd setting, with 50% systematic uncertainty on σ values (2018Fu08).

Adopted Levels

$Q(\beta^-)=6590$ syst; $S(n)=3810$ syst; $S(p)=11930$ syst; $Q(\alpha)=-2810$ syst [2021Wa16](#)

Estimated uncertainties ([2021Wa16](#)): $\Delta Q(\beta^-)=500$, $\Delta S(n)=500$, $\Delta S(\alpha)=570$, $\Delta S(p)=570$.

$S(2n)=9260$ 400, $Q(\beta^-n)=820$ 400, $S(2p)=23140$ 640 from [2021Wa16](#) (systematics).

Edited/Adapted the XUNDL dataset of [2022Ki23](#), compiled by B. Singh (McMaster), May 04, 2023; and the ENSDF update by F.G. Kondev, January 2, 2022.

2012Ku26: ^{169}Gd produced and identified in $^9\text{Be}(^{238}\text{U},\text{F})$, $E=1$ GeV/nucleon reaction using SIS-18 synchrotron facility at GSI.

Target= 1.6 g/cm^2 ^9Be placed at the entrance of projectile Fragment Separator (FRS). Particle identification was achieved by event-by-event in-flight analysis of time-of-flight, energy loss measurement, and magnetic rigidity (tof- $\Delta E'$ - $B\rho$). Time-of-flight measured using two plastic scintillation detectors, energy loss or deposit by ionization chambers (MUSIC), and magnetic rigidity by four time-projection chambers (TPC), which also provided energy deposit information. Isomer tagging method for known μs isomers was used to verify event-by-event identification and in-flight separation of new isotopes. Gamma rays from the known isomers were recorded in coincidence with the incoming ions using either the RISING array of Ge detectors at GSI or only two Ge detectors, a stopper foil and a scintillator for veto signal. Measured production cross section. Comparison of measured σ with predictions from ABRABLA model and EPAX-3 model.

2017Wu04: The ^{169}Gd nuclide was produced at the RIBF-RIKEN facility using the $^9\text{Be}(^{238}\text{U},\text{F})$ reaction at $E=345$ MeV/nucleon.

Two experiments, optimized for the transmission of ^{158}Nd and ^{170}Dy ions, were carried out with average beam intensities of 7 pnA and 12 pnA, respectively. The identification of the nuclide of interest was made in the BigRIPS separator by determining the atomic number and the mass-to-charge ratio of the ion using the tof- $B\rho$ - ΔE method. The reaction products were transported through the ZeroDegree Spectrometer and implanted into the beta-counting system WAS3ABi that was surrounded by the EURICA array comprising of 84 HPGe detectors. The typical implantation rate was ≈ 100 ions/s. Measured: implanted ion- β^- -t, implanted ion- β^- - γ -t and implanted ions- γ -t correlations. Deduced: $T_{1/2}$.

2022Ki23: ^{169}Gd nuclide was produced at the RIBF-RIKEN facility using the $^9\text{Be}(^{238}\text{U},\text{F}), E(^{238}\text{U})=345$ MeV/nucleon, followed by separation of fission fragments by measuring the energy loss (ΔE), magnetic rigidity ($B\rho$) and time-of-flight (tof) of the ions using the BigRIPS separator, multisampling ionization chambers (MUSIC), and parallel-plate avalanche counters (PPACs), and plastic scintillators. The radioactive ions were implanted in the Advanced Implantation Detector Array (AIDA) consisting of a stack of six double-sided silicon strip detectors (DSSSDs), and centered in the BRIKEN neutron detector consisting of 140 ^3He -filled proportional counters embedded in a large polyethylene moderator matrix. For γ and $n\gamma$ -coin detection, two CLARION-type clover HPGe detectors were used, but γ data were not analyzed in the present experiment. Measured (implanted ions)(β^-) correlations, and (implanted ions)(β^-)(neutron) correlations. Deduced half-life and $\% \beta^-n$ for the decay of ^{169}Gd .

 ^{169}Gd Levels

E(level)	$T_{1/2}$	Comments
0.0	0.90 s 10	$\% \beta^- = 100$; $\% \beta^-n \leq 0.7$ (2022Ki23) $\% \beta^-$: Only β^- decay mode is expected, followed by β^-n decay. J^π: $7/2^-$ from $\Omega_\nu=7/2^-$ orbital proposed in 2019Mo01. $T_{1/2}$: weighted average of 0.75 s 21 (2017Wu04) and 0.93 s 10 (2022Ki23). Uncertainty from 2022Ki23, lower between the two reported uncertainties. 2017Wu04 deduced 0.75 s 21 from a fit to the implanted ion-β^--t spectrum using the least-squares and maximum-likelihood methods. The data analysis included contributions from the parent, daughter and ground-daughter decays, as well as a constant background. In 2022Ki23, 0.93 s 10 was deduced from binned maximum likelihood fitting of the (implant)β^- correlated decay curve, using Bateman equations to account for the activities of the parent, daughter, grand-daughter, and great-grand-daughter, and the β^--delayed neutron branch of the decay chain (2022Ki23). $\% \beta^-n$ deduced from neutron-gated β^--decay events, fitted by an exponential function of the background subtracted time distribution of (implants)(β^-)(neutron)-correlations (2022Ki23). For further details of the analysis method, consult 2020ToZY (Thesis, Univ. of Valencia (2020)). Production σ(at 1 GeV/nucleon)=10.6 nb 15 (2012Ku26).

Adopted Levels

$Q(\beta^-)=5120$ syst; $S(n)=5770$ syst; $S(p)=9620$ syst; $Q(\alpha)=-2180$ syst (2021Wa16)

$\Delta Q(\beta^-)=430$, $\Delta S(n)=300$, $\Delta S(p)=420$, $\Delta Q(\alpha)=300$ (syst, 2021Wa16).

$S(2n)=10740$ 300, $S(2p)=21290$ 500, $Q(\beta^-n)=10$ 330 (syst, 2021Wa16).

Edited/Adapted the ENSDF update by F.G. Kondev, February 20, 2017.

2012Ku26: ^{169}Tb produced and identified in $^9\text{Be}(^{238}\text{U}, \text{F})$, $E=1$ GeV/nucleon reaction using SIS-18 synchrotron facility at GSI.

Target= 1.6 g/cm^2 ^9Be placed at the entrance of projectile Fragment Separator (FRS). Particle identification was achieved by event-by-event in-flight analysis of time-of-flight, energy loss measurement, and magnetic rigidity ($\text{tof}-\Delta E'-B\rho$). Time-of-flight measured using two plastic scintillation detectors, energy loss or deposit by ionization chambers (MUSIC), and magnetic rigidity by four time-projection chambers (TPC), which also provided energy deposit information. Isomer tagging method for known μs isomers was used to verify event-by-event identification and in-flight separation of new isotopes. Gamma rays from the known isomers were recorded in coincidence with the incoming ions using either the RISING array of Ge detectors at GSI or only two Ge detectors, a stopper foil and a scintillator for veto signal. Measured production cross section. Comparison of measured σ with predictions from ABRABLA model and EPAX-3 model.

2017Wu04: The ^{169}Tb nuclide was produced at the RIBF-RIKEN facility using the $^9\text{Be}(^{238}\text{U}, \text{F})$ reaction at $E=345$ MeV/nucleon.

Two experiments, optimized for the transmission of ^{158}Nd and ^{170}Dy ions, were carried out with average beam intensities of 7 pnA and 12 pnA, respectively. The identification of the nuclide of interest was made in the BigRIPS separator by determining the atomic number and the mass-to-charge ratio of the ion using the $\text{tof}-B\rho-\Delta E$ method. The reaction products were transported through the ZeroDegree Spectrometer and implanted into the beta-counting system WAS3ABi that was surrounded by the EURICA array comprising of 84 HPGe detectors. The typical implantation rate was 100 ions/s. Measured: implanted ion- β^- -t, implanted ion- β^- - γ -t and implanted ions- γ -t correlations. Deduced: $T_{1/2}$.

Mass excess: -50368.5 keV 96 (2024Ja12) cf. -50580 keV 300 sys (2021Wa16).

 ^{169}Tb Levels

E(level)	$T_{1/2}$	Comments
0.0	5.13 s 32	$\% \beta^- = 100$; $\% \beta^- n = ?$ $\% \beta^-$: Only β^- decay mode is expected. J^π : $3/2^+$ from $\Omega_\nu = 7/2^-$ orbital proposed in 2019Mo01. $T_{1/2}$: from a fit to the implanted ion- β^- -t spectrum using the least-squares and maximum-likelihood methods (2017Wu04). The data analysis included contributions from the parent, daughter and grand-daughter decays, as well as a constant background. Production σ (at 1 GeV/nucleon)=751 nb 28 (2012Ku26).

Adopted Levels, Gammas

$Q(\beta^-)=3.2\times 10^3$ 3; $S(n)=5.11\times 10^3$ 33; $S(p)=1.01\times 10^4$ 3; $Q(\alpha)=-1.5\times 10^3$ 3 [2021Wa16](#)

Edited/Adapted the ENSDF update by E.A. McCutchan, June 2, 2021.

[2010So03](#): $^{170}\text{Er}(^{82}\text{Se},x)$, $E=460$ MeV; measured yields and distributions of product nuclei using PRISMA spectrometer, CLARA

HPGe array of 23 Compton suppressed clover detectors. Deduced yields for the beamlike fragments relative to ^{84}Kr and the

corresponding target-like fragments as obtained from PRISMA in coincidence with CLARA.

Mass excess: -55523.1 keV 57 ([2024Ja12](#)) cf. -55600 keV 300 ([2021Wa16](#)).

 ^{169}Dy LevelsCross Reference (XREF) Flags

A $^9\text{Be}(^{238}\text{U},F\gamma)$

<u>E(level)[†]</u>	<u>J^π</u>	<u>T_{1/2}</u>	<u>XREF</u>	<u>Comments</u>
0.0	(5/2) ⁻	39 s 8	A	$\% \beta^- = 100$ J ^π : log $ft \approx 5.5$ to $7/2^-$ 7/2[523] g.s. of ^{169}Ho ; 5/2[512] assignment for 103rd neutron orbital is well established in this mass region. T _{1/2} : from 1990Ch34 , weighted average of 35 s 11 by $\gamma(t)$ and 43 s 11 by $\beta(t)$. Other: 78 s 37 (2017Wu04 – in Fig. 3, numerical value from the XUNDL data set).
166.1 3	(1/2) ⁻	1.26 μs 17	A	$\%IT=100$ J ^π : from systematics of (1/2) ⁻ isomers in heavier N=103 isotones, such as 168.6 keV and 398.9 keV isomers in ^{171}Er and ^{173}Yb , respectively. T _{1/2} : from 166.1 $\gamma(t)$ in $^9\text{Be}(^{238}\text{U},F\gamma)$.

[†] From E_γ .

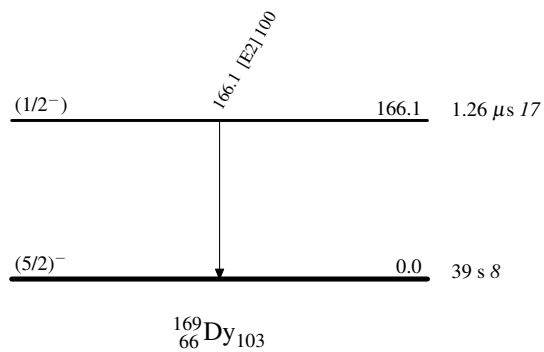
 $\gamma(^{169}\text{Dy})$

<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_γ</u>	<u>I_γ</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.</u>	<u>α[†]</u>	<u>Comments</u>
166.1	(1/2) ⁻	166.1 3	100	0.0	(5/2) ⁻	[E2]	0.443 7	B(E2)(W.u.)=0.045 6

[†] Total theoretical internal conversion coefficients, calculated using the BrIcc code ([2008Ki07](#)) with “Frozen Orbitals” approximation based on γ -ray energies, assigned multiplicities, and mixing ratios, unless otherwise specified.

Adopted Levels, Gammas**Level Scheme**

Intensities: Relative photon branching from each level



$^9\text{Be}(^{238}\text{U}, \text{F}\gamma)$ 2019Zh49

Edited/Adapted the ENSDF update by E.A. McCutchan, June 2, 2021.

[2019Zh49](#): E=345 MeV/nucleon ^{238}U beam produced at Radioactive Isotope Beam Factory (RIBF), RIKEN. Fission fragments separated using the in-flight separator BigRIPS and identified using ΔE -tof-B ρ method. Fragments implanted into WAS3ABi consisting of two double-sided Si-strip detectors. Measured E_γ , I_γ , $\gamma(t)$ using the EURICA γ -ray spectrometer, consisting of 12 Cluster-type detectors.

 ^{169}Dy Levels

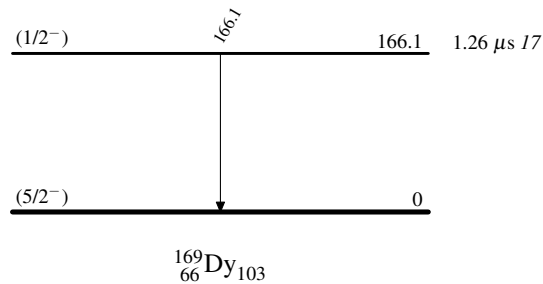
<u>$E(\text{level})^\dagger$</u>	<u>$J^\pi^\ddagger$</u>	<u>$T_{1/2}$</u>	<u>Comments</u>
0	($5/2^-$)		
166.1 3	($1/2^-$)	1.26 μs 17	%IT=100 $T_{1/2}$: from 166.1 $\gamma(t)$ (2019Zh49).

† From E_γ .

‡ As proposed by [2019Zh49](#) based on systematics.

 $\gamma(^{169}\text{Dy})$

<u>E_γ</u>	<u>$E_i(\text{level})$</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Comments</u>
166.1 3	166.1	($1/2^-$)	0	($5/2^-$)	E_γ : no uncertainty is given in 2019Zh49 ; evaluator assigns uncertainty based on uncertainties given to ^{168}Dy γ transitions, also studied in 2019Zh49 .

 $^9\text{Be}(^{238}\text{U}, \text{F}\gamma)$ 2019Zh49Level Scheme

Adopted Levels, Gammas

$Q(\beta^-)=2125$ 20; $S(n)=6810$ 40; $S(p)=7.53\times 10^3$ 14; $Q(\alpha)=-632$ 20 [2021Wa16](#)

$S(2n)=12659$ 21, $S(2p)=17491$ 20 ([2021Wa16](#)).

Mass excess: -58820.7 keV 47 ([2024Ja12](#)) cf. -58796 keV 20 ([2021Wa16](#)).

 ^{169}Ho LevelsCross Reference (XREF) Flags

A ^{169}Dy β^- decay
B $^{170}\text{Er}(d, ^3\text{He})$
C $^{170}\text{Er}(\text{pol } t, \alpha)$
D $^{170}\text{Er}(^{136}\text{Xe}, X\gamma)$

<u>E(level)[†]</u>	<u>J^π[‡]</u>	<u>T_{1/2}</u>	<u>XREF</u>	<u>Comments</u>
0.0 [#]	7/2 ⁻	4.7 min 1	ABCD	$\% \beta^- = 100$ J^π : $\log ft=4.9$ to 853 level in ^{169}Er indicates allowed unhindered β^- decay which, in this mass region, establishes configurations of (π 7/2[523]) for this level and (ν 5/2[523]) for the ^{169}Er state fed. This is also consistent with known structure in lighter odd-mass Ho nuclei. $T_{1/2}$: weighted average of 4.8 min 1 ($\gamma(t)$ – 1963Mi17), 4.4 min 2 ($\gamma(t)$ – 1966Fu09), and 4.7 min 2 ($\gamma(t)$ – 1978Ka16).
97.5 [#] 2	9/2 ⁻		BCD	
216.9 [#] 2	11/2 ⁻		BCD	
254 [@] 4	3/2 ⁺		BC	
315 [@] 4	5/2 ⁺		BC	E(level): weighted average of 320 10 from ($d, ^3\text{He}$) and 314 4 from (pol t, α).
357.6 [#] 3	13/2 ⁻		D	
359 ^{&} 4	3/2 ⁺		BC	
382 [@] 4	7/2 ⁺		BC	E(level): weighted average of 385 10 from ($d, ^3\text{He}$) and 381 4 from (pol t, α).
460 [@] 4	9/2 ⁺		BC	J^π : from (pol t, α). However, $L(d, ^3\text{He})=2$ is inconsistent with the spin.
493 ^{&} 4	7/2 ⁺		BC	E(level): weighted average of 497 10 from ($d, ^3\text{He}$) and 492 4 from (pol t, α).
518.7 [#] 3	15/2 ⁻		D	
520 4	(7/2 ⁺ , 9/2 ⁺)		BC	E(level): weighted average of 529 10 from ($d, ^3\text{He}$) and 518 4 from (pol t, α). J^π : $L(d, ^3\text{He})=4$ for poorly resolved state.
701.1 [#] 4	17/2 ⁻		D	
722 4			C	
775 ^f 4	(5/2 ⁻)		BC	E(level): weighted average of 768 10 from ($d, ^3\text{He}$) and 776 4 from (pol t, α). J^π : tentative band assignment from ($d, ^3\text{He}$).
860 ^f 10	(9/2 ⁻)		B	J^π : tentative band assignment from ($d, ^3\text{He}$).
902.8 [#] 4	19/2 ⁻		D	
1017 4	(5/2 ⁺)		C	
1069 15	(1/2 ⁺)		B	J^π : $L(d, ^3\text{He})=(0)$.
1079 ^a 4	7/2 ⁺		C	J^π : from (pol t, α). However, $L(d, ^3\text{He})=2$.
1137 15			B	
1179 ^b 4	7/2 ⁺		BC	J^π : from (pol t, α). However, $L(d, ^3\text{He})=2$ implies (3/2, 5/2) ⁺ .
1277 ^b 4	9/2 ⁺		BC	
1343 15			B	
1365 ^c 4	7/2 ⁻		BC	E(level): weighted average of 1357 15 from ($d, ^3\text{He}$) and 1366 4 from (pol t, α). J^π : from (pol t, α). However, $L(d, ^3\text{He})=2$ for weakly excited state.
1386.4 4	(19/2 ⁺)	118 μs 6	D	J^π : 19/2 ⁺ preferred over other possible choices of 19/2 ⁻ and 21/2 ⁻ . Proposed configuration: $\pi 7/2[523] \otimes \nu 5/2[512] \otimes \nu 7/2[633]$. $T_{1/2}$: from mean lifetime (τ)=170 μs 8, determined from time dependence of

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Ho Levels (continued)

<u>E(level)[†]</u>	<u>$J^{\pi\dagger}$</u>	<u>XREF</u>	<u>Comments</u>
			the intensity of selected transitions following the decay of the isomer (2010Dr05) ($^{136}\text{Xe}, x\gamma$).
1420 4	(3/2 ⁺ , 5/2 ⁺)	BC	E(level): weighted average of 1410 15 from (d, ^3He) and 1421 4 from (pol t, α). J^{π} : L(d, ^3He)=2 for weakly-populated state.
1536 ^c 4	11/2 ⁻	BC	XREF: B(1524)
1578.2 4	(3/2, 5/2, 7/2) ⁻	A	J^{π} : log ft $\approx$ 4.9 from (5/2) ⁻ ^{169}Dy . 1990Ch34 suggest that this may be a three quasiparticle state with configuration (π 7/2[523]) $\otimes$ (ν 5/2[512]) $\otimes$ (ν 5/2[523]) ⁻¹ , but decline to actually make this assignment.
1618 15		B	
1651 4	(11/2 ⁻)	C	
1692 ^e 5	5/2 ⁺	BC	E(level): weighted average of 1673 15 from (d, ^3He) and 1693 4 from (pol t, α). J^{π} : from L=2 and analyzing power in (pol t, α); supported by L(d, ^3He)=(2).
1745 4	(1/2 ⁺)	C	
1786 ^d 4	1/2 ⁺	BC	XREF: B(1768) J^{π} : from (pol t, α). L=(3) in (d, ^3He) but angular distribution does not enable definitive fit; possibly different states are excited by these two reactions.
1850 ^d 4	5/2 ⁺	C	
1864 5	(11/2 ⁻)	BC	E(level): weighted average of 1844 15 from (d, ^3He) and 1865 4 from (pol t, α).

[†] From a least-squares fit to E_{γ} 's, assuming 0.3 keV uncertainty for γ rays without uncertainties. Excited level energies without depopulating gammas are from ^{170}Er (pol t, α), except when seen only in ^{170}Er (d, ^3He) or where noted otherwise.

[‡] From angular distributions and analyzing powers in ^{170}Er (pol t, α), except where noted.

Band(A): 7/2[523] band. Band parameter: A=10.7.

@ Band(B): 3/2[411] band. Band parameters: A=12.1, B=-100 (3/2, 5/2, 7/2, 9/2 levels).

& Band(C): 1/2[411] band.

^a Band(D): 7/2[404] band.

^b Band(E): 5/2[413] band. Band parameter: A=10.9.

^c Band(F): 5/2[532] band. Band parameter: A=8.5.

^d Band(G): 1/2[420] band.

^e Band(H): 5/2[402]? band.

^f Band(I): Tentative 1/2[541] band.

 $\gamma(^{169}\text{Ho})$

<u>$E_i(\text{level})$</u>	<u>J_i^{π}</u>	<u>$E_{\gamma}^{\dagger}$</u>	<u>$I_{\gamma}^{\#}$</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.</u>	<u>$\alpha^@$</u>	<u>Comments</u>
97.5	9/2 ⁻	97.7	100	0.0	7/2 ⁻			
216.9	11/2 ⁻	119.2	100	97.5	9/2 ⁻			
		216.7	21.9 24	0.0	7/2 ⁻			
357.6	13/2 ⁻	140.4	100	216.9	11/2 ⁻			
		260.4	31.0 29	97.5	9/2 ⁻			
518.7	15/2 ⁻	161.1	100	357.6	13/2 ⁻			
		301.7	42.6 37	216.9	11/2 ⁻			
701.1	17/2 ⁻	182.5	100	518.7	15/2 ⁻			
		343.6	61.3 36	357.6	13/2 ⁻			
902.8	19/2 ⁻	201.7		701.1	17/2 ⁻			
		384.0		518.7	15/2 ⁻			
1386.4	(19/2 ⁺)	483.6	23.7 17	902.8	19/2 ⁻	[E1]	0.00577 8	B(E1)(W.u.)=3.14 $\times$ 10 ⁻¹² +28-26
		685.4	100.0 43	701.1	17/2 ⁻	[E1]	0.00273 4	B(E1)(W.u.)=4.65 $\times$ 10 ⁻¹² +27-24

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{169}\text{Ho})$ (continued)

<u>$E_i(\text{level})$</u>	<u>J_i^π</u>	<u>$E_\gamma^\dagger$</u>	<u>$I_\gamma^\#$</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.</u>	<u>$\alpha^\@$</u>
1386.4	(19/2 ⁺)	867.3 ^{&}	≤ 2.1	518.7	15/2 ⁻	[M2]	0.02101 29
1578.2	(3/2,5/2,7/2) ⁻	1578.2 [‡] 4	100	0.0	7/2 ⁻	[M1,E2]	0.00173 32

[†] From ($^{136}\text{Xe},x\gamma$), except where otherwise noted.

[‡] From ^{169}Dy β^- decay.

[#] Relative photon branching from β^- decay.

[@] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with “Frozen Orbitals” approximation based on γ -ray energies, assigned multiplicities, and mixing ratios, unless otherwise specified.

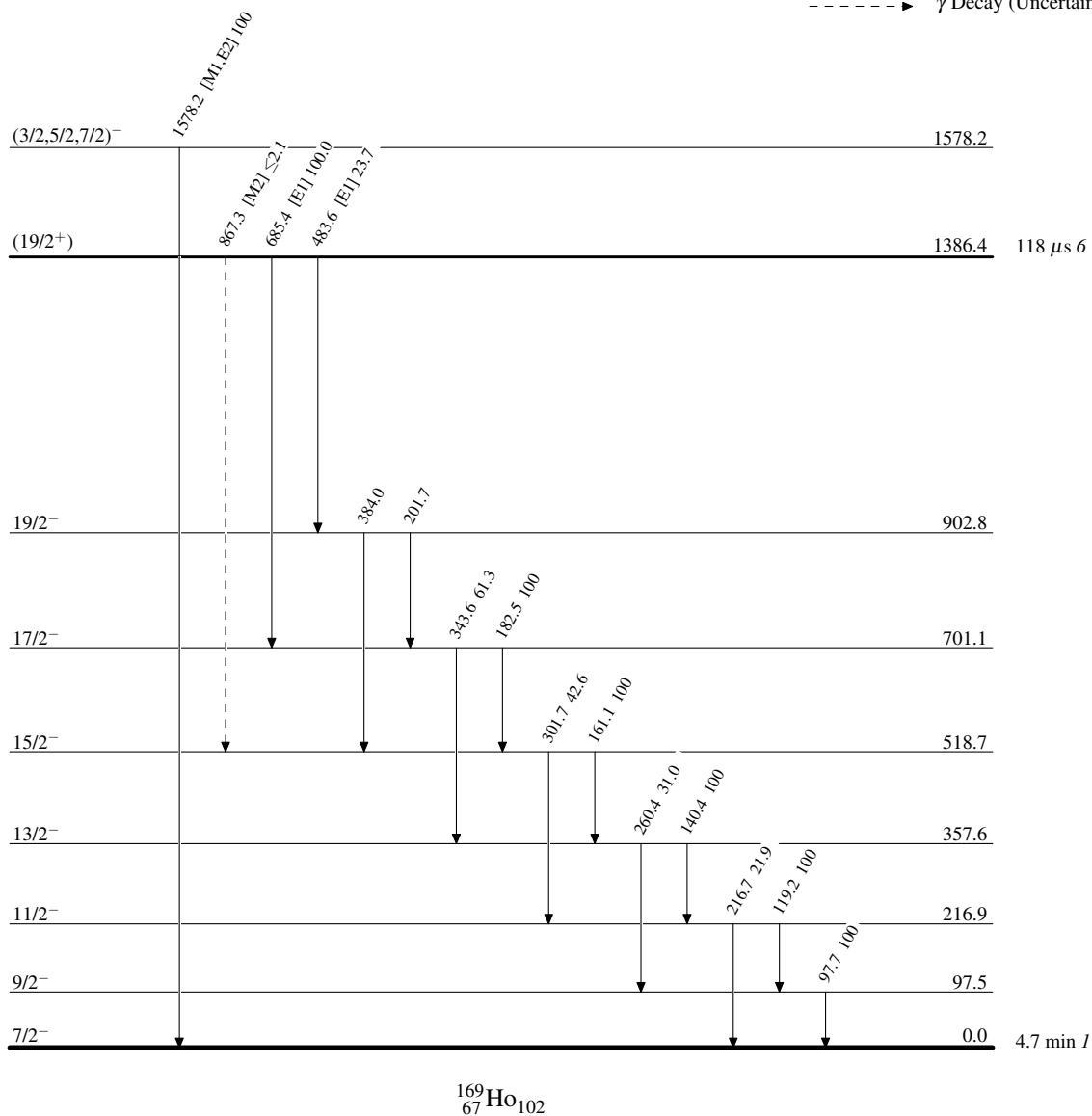
[&] Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

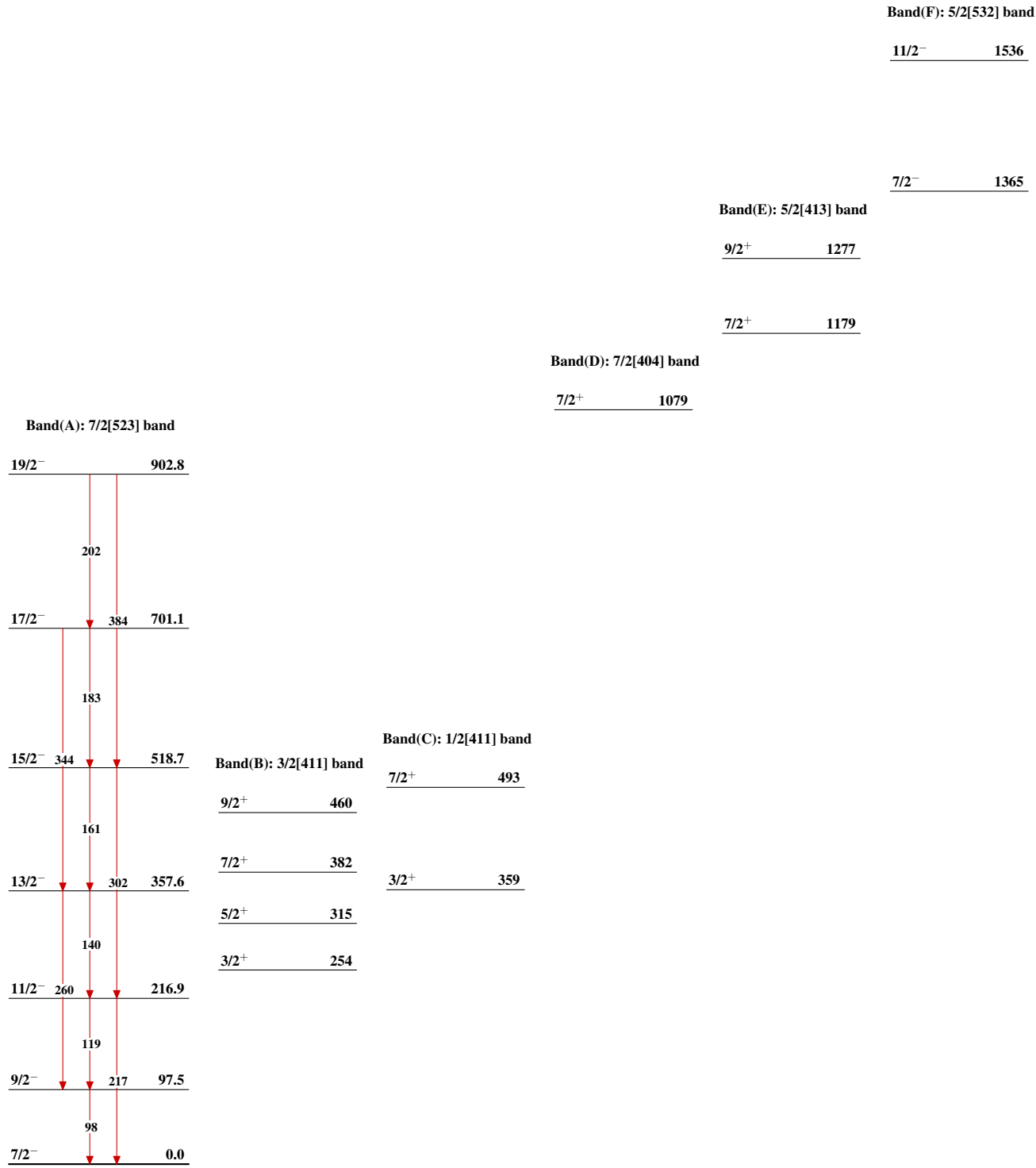
Legend

Level Scheme

Intensities: Relative photon branching from each level

-----► γ Decay (Uncertain)

Adopted Levels, Gammas



Adopted Levels, Gammas (continued)**Band(G): 1/2[420] band**

<u>5/2⁺</u>	<u>1850</u>

<u>1/2⁺</u>	<u>1786</u>

Band(H): 5/2[402]? band

<u>5/2⁺</u>	<u>1692</u>

**Band(I): Tentative
1/2[541] band**

<u>(9/2⁻)</u>	<u>860</u>

<u>(5/2⁻)</u>	<u>775</u>

 $^{169}_{67}\text{Ho}_{102}$

$^{169}\text{Dy } \beta^- \text{ decay}$ [1990Ch34](#)

Parent: ^{169}Dy : $E=0.0$; $J^\pi=(5/2)^-$; $T_{1/2}=39 \text{ s}$; $Q(\beta^-)=3.2\times 10^3 \text{ keV}$; $\% \beta^- \text{ decay}=100.0$

^{169}Dy - J^π , $T_{1/2}$: from ^{169}Dy Adopted Levels.

^{169}Dy - $Q(\beta^-)$: from [2021Wa16](#).

The partial decay scheme and all data are from [1990Ch34](#). Sources from multi-nucleon transfer reactions between ^{170}Er and tungsten targets, on-line mass separation; $E(^{170}\text{Er})=1445 \text{ MeV}$; measured $E\beta$, $I\beta$ (plastic, silicon detectors), $E\gamma$, $I\gamma$ (Ge, planar HPGe), time-resolved singles measurements, $\beta\gamma$ coin, $\gamma\gamma$ coin.

 ^{169}Ho Levels

<u>E(level)</u>	<u>$J^\pi^\dagger$</u>	<u>$T_{1/2}^\dagger$</u>
0.0	$7/2^-$	4.7 min <i>I</i>
1578.2 4	$(3/2, 5/2, 7/2)^-$	

† From Adopted Levels.

 β^- radiations

<u>E(decay)</u>	<u>E(level)</u>	<u>$I\beta^{-\dagger}$</u>	<u>Log ft</u>	<u>Comments</u>
$(1.62\times 10^3 \text{ keV } 30)$	1578.2	≈ 20	≈ 4.9	$I\beta^-$: a ground-state to excited-state (1578 keV) β branching ratio of 3.5 was determined with an estimated uncertainty of $\sim 20\%$ (1990Ch34). Log ft : lower than any known log ft value involving the $\nu 5/2[512]$ orbital (1990Ch34); configuration for 1578 level not understood. 1990Ch34 suggest that this may be a three quasiparticle state with configuration $(\pi 7/2[523])\otimes(\nu 5/2[512])\otimes(\nu 5/2[523])^{-1}$, but decline to actually make that assignment.
$(3.20\times 10^3 \text{ keV } 30)$	0.0	≈ 80	≈ 5.5	$I\beta^-$: the intensity of the ground-state β branch was estimated by fitting the 2.1-2.9-MeV interval of a calculated “ideal” β particle spectrum, with a 3.2-MeV β end point, to the measured β spectrum (1990Ch34). Log ft : relatively low, compared with log $ft=5.9$ for $7/2[523]$ to $5/2[512]$ transition in ^{167}Ho decay and log $ft=6.4$ for $5/2[512]$ to $7/2[523]$ transition in ^{171}Er decay, but not inconsistent with those values (1990Ch34).

† Absolute intensity per 100 decays.

 $\gamma(^{169}\text{Ho})$

$I\gamma$ normalization: assuming $I(\gamma+\text{ce})(1578\gamma)=I\beta(1578 \text{ level})$.

<u>E_γ</u>	<u>$I_\gamma^\dagger$</u>	<u>$E_i(\text{level})$</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.</u>	<u>$\alpha^\ddagger$</u>
1578.2 4	100	1578.2	$(3/2, 5/2, 7/2)^-$	0.0	$7/2^-$	[M1, E2]	0.00173 32

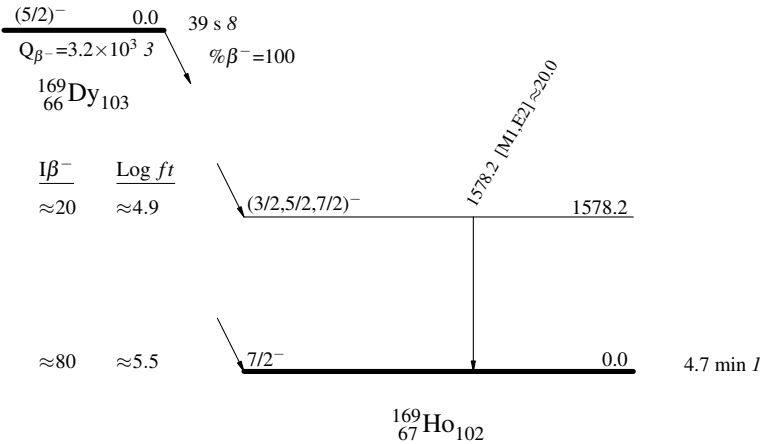
† For absolute intensity per 100 decays, multiply by ≈ 0.20 .

‡ Total theoretical internal conversion coefficients, calculated using the BrIcc code ([2008Ki07](#)) with “Frozen Orbitals” approximation based on γ -ray energies, assigned multiplicities, and mixing ratios, unless otherwise specified.

$^{169}\text{Dy} \beta^-$ decay 1990Ch34

Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays



$^{170}\text{Er}(\text{d}, ^3\text{He})$ **1976SuZR**

No significant changes compared to that in the previous evaluation (2008Ba31) by C.M. Baglin.

$E(\text{d})=35$ MeV; enriched (>96%) ^{170}Er targets; measured $E(\text{level})$ (mag spect, FWHM=35-45 keV), angular distributions (10° to 30°); interpreted levels in terms of the Nilsson model, including pairing and Coriolis coupling.

Agreement with the results from $^{170}\text{Er}(\text{pol t}, \alpha)$ (1979Lo02) is fair. 1979Lo02 state that poor resolution in 1976SuZR led to some incorrect conclusions.

 ^{169}Ho Levels

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$L^\#$	$S\&$	Comments
0.0 ^a	$7/2^-$	(3)	0.06	Bandhead was placed at centroid of unresolved multiplet; the nature of an additional nearby transition is unknown (possibly from a contaminant).
106 ^a 10	$9/2^-$	5	0.22	
213 ^a 10	$11/2^-$	5	0.81	S: large value attributed to Coriolis mixing with higher $\pi=-$ states.
253 ^b 10	$3/2^+$	2	0.05	
320 ^b 10	$5/2^+$	2	0.63	
359 ^c 10	$3/2^+$	2	0.21	Multiplet; peak probably includes weak component from $1/2^+$ $1/2[411]$ state.
385 ^b 10	$7/2^+$	4	0.27	Partially resolved from a larger peak; population strength attributed to strong Coriolis mixing.
457 ^d 10	$(5/2^+)^\oplus$	2	0.03	J^π : $9/2^+$ in the Adopted Levels.
497 ^d 10	$(7/2^+)^\oplus$	4	0.47	J^π : strong population favors $7/2^+$ $5/2[413]$ assignment over $7/2^+$ $1/2[411]$; overlap with expected $9/2^+$ $3/2[411]$ state increases uncertainty of assignment.
529 ^c 10	$(7/2^+)^\oplus$	4	0.16	
768 ^e 10	$5/2^-$		0.08	
860 ^e 10	$9/2^-$		0.07	
1069 ^f 15	$1/2^+$	(0)	0.10 ^h	
1137 ^f 15	$(3/2^+)^\oplus$		0.02 ^h	Partially resolved from a larger peak.
1176 ^f 15	$5/2^+^\oplus$	2	0.09 ^h	J^π : $7/2^+$ in the Adopted Levels.
1270 ^f 15	$7/2^+$	4	0.20 ^h	
1343 ^f 15	$(9/2^+)^\oplus$		0.10 ^h	Partially resolved from a larger peak.
1357 ^g 15	$3/2^+^\oplus$	2	0.11	J^π : $7/2^-$ in the Adopted Levels.
1410 ^g 15	$5/2^+$	2	0.04	
1524 ^g 15	$7/2^+$		0.40	
1618 15				
1673 15		(2)	≈ 0.06	
1768 15		(3)	≈ 0.09	
1844 15	$11/2^-$	5	0.68	J^π : possibly $11/2^-$ $5/2[532]$ state (analogous level observed in ^{165}Ho).

[†] See ^{169}Ho Adopted Levels for monotonically increasing discrepancies between these values and the corresponding adopted energies.

[‡] From angular distributions and level structure (authors' values). Inconsistencies with values adopted from $^{170}\text{Er}(\text{pol t}, \alpha)$ are noted.

[#] From DWBA analysis of angular distributions.

[⊕] Inconsistent with the adopted J^π .

[&] Values for multiplet were calculated by assigning the entire multiplet level strength to the dominant member (J^π indicated).

^a $7/2[523]$ band member.

^b $3/2[411]$ band member.

^c $1/2[411]$ band member; assignment uncertain because of possible band mixing.

^d $5/2[413]$ band member; assignment uncertain because of possible band mixing.

^e $1/2[541]$ band member (tentative).

^f $1/2[420]$ band member; low spectroscopic factors throughout band, even with Coriolis mixing considered, suggest possible band mixing with a K-2 γ -vibrational band built on either the $3/2^+$ $3/2[411]$ or $5/2^+$ $5/2[413]$ state.

Continued on next page (footnotes at end of table)

¹⁷⁰Er(d,³He) **1976SuZR (continued)**

¹⁶⁹Ho Levels (continued)

^g 3/2[422] band member.
^h See comment with band assignment.

$^{170}\text{Er}(\text{pol } t, \alpha)$ **1979Lo02**

No significant changes compared to that in the previous evaluation ([2008Ba31](#)) by C.M. Baglin.

E(t)=17 MeV, polarization=0.78 (average value); metallic Er targets enriched to 96.9% in ^{170}Er ; measured E(level) (Q3D mag spect, FWHM $\approx$ 16 keV), angular distributions (9 angles from 10° to 50°), analyzing powers; interpreted levels in terms of the Nilsson model, including pairing and Coriolis coupling, aided by analogies with known levels in ^{165}Ho and ^{167}Ho .

 ^{169}Ho Levels

E(level)	$J^\pi^\dagger$	$S^\ddagger$	Comments
0.0 [#]	7/2 ⁻	0.054	
97 [#] 4	9/2 ⁻	0.19	
215 [#] 4	11/2 ⁻	1.90	S: large value attributed to Coriolis mixing with other orbitals from the $h_{11/2}$ shell.
254 [@] 4	3/2 ⁺	0.11	
314 [@] 4	5/2 ⁺	0.79	
359 ^{&} 4	3/2 ⁺	0.27	
381 [@] 4	7/2 ⁺	$\approx$ 0.15	J^π : angular distribution not shown.
460 [@] 4	9/2 ⁺	0.16	
492 ^{&} 4	7/2 ⁺	0.34	
518 4			
722 4			
776 4			
1017 4	(5/2 ⁺)	0.018	
1079 ^a 4	7/2 ⁺	0.78	S: See comment on S for 1179 level.
1179 ^b 4	7/2 ⁺	0.52	S: value is much smaller than expected (level is dominant band member) because Coriolis coupling to the 7/2 ⁺ 7/2[404] state moves strength to that level.
1277 ^b 4	9/2 ⁺	0.15	
1366 ^c 4	7/2 ⁻	0.20	
1421 4			
1536 ^c 4	11/2 ⁻	0.76	S: large value attributed to origin of the 5/2[532] orbital in the $h_{11/2}$ shell-model state.
1651 4	(11/2 ⁻)	0.57	
1693 ^e 4	5/2 ⁺	0.070	
1745 4	(1/2 ⁺)	0.029	
1786 ^d 4	1/2 ⁺	0.077	
1850 ^d 4	5/2 ⁺	0.13	S: value is smaller than predicted value (1/2[420] orbital has its origin in the $2d_{5/2}$ shell-model state) suggesting high-energy fragmentation of single-particle strength.
1865 4	(11/2 ⁻)	0.76	

[†] From angular distributions and analyzing powers (authors' values). These values are also the adopted ones.

[‡] Nuclear structure factor calculated from $d\sigma/d\Omega(\text{exp})/(2N d\sigma/d\Omega(\text{DWBA}))$ assuming $N=32.5$.

[#] Band(A): 7/2[523] band.

[@] Band(B): 3/2[411] band.

[&] Band(C): 1/2[411] band.

^a Band(D): 7/2[404] band.

^b Band(E): 5/2[413] band.

^c Band(F): 5/2[532] band.

^d Band(G): 1/2[420] band.

^e Band(H): 5/2[402]? band.

$^{170}\text{Er}(\text{pol t}, \alpha)$ 1979Lo02

Band(F): 5/2[532] band

11/2⁻ 15367/2⁻ 1366

Band(E): 5/2[413] band

9/2⁺ 12777/2⁺ 1179

Band(D): 7/2[404] band

7/2⁺ 1079

Band(C): 1/2[411] band

Band(B): 3/2[411] band

7/2⁺ 4929/2⁺ 4607/2⁺ 3813/2⁺ 3595/2⁺ 314

Band(A): 7/2[523] band

3/2⁺ 25411/2⁻ 2159/2⁻ 977/2⁻ 0.0

¹⁷⁰Er(pol t,α) 1979Lo02 (continued)

Band(G): 1/2[420] band

5/2⁺ 1850

1/2⁺ 1786

Band(H): 5/2[402]? band

5/2⁺ 1693

¹⁶⁹₆₇Ho₁₀₂

$^{170}\text{Er}(^{136}\text{Xe}, \text{X}\gamma)$ 2010Dr05

Edited/Adapted the XUNDL dataset compiled by B. Singh (McMaster) Sept 23, 2010.

E=830 MeV, pulsed and chopped beam from ATLAS facility at ANL. Measured E_γ , I_γ , $\gamma\gamma$, lifetimes using Gammasphere array.

Comparison with multiquasiparticle calculations.

 ^{169}Ho Levels

In table II, 2010Dr05 also give values of transition probabilities and hindrance factors for $J^\pi(1386 \text{ level})=19/2^-$ and $21/2^-$ with associated multiplicities. In this dataset, the listed values are for $J^\pi(1386 \text{ level})=19/2^+$.

Authors (2010Dr05) give absolute (g_K-g_R) values, calculated by assuming $Q_0=7.7$.

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$T_{1/2}$	Comments
0.0 [#]	7/2 ⁻		
97.5 [#] 3	9/2 ⁻		
216.9 [#] 3	11/2 ⁻		Absolute (g_K-g_R)=0.68 4.
357.6 [#] 3	13/2 ⁻		Absolute (g_K-g_R)=0.88 +5-4.
518.7 [#] 3	15/2 ⁻		Absolute (g_K-g_R)=0.98 +5-4.
701.0 [#] 4	17/2 ⁻		Absolute (g_K-g_R)=0.98 3.
902.7 [#] 4	19/2 ⁻		
1386.2 4	(19/2 ⁺)	118 μs 6	J^π : 19/2 ⁺ preferred over other possible choices of 19/2 ⁻ and 21/2 ⁻ . Proposed configuration: $\pi 7/2[523]\otimes\nu 5/2[512]\otimes\nu 7/2[633]$. $T_{1/2}$: from mean lifetime (τ)=170 μs 8, determined from time dependence of the intensity of selected transitions following the decay of the isomer (2010Dr05).

[†] From a least-squares fit to E_γ 's, assuming 0.3 keV uncertainty for each γ ray.

[‡] As given in 2010Dr05.

[#] Band(A): $\pi 7/2[523]$ band.

 $\gamma(^{169}\text{Ho})$

$E_i(\text{level})$	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult.	Comments
97.5	9/2 ⁻	97.7		0.0	7/2 ⁻		
216.9	11/2 ⁻	119.2	100	97.5	9/2 ⁻		
		216.7	21.9 24	0.0	7/2 ⁻		
357.6	13/2 ⁻	140.4	100	216.9	11/2 ⁻		
		260.4	31.0 29	97.5	9/2 ⁻		
518.7	15/2 ⁻	161.1	100	357.6	13/2 ⁻		
		301.7	42.6 37	216.9	11/2 ⁻		
701.0	17/2 ⁻	182.5	100	518.7	15/2 ⁻		
		343.6	61.3 36	357.6	13/2 ⁻		
902.7	19/2 ⁻	201.7		701.0	17/2 ⁻		
		384.0		518.7	15/2 ⁻		
1386.2	(19/2 ⁺)	483.6	23.7 17	902.7	19/2 ⁻	[E1]	Relative $I_\gamma=223$ 16. $B(E1)=6.2\times 10^{-14}$ 6. Reduced hindrance factor $f_v=200$.
		685.4	100.0 43	701.0	17/2 ⁻	[E1]	Relative $I_\gamma=940$ 40. $B(E1)=9.1\times 10^{-14}$ 7. Reduced hindrance factor $f_v=185$.
		867.3 [†]	≤ 2.1	518.7	15/2 ⁻	[M2]	Relative $I_\gamma\leq 16$ 4. $B(M2)\leq 1.2\times 10^{-5}$ 3. Reduced hindrance factor $f_v\geq 45$.

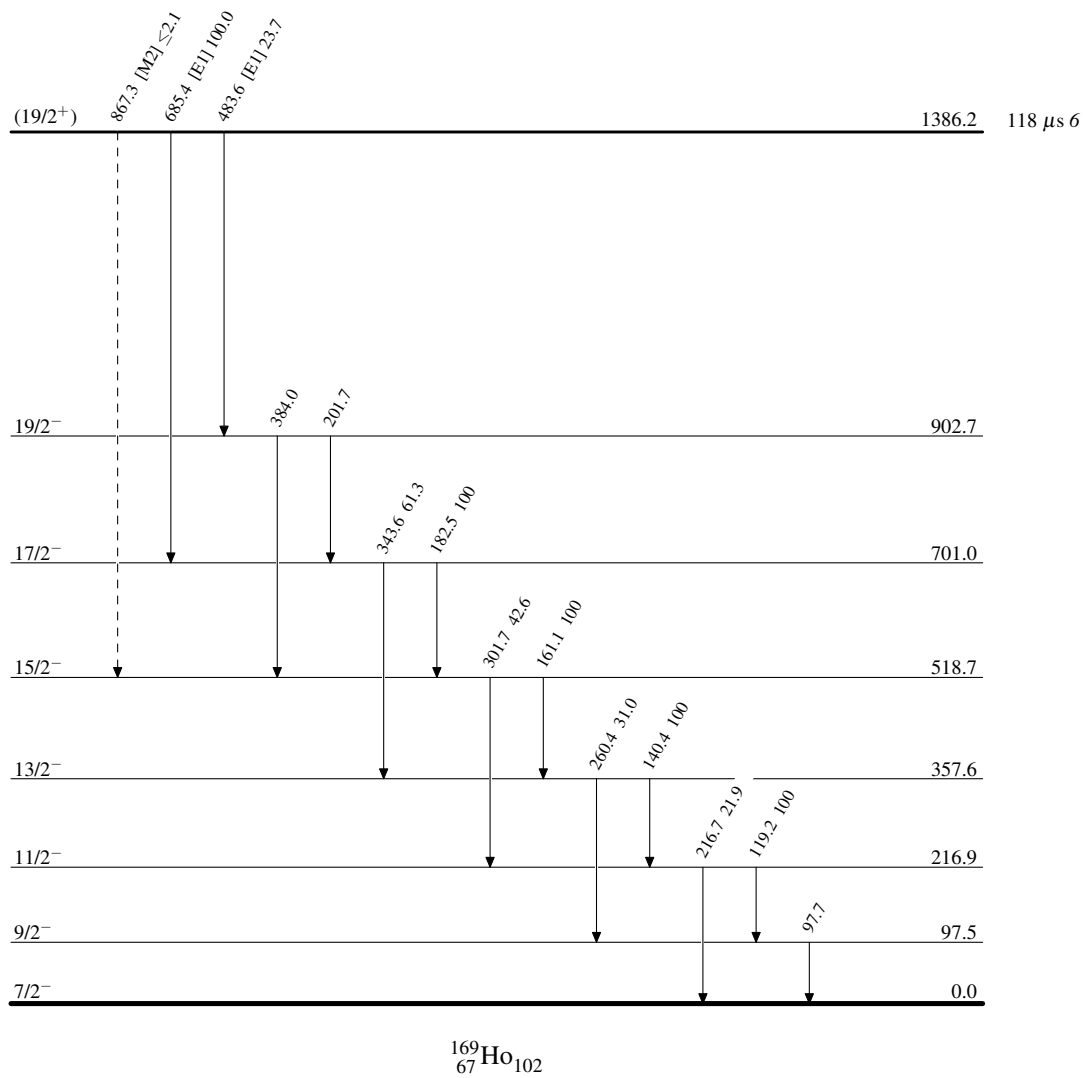
[†] Placement of transition in the level scheme is uncertain.

$^{170}\text{Er}(^{136}\text{Xe}, \text{X}\gamma)$ 2010Dr05

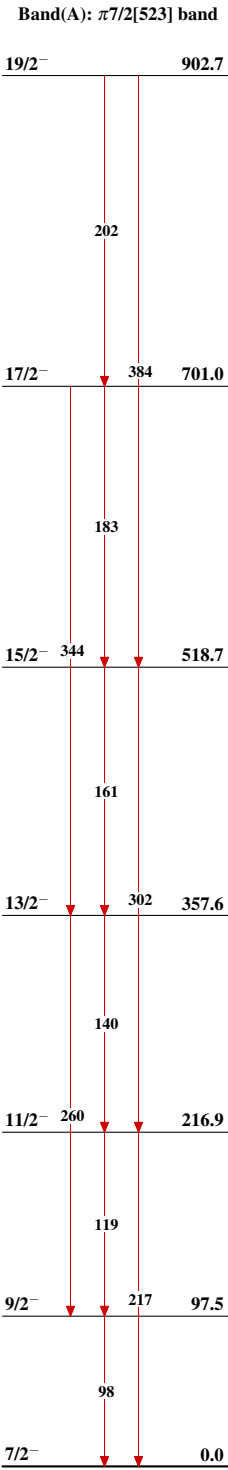
Legend

Level Scheme

Intensities: Relative photon branching from each level

-----► γ Decay (Uncertain)

¹⁷⁰Er(¹³⁶Xe,Xγ) 2010Dr05



¹⁶⁹Ho₁₀₂

Adopted Levels, Gammas

$Q(\beta^-)=353.5$ 8; $S(n)=6003.25$ 15; $S(p)=8150$ 30; $Q(\alpha)=266.2$ 7 [2021Wa16](#)
 $S(2n)=13774.54$ 19, $S(2p)=15588$ 4 ([2021Wa16](#)).

Other reaction:

$^{168}\text{Er}(n,\gamma)$ $E=10\text{-}90$ keV, 550 keV ([2000HaZX](#)):

Measured cross sections ($\pm 5\%$) and capture γ spectra.

 ^{169}Er LevelsCross Reference (XREF) Flags

A	^{169}Ho β^- decay	F	$^{168}\text{Er}(\text{d},\text{p}\gamma)$
B	$^{167}\text{Er}(\text{t},\text{p})$	G	$^{168}\text{Er}(^{16}\text{O},^{15}\text{O}),(^{12}\text{C},^{11}\text{C})$
C	$^{168}\text{Er}(n,\gamma)$ $E=\text{thermal}$	H	$^{170}\text{Er}(^3\text{He},\alpha)$
D	$^{168}\text{Er}(n,\gamma)$ $E=\text{resonance}$	I	$^{170}\text{Er}(^{238}\text{U},^{238}\text{U}'n\gamma)$
E	$^{168}\text{Er}(\text{d},\text{p}), ^{170}\text{Er}(\text{d},\text{t})$		

$E(\text{level})^\dagger$	$J^\pi{}^b$	$T_{1/2}$	XREF	Comments
0.0 ^e	$1/2^-$	9.39 d 2	A CDEF I	$\% \beta^- = 100$ $\mu = +0.4848$ 4 μ : atomic beam (direct) (1963Do09/1965Sm04 , 2019StZV). J^π : atomic beam (1961Ca07 , 2013Ma15); $E1$ γ from $1/2^+$ in $^{168}\text{Er}(n,\gamma)$ $E=\text{resonance}$. $T_{1/2}$: weighted average of 9.40 d 2 (1977My02) and 9.36 d 4 (2004Sc04). Others: 9.4 d 2 (1948Ke11), 9.0 d 2 (1956Bi30), 9.8 d 5 (1960Wi10), 9.6 d 1 (1961Bj02), 9.0 d 1 (1963Ra15), and 9.5 d (1958Pa16). Weighted average of all values, except the one without uncertainty, yields 9.37 d 4 with $\chi^2=4.1$ cf. $\chi^2_{\text{crit}}=2.6$. Prior measurements of 1977My02 generally dealt with the production or decay of a number of different isotopes and the ^{169}Er half-life was a minor detail noted by authors of 1977My02 .
64.551 ^f 20	$3/2^-$ ^c		A CDEF I	J^π : $M1+E2$ 65γ to $1/2^-$ g.s..
74.58 ^e 6	$5/2^-$ ^c		A C EF I	
92.01 ^g 9	$(5/2)^-$	285 ns 20	A C EF	J^π : $E1$ 152γ from $7/2^+$ 244; Nilsson $5/2[512]$ orbital bandhead was predicted around this excitation energy (1969Tj01 – (d,p),(d,t)). Also mentioned by authors of 1966Fu09 (^{169}Ho β^- decay). $T_{1/2}$: from $\text{p}\gamma(\text{t})$, $\text{p-cc}(\text{t})$ in $^{168}\text{Er}(\text{d},\text{p}\gamma)$.
176.76 ^g 10	$(7/2)^-$		A C EFG	J^π : $M1$ 84.9γ to $(5/2)^-$ 92; $7/2^-$ consistent with band assignment.
224.18 ^f 7	$7/2^-$		A C E I	J^π : from band member assignment. Detailed arguments are available in the band footnotes.
241.99 ^e 11	$9/2^-$		A C E I	J^π : from comparison of theoretical (Nilsson model estimates) and experimental cross section in (d,p) (1970Mu15). Band assignment.
243.66 ^h 16	$7/2^+$	200 ns 10	ABC F I	J^π : $L=0$ in $^{167}\text{Er}(\text{t},\text{p})$ on $7/2^+$ target. $T_{1/2}$: from $\text{p}\gamma(\text{t})$, $\text{p-cc}(\text{t})$ in $^{168}\text{Er}(\text{d},\text{p}\gamma)$.
285.16 ^g 22	$(9/2^-)$ ^c		C EF	
317.3 ⁱ 5	$(9/2^+)$ ^c		AB E I	
413.1 ^h 5	$(11/2^+)$		B I	J^π : from analysis of level energy and intensity data for $7/2[633]$ band members in $^{167}\text{Er}(\text{t},\text{p})$. Stronger population of the bandhead (1985Lo19).
416 ^g 3	$(11/2^-)$ ^c		E	
475.2 ^f 10	$11/2^-$ ^c		E I	
501.0 ^e 10	$(13/2^-)$		I	J^π : g.s. band member.
526.3 ⁱ 11	$(13/2^+)$		B E GHI	J^π : $L=6$ in $^{170}\text{Er}(^3\text{He},\alpha)$; $13/2^+$ consistent with band assignment.
562.03 ^j 9	$(1/2)^-$		CDE	XREF: E(557)

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Er Levels (continued)

E(level) [†]	J ^π ^b	XREF	Comments
			J ^π : primary γ from 1/2 ⁺ in $^{168}\text{Er}(n,\gamma)$ E=resonance, probable E1; J=1/2 consistent with band assignment.
592.5		B	
599.28 ^j 8	(3/2) ⁻	CDE	J ^π : primary γ from 1/2 ⁺ in $^{168}\text{Er}(n,\gamma)$ E=resonance, probable E1; 3/2 ⁻ consistent with band assignment.
654.17 ^j 10	(5/2) ⁻ ^c	C E	
664.1 ^h 11	(15/2) ⁺	I	J ^π : band assignment.
714.68 ^k 10	(3/2) ⁻	CDE	J ^π : primary γ from 1/2 ⁺ in $^{168}\text{Er}(n,\gamma)$ E=resonance, probable E1; 3/2 ⁻ consistent with band assignment.
739.7 ^j 7	(7/2) ⁻ ^c	C E	
769.55 ^k 9	(5/2) ⁻ ^c	A C E	
813.2 ^f 14	(15/2) ⁻	I	J ^π : g.s. band member.
816.3 ⁱ 15	(17/2) ⁺	I	J ^π : band assignment.
822 ^l 3	(7/2) ⁻ ^c	E	J ^π : expected 5/2[523] bandhead below 1000 keV for the heaviest erbium nuclei, in analogy to the assignments in ytterbium nuclei (1966Bu16).
848.0 ^e 14	(17/2) ⁻	I	J ^π : g.s. band member.
848.5	⁺	B	J ^π : L=2 in $^{167}\text{Er}(t,p)$ on 7/2 ⁺ target.
852 ^{ak} 3	(7/2) ⁻ ^c	E H	
853.00 ^m 8	5/2 ⁻	A C	J ^π : log ft=4.9 from 7/2 ⁻ ; indicates allowed unhindered transition which, in this mass region, would establish configurations of (ν 5/2[523]) for this state and (π 7/2[523]) for the ^{169}Ho parent.
860.11 14	(3/2 ⁺ , 5/2 ⁺)	CD	J ^π : primary γ from 1/2 ⁺ in (n,γ) E=thermal; 617γ to 7/2 ⁺ 244. Assignment as member of K-2 γ-vibration band built on 7/2[633], suggested in 1970Mu15 (n,γ), is questioned by authors of 1985Lo19.
905.5	7/2 ⁺	B	J ^π : L=0 in $^{167}\text{Er}(t,p)$ on 7/2 ⁺ target.
927 ^a 3	(9/2) ⁻	E GH	
941.05 ^m 12	(7/2) ⁻	A E	J ^π : log ft=5.5 from 7/2 ⁻ ; 7/2 ⁻ consistent with band assignment.
≈947 ^k	(9/2) ⁻ ^c	E G	XREF: G(940)
971.5	(⁺)	B	J ^π : L=(4) in $^{167}\text{Er}(t,p)$ on 7/2 ⁺ target.
990 ^a 3	(⁺)	B E	J ^π : L=(2) in $^{167}\text{Er}(t,p)$ on 7/2 ⁺ target.
999.1 ^h 15	(19/2) ⁺	I	J ^π : band assignment.
1051 ^l 5	(11/2) ⁻ ^c	E	J ^π : band assignment.
1052 ^{am} 5	(9/2) ⁻ ^c	E H	
1053.2 5	1/2 ⁻ , 3/2 ⁻	D	
1056.5		B	
1077 ^k 2	(11/2) ⁻ ^c	E	
1081.62 ⁿ 22	(3/2) ⁻	CDE	J ^π : primary γ from 1/2 ⁺ in $^{168}\text{Er}(n,\gamma)$ E=resonance, (E1); 3/2 ⁻ consistent with band assignment.
1085.5		B	
1094.33 11	1/2 ⁻ , 3/2 ⁻	CDE	
1113 [#] 5		B e	XREF: e(1112)
1116.99 14	(3/2) ⁻	C e	XREF: e(1112)
			J ^π : dipole γ from 1/2 ⁺ in $^{168}\text{Er}(n,\gamma)$ E=thermal; possible γ to (7/2) ⁻ .
1118.3		E	
1136 ^a 3	(⁺)	B E	J ^π : L=(4) in $^{167}\text{Er}(t,p)$ on 7/2 ⁺ target.
1142.8 6	1/2, 3/2 ^d	C	
1144.67 ⁿ 11	(5/2) ⁻ ^c	C E	
1168 ^{ao} 2	(13/2) ⁺	E G	XREF: G(1150)
			J ^π : based on relative population strengths in $^{168}\text{Er}(^{16}\text{O}, ^{15}\text{O}\gamma)$ and $^{168}\text{Er}(^{12}\text{C}, ^{11}\text{C}\gamma)$; 13/2 ⁺ consistent with band assignment.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Er Levels (continued)

E(level) [†]	J ^π ^b	XREF	Comments
1186 ^m 4	(11/2 ⁻) ^c	E	
1186.3 ⁱ 18	(21/2 ⁺)	I	J ^π : band assignment.
1218 4		E	
1221 5	(⁺)	B	J ^π : L=(2) in $^{167}\text{Er}(\text{t,p})$ on 7/2 ⁺ target.
1232 ^{an} 3	(7/2 ⁻) ^c	E H	
1235 3		B E	E(level): weighted average of 1238 5 from (t,p), and 1234 3 from (d,p).
1237.2 ^f 17	(19/2 ⁻)	I	J ^π : g.s. band member.
1274 3		B E	E(level): weighted average of 1278 5 from (t,p) and 1273 3 from (d,p).
1280.0 ^e 17	(21/2 ⁻)	I	J ^π : g.s. band member.
1296 5		B	
1341 ⁿ 5	(9/2 ⁻) ^c	E	
1360.09 17	1/2 ⁽⁺⁾	C E	Possibly two levels (E(level)=1360 5 in (d,t), E(level)=1364 5 in (d,p)). J ^π : D γ from 1/2 ⁺ in $^{168}\text{Er}(\text{n},\gamma)$ E=thermal; absence of population in $^{168}\text{Er}(\text{n},\gamma)$ E=resonance and absence of decay to 5/2 ⁻ states suggest 1/2 ⁺ .
1386.81 12	1/2 ⁻ , 3/2 ⁻	CDE	
1394 ^{‡p} 2	(11/2 ⁻) ^c	E H	E(level): weighted average of 1394 2 from (d,p) and 1397 15 from ($^3\text{He},\alpha$).
1415 5		E	Possibly two levels with same energy (one seen in (d,p), one seen in (d,t)).
1419.1 ^h 18	(23/2 ⁺)	I	J ^π : band assignment.
1434 5		B	
1459 ^a 2		B E	Possibly two levels with same energy (one seen in (d,p), one seen in (d,t)).
1470.1 [@] 5	1/2 ⁽⁻⁾ , 3/2 ⁽⁻⁾	CDE	E(level): weighted average of 1469.9 5 from (n,γ) E=resonance and 1470.7 8 from (n,γ) E=thermal. Other: 1471 5 from (d,p).
1483.9 [@] 18	1/2, 3/2 ^d	BC E	
1488.0 [@] 12	1/2 ⁻ , 3/2 ⁻	CDE	
1529 ^q 2	(3/2 ⁺) ^c	E	
1529.6 [@] 8	1/2 ⁻ , 3/2 ⁻	CD	
1535 5		E	
1548 [‡] 5	11/2 ⁺ , 13/2 ⁺	B H	J ^π : L=6 in $^{170}\text{Er}(\text{}^3\text{He},\alpha)$.
1553.7 [@] 8	1/2 ⁻ , 3/2 ⁻	CDE	
1564 5		E	
1572.4 ^{&} 5	1/2 ⁽⁻⁾ , 3/2 ⁽⁻⁾	DE	
1601 5		E	
1608 5		E	
1622 ^a 5		B E	Possibly two levels (E(level)=1622 5 in (d,p), E(level)=1623 5 in (d,t)) are same.
1632.3 ⁱ 21	(25/2 ⁺)	I	J ^π : band assignment.
1647.2 ^{@r} 7	(1/2 ⁺) ^c	C E	
1652 4		B E	E(level): weighted average of 1654 5 from (t,p), and 1650 5 from (d,p).
1667.5 17	1/2, 3/2 ^d	C	
1676 4		B E	E(level): weighted average of 1675 5 from (t,p), and 1677 5 from (d,p).
1680.0 [@] 10	1/2, 3/2 ^d	C E	
1700 4		E	Possibly two levels (E(level)=1699 5 in (d,p), E(level)= 1702 5 in (d,t)) are same; listed energy is weighted average.
1710.1 8	1/2, 3/2 ^d	C	
1716 4		E	Possibly two levels (E(level)=1715 5 in (d,p), E(level)= 1718 5 in (d,t)) are same; listed energy is weighted average.
1727 5		E	
1741.2 ^f 20	(23/2 ⁻)	I	J ^π : g.s. band member.
1743 5		B	
1755 5		E	
1775 [‡] 4		B E	E(level): weighted average of 1773 5 from (t,p) and 1776 5 from (d,p).
1783.6 [@] 8	1/2, 3/2 ^d	CD	

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Adopted Levels, Gammas (continued) ^{169}Er Levels (continued)

E(level) [†]	J ^π ^b	XREF	Comments
1790 5		E	
1793.0 ^e 20	(25/2 ⁻)	I	J ^π : g.s. band member.
1795.3 [@] 10	1/2,3/2 ^d	CD	
1806.3 19	1/2,3/2 ^d	C	
1819.7 [@] 17	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾	CDe	
1826.0 [@] 12	1/2,3/2 ^d	BC e	
1839.3 [@] 9	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾	CDe	
1848.4 [@] 9	1/2 ⁻ ,3/2 ⁻	CDe	
1856 5		B E	E(level): from (t,p).
1867.2 [@] 9	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾	CDE	
1886 5		E	
1897.7 [@] 8	1/2,3/2 ^d	CDE	Possibly two levels (E(level)=1899 5 in (d,p), E(level)=1904 5 in (d,t)) are same.
1913 5		E	
1919.1 ^h 21	(27/2 ⁺)	I	J ^π : band assignment.
1924 5		E	
1928.8 [@] 8	1/2 ⁻ ,3/2 ⁻	CDE	
1948.0 [@] 15	1/2 ⁻ ,3/2 ⁻	bCD	
1955.3 [@] 23	1/2 ⁻ ,3/2 ⁻	bCDE	
1966.9	1/2,3/2	D	J ^π : dipole γ from 1/2 ⁺ in $^{168}\text{Er}(n,\gamma)$ E=resonance.
1974 5		E	
1978.9 8	1/2,3/2 ^d	C	
1997.0 [@] 8	1/2,3/2 ^d	CDE	
2018 5		E	
2023.0 5	1/2 ⁻ ,3/2 ⁻	D	
2029.3 [@] 9	1/2 ⁻ ,3/2 ⁻	CDE	
2047.1 [@] 14	1/2,3/2 ^d	BC	
2055 4		E	Possibly two levels (E(level)=2053 5 in (d,p), E(level)= 2057 5 in (d,t)) are same; listed energy is weighted average.
2063.0 9	1/2,3/2 ^d	C	
2092 ^a 5		b E	
2098 ^{&}	1/2,3/2	b D	J ^π : dipole γ from 1/2 ⁺ in $^{168}\text{Er}(n,\gamma)$ E=resonance.
2112.5 10	1/2,3/2 ^d	C	
2125.2 [@] 8	1/2 ⁻ ,3/2 ⁻	CDE	
2141 [@] 3	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾	CD	
2149.3 ⁱ 23	(29/2 ⁺)	I	J ^π : band assignment.
2165.5 [@] 17	1/2 ⁻ ,3/2 ⁻	CD	
2180.4 [@] 8	1/2 ⁻ ,3/2 ⁻	CD	
2185.2 [@] 9	1/2,3/2 ^d	C E	
2204 5		E	
2219.4 [@] 8	1/2,3/2 ^d	BCd	
2225.3 [@] 12	1/2 ⁻ ,3/2 ⁻	CdE	
2237.9 9	1/2,3/2 ^d	C	
2255 5		E	
2264.5 10	1/2,3/2	D	J ^π : dipole γ from 1/2 ⁺ in $^{168}\text{Er}(n,\gamma)$ E=resonance.
2272 5		E	
2295 ^a 5		E G	
2324.2 ^f 22	(27/2 ⁻)	I	J ^π : band assignment.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Er Levels (continued)

E(level) [†]	J^π ^b	XREF	Comments
2336 5		E	
2382 5		E	
2383.0 ^e 22	(29/2 ⁻)	I	J^π : g.s. band member.
2420 5		E	
2440 5		E	
2482 5		B E	E(level): from (t,p).
2522 15		E	
2582 15		E	
2979 ^f 3	(31/2 ⁻)	I	J^π : g.s. band member.
3045 ^e 3	(33/2 ⁻)	I	J^π : g.s. band member.
≈3400		G	
3701 ^f 3	(35/2 ⁻)	I	J^π : g.s. band member.
3773 ^e 3	(37/2 ⁻)	I	J^π : g.s. band member.
4549 ^e 3	(41/2 ⁻)	I	J^π : g.s. band member.

[†] From least-squares fit to E_γ , except where noted. $\Delta E=1$ keV was assumed for missing E_γ uncertainties. Levels not connected by E_γ are from particle dataset.

[‡] Weighted average from reactions populating level.

From $^{167}\text{Er}(t,p)$.

@ From $^{168}\text{Er}(n,\gamma)$ E=thermal.

& From $^{168}\text{Er}(n,\gamma)$ E=resonance.

^a From $^{168}\text{Er}(d,p)$, $^{170}\text{Er}(d,t)$.

^b From population by E1 (or probable E1) γ from 1/2⁺ in $^{168}\text{Er}(n,\gamma)$ E=resonance, except as noted.

^c From combined analysis of the relative populations of band members, absolute cross sections, and angular distributions in $^{168}\text{Er}(d,p)$, $^{170}\text{Er}(d,t)$ (1969Tj01, 1970Mu15).

^d From population by primary γ in $^{168}\text{Er}(n,\gamma)$ E=thermal.

^e Band(A): 1/2[521], $\alpha=+1/2$. Band parameters: A=11.7, a=+0.84 (1/2, 3/2, 5/2, 7/2, 9/2 levels). Definite J^π is assigned to band members with $J \leq 41/2$ based on independently determined $J^\pi=1/2^-$ for bandhead and mult=M1+E2 for 65 γ . Also, observed (d,p) cross sections for J=1/2 through 7/2 band members match calculated fingerprint for 1/2[521] band.

^f Band(a): 1/2[521], $\alpha=-1/2$. See comment on signature partner band.

^g Band(B): 5/2[512]. Band parameters: A=12.3, B=-9.1 (5/2, 7/2, 9/2, 11/2 levels).

^h Band(c): 7/2[633], $\alpha=-1/2$. Band parameters: A=7.7, B=13.5 (7/2, 9/2, 11/2, 13/2 levels).

ⁱ Band(C): 7/2[633], $\alpha=+1/2$. See comment on signature partner band.

^j Band(D): 1/2[510] + (5/2[512] γ vibration). Band parameters: A=11.6, a=0.051 (1/2, 3/2, 5/2, 7/2 levels).

^k Band(E): 3/2[521] + (1/2[521] γ vibration). Band parameters: A=11.1, B=5.2 (3/2, 5/2, 7/2, 11/2 levels).

^l Band(F): 7/2[514]. Band parameters: A=11.4 (7/2, 9/2, 11/2 levels).

^m Band(G): 5/2[523]. Band parameters: A=12.3 (5/2, 7/2, 9/2, 11/2 levels).

ⁿ Band(H): 3/2[512]. Band parameters: A=12.3 (3/2, 5/2, 7/2, 9/2 levels).

^o Band(I): 9/2[624].

^p Band(J): 11/2[505].

^q Band(K): 3/2[402].

^r Band(L): 1/2[400].

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Er})$									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\oplus$	E_f	J_f^π	Mult. &	$\delta^\&$	α^a	Comments
64.551	3/2 ⁻	64.55 2	100	0.0	1/2 ⁻	M1+E2	0.61	11.86 17	
74.58	5/2 ⁻	(10.0)		64.551	3/2 ⁻	[M1]		69.1	E_γ : from level energy difference.
		74.6 1	100 20	0.0	1/2 ⁻	(E2)		9.23 14	
92.01	(5/2) ⁻	(17.46)	>18 &	74.58	5/2 ⁻				E_γ : from level energy difference.
		27.6 2	100 &	64.551	3/2 ⁻			20.0 6	
176.76	(7/2) ⁻	84.9 1	100	92.01	(5/2) ⁻	M1		4.56 7	
224.18	7/2 ⁻	149.6 2	95 16	74.58	5/2 ⁻	[M1,E2]		0.79 11	I_γ : weighted average of 100 22 from ^{169}Ho β^- decay and 90 22 from (n, γ) E=thermal.
		159.59 9	100 20	64.551	3/2 ⁻	[E2]		0.542 8	
241.99	9/2 ⁻	167.4 1	100	74.58	5/2 ⁻	[E2]		0.460 7	
243.66	7/2 ⁺	67.3 3	$\approx 9^\#$	176.76	(7/2) ⁻	(E1)		0.917 17	B(E1)(W.u.)= 2.6×10^{-7} +17-14 Other I_γ : 35 from (d,p γ) for $E_\gamma=65.5$.
		151.5 2	100 [#] 11	92.01	(5/2) ⁻	E1		0.1079 16	B(E1)(W.u.)= 2.49×10^{-7} 21
285.16	(9/2) ⁻	108.4 2	100	176.76	(7/2) ⁻	[M1]		2.258 34	
317.3	(9/2) ⁺	73.6 ^d 5	100	243.66	7/2 ⁺				E_γ : from β^- decay.
413.1	(11/2) ⁺	169.4 [‡]	100	243.66	7/2 ⁺				
475.2	11/2 ⁻	251 [‡]	100	224.18	7/2 ⁻				E_γ, I_γ : multiple placement and no I_γ was given ($^{238}\text{U}, ^{238}\text{U}'\text{n}\gamma$). Branching 100 by the evaluator, considering the only E_γ from this level.
501.0	(13/2) ⁻	259 [‡]	100	241.99	9/2 ⁻				
526.3	(13/2) ⁺	209 [‡]	100	317.3	(9/2) ⁺				
562.03	(1/2) ⁻	470.2 4	28 7	92.01	(5/2) ⁻				
		497.5 1	100 20	64.551	3/2 ⁻				
		562.0 2	27 6	0.0	1/2 ⁻				
599.28	(3/2) ⁻	507.1 2	24 6	92.01	(5/2) ⁻				
		524.8 1	72 16	74.58	5/2 ⁻				
		534.7 2	41 8	64.551	3/2 ⁻				
		599.2 2	100 21	0.0	1/2 ⁻				
654.17	(5/2) ⁻	429.9 ^b 1	<221 ^b	224.18	7/2 ⁻				
		579.3 4	7.1 17	74.58	5/2 ⁻				
		589.6 3	100 21	64.551	3/2 ⁻				
664.1	(15/2) ⁺	251 [‡]	100	413.1	(11/2) ⁺				E_γ, I_γ : multiple placement and no I_γ was given ($^{238}\text{U}, ^{238}\text{U}'\text{n}\gamma$). Branching 100 by the evaluator, considering the only E_γ from this level.
714.68	(3/2) ⁻	622.8 6	3.1 12	92.01	(5/2) ⁻				
		640.0 2	17 4	74.58	5/2 ⁻				
		650.0 2	55 12	64.551	3/2 ⁻				
		714.5 2	100 20	0.0	1/2 ⁻				

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Er})$ (continued)						Comments
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\oplus$	E_f	J_f^π	
739.7	(7/2 ⁻)	665.1 ^d 7	100	74.58	5/2 ⁻	
769.55	(5/2 ⁻)	545.0 ^b 6	<15 ^b	224.18	7/2 ⁻	
		695.0 2	100 21	74.58	5/2 ⁻	
		705.0 [#] 1	83 17	64.551	3/2 ⁻	Other I_γ : 100 23 in β^- decay.
813.2	(15/2 ⁻)	338 [‡]	100	475.2	11/2 ⁻	
816.3	(17/2 ⁺)	290 [‡]	100	526.3	(13/2 ⁺)	
848.0	(17/2 ⁻)	347 [‡]	100	501.0	(13/2 ⁻)	
853.00	5/2 ⁻	628.9 [#] 3	13.1 [#] 20	224.18	7/2 ⁻	
		676.5 [#] 2	19.9 [#] 19	176.76	(7/2 ⁻)	
		760.9 ^c 2	49 ^c 9	92.01	(5/2 ⁻)	E_γ : weighted average of 761.0 2 from ^{169}Ho β^- decay and 760.7 2 from (n, γ) E=thermal.
		778.4 2	48 [#] 3	74.58	5/2 ⁻	E_γ : weighted average of 778.4 1 from ^{169}Ho β^- decay and 779.4 5 from (n, γ) E=thermal.
		788.4 [#] 1	100 [#] 10	64.551	3/2 ⁻	
		853.0 2	53 [#] 6	0.0	1/2 ⁻	E_γ : weighted average of 852.9 2 from ^{169}Ho β^- decay and 853.2 3 from (n, γ) E=thermal.
860.11	(3/2 ⁺ , 5/2 ⁺)	616.8 4	9.1 26	243.66	7/2 ⁺	
		785.4 2	100 23	74.58	5/2 ⁻	
		795.6 2	71 14	64.551	3/2 ⁻	
941.05	(7/2 ⁻)	697.0 ^{#d} 5	9 [#] 5	243.66	7/2 ⁺	
		698.8 [#] 4	21 [#] 7	241.99	9/2 ⁻	
		717.0 [#] 2	71 [#] 5	224.18	7/2 ⁻	
		764.9 [#] 6	11 [#] 3	176.76	(7/2 ⁻)	
		849.4 [#] 6	23 [#] 3	92.01	(5/2 ⁻)	
		866.4 [#] 2	100 [#] 14	74.58	5/2 ⁻	
		876.4 [#] 3	47 [#] 9	64.551	3/2 ⁻	
999.1	(19/2 ⁺)	335 [‡]	100	664.1	(15/2 ⁺)	
1081.62	(3/2 ⁻)	989.6 2	100	92.01	(5/2 ⁻)	
1094.33	1/2 ⁻ , 3/2 ⁻	1002.1 2	14 3	92.01	(5/2 ⁻)	
		1019.9 2	26 6	74.58	5/2 ⁻	
		1029.8 2	33 7	64.551	3/2 ⁻	
		1094.5 3	100 20	0.0	1/2 ⁻	
1116.99	(3/2 ⁻)	939.60 ^d 25	38 10	176.76	(7/2 ⁻)	
		1042.5 3	100 22	74.58	5/2 ⁻	
		1052.6 ^b 2	<230 ^b	64.551	3/2 ⁻	

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Er})$ (continued)						Comments
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\oplus$	E_f	J_f^π	
1116.99	(3/2 ⁻)	1117.8 4	71 15	0.0	1/2 ⁻	
1144.67	(5/2 ⁻)	429.9 ^b 1	<630 ^b	714.68	(3/2 ⁻)	
		545.0 ^b 6	<33 ^b	599.28	(3/2 ⁻)	
		968.4 2	100 21	176.76	(7/2 ⁻)	
		1052.6 ^b 2	<240 ^b	92.01	(5/2 ⁻)	
		1069.8 ^d 10	24 13	74.58	5/2 ⁻	
1186.3	(21/2 ⁺)	370 [‡]	100	816.3	(17/2 ⁺)	
1237.2	(19/2 ⁻)	424 [‡]	100	813.2	(15/2 ⁻)	
1280.0	(21/2 ⁻)	432 [‡]	100	848.0	(17/2 ⁻)	
1360.09	1/2 ⁽⁺⁾	760.8 ^c 2	<29 ^c	599.28	(3/2 ⁻)	
		798.6 5	100 28	562.03	(1/2 ⁻)	
		1295.5 ^b 5	<57 ^b	64.551	3/2 ⁻	
		1359.6 5	68 16	0.0	1/2 ⁻	
1386.81	1/2 ⁻ , 3/2 ⁻	292.6 3	2.6 9	1094.33	1/2 ⁻ , 3/2 ⁻	
		732.2 ^d 2	100 21	654.17	(5/2 ⁻)	
		787.9 3	14 9	599.28	(3/2 ⁻)	E_γ, I_γ : from (n, γ) E=thermal. Doublet; divided I_γ given.
		1295.5 ^b 5	<9.1 ^b	92.01	(5/2 ⁻)	
		1312.1 3	12 3	74.58	5/2 ⁻	
		1322.5 3	10.5 23	64.551	3/2 ⁻	
		1387.0 4	7.9 19	0.0	1/2 ⁻	
1419.1	(23/2 ⁺)	420 [‡]	100	999.1	(19/2 ⁺)	
1632.3	(25/2 ⁺)	446 [‡]	100	1186.3	(21/2 ⁺)	
1741.2	(23/2 ⁻)	504 [‡]	100	1237.2	(19/2 ⁻)	
1793.0	(25/2 ⁻)	513 [‡]	100	1280.0	(21/2 ⁻)	
1919.1	(27/2 ⁺)	500 [‡]	100	1419.1	(23/2 ⁺)	
2149.3	(29/2 ⁺)	517 [‡]	100	1632.3	(25/2 ⁺)	
2324.2	(27/2 ⁻)	583 [‡]	100	1741.2	(23/2 ⁻)	
2383.0	(29/2 ⁻)	590 [‡]	100	1793.0	(25/2 ⁻)	
2979	(31/2 ⁻)	655 [‡]	100	2324.2	(27/2 ⁻)	
3045	(33/2 ⁻)	662 [‡]	100	2383.0	(29/2 ⁻)	
3701	(35/2 ⁻)	722 [‡]	100	2979	(31/2 ⁻)	
3773	(37/2 ⁻)	728 [‡]	100	3045	(33/2 ⁻)	
4549	(41/2 ⁻)	776 [‡]	100	3773	(37/2 ⁻)	

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Er})$ (continued)

- [†] From ¹⁶⁸Er(n, γ) E=thermal, except where otherwise noted.
[‡] From (²³⁸U,²³⁸U' γ).
[#] From ¹⁶⁹Ho β^- decay.
[@] Relative photon branching from each level; values are from ¹⁶⁸Er(n, γ) E=thermal, except as noted. Upper limits are given for photon branching ratios affected by multiple placement.
[&] From ¹⁶⁸Er(d,p γ).
^a Total theoretical internal conversion coefficients, calculated using the BrIcc code ([2008Ki07](#)) with “Frozen Orbitals” approximation based on γ -ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.
^b Multiply placed with undivided intensity.
^c Multiply placed with intensity suitably divided.
^d Placement of transition in the level scheme is uncertain.

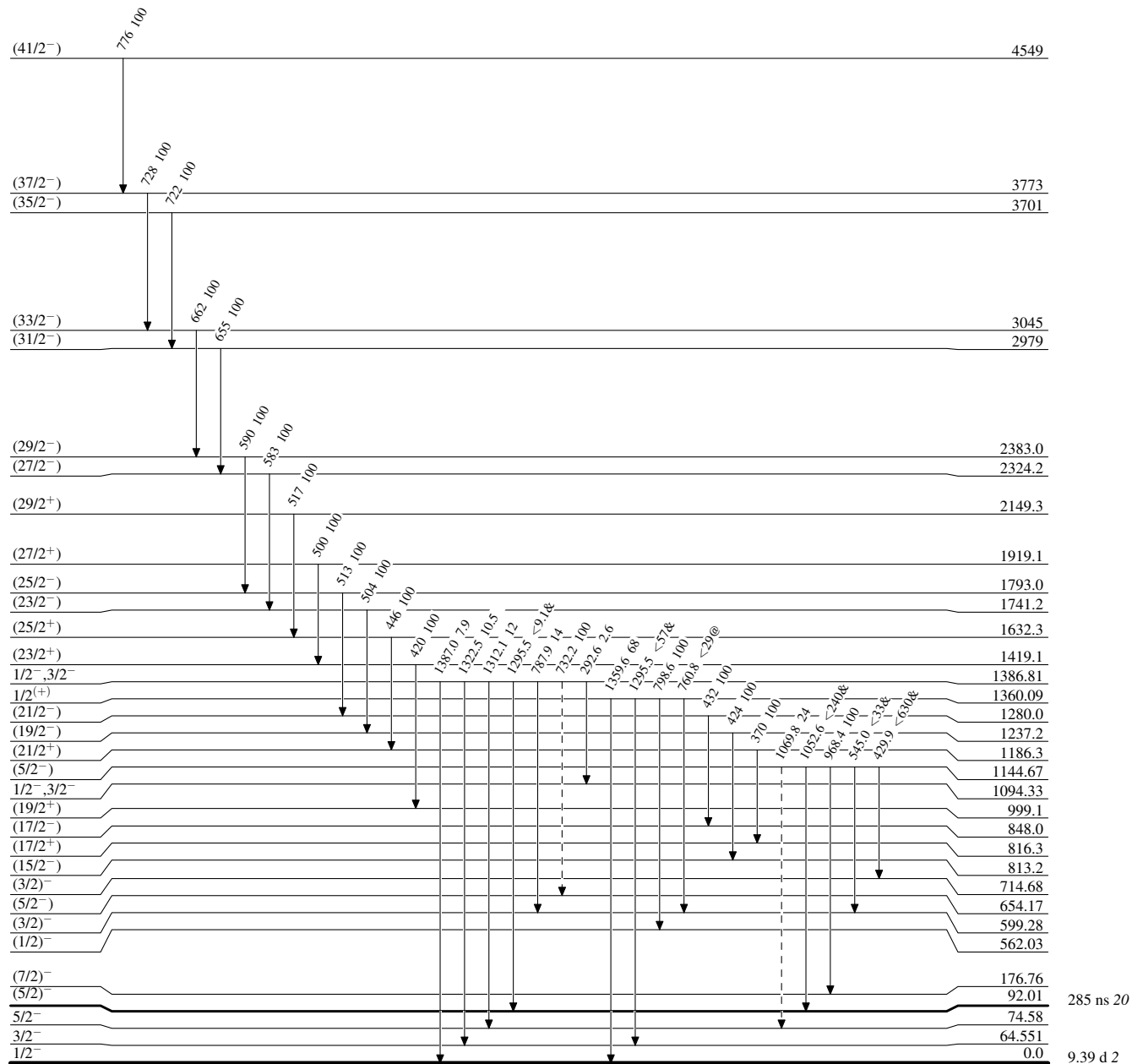
Adopted Levels, Gammas

Level Scheme

Legend

Intensities: Relative photon branching from each level
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided

-----► γ Decay (Uncertain)



$^{169}_{68}\text{Er}_{101}$

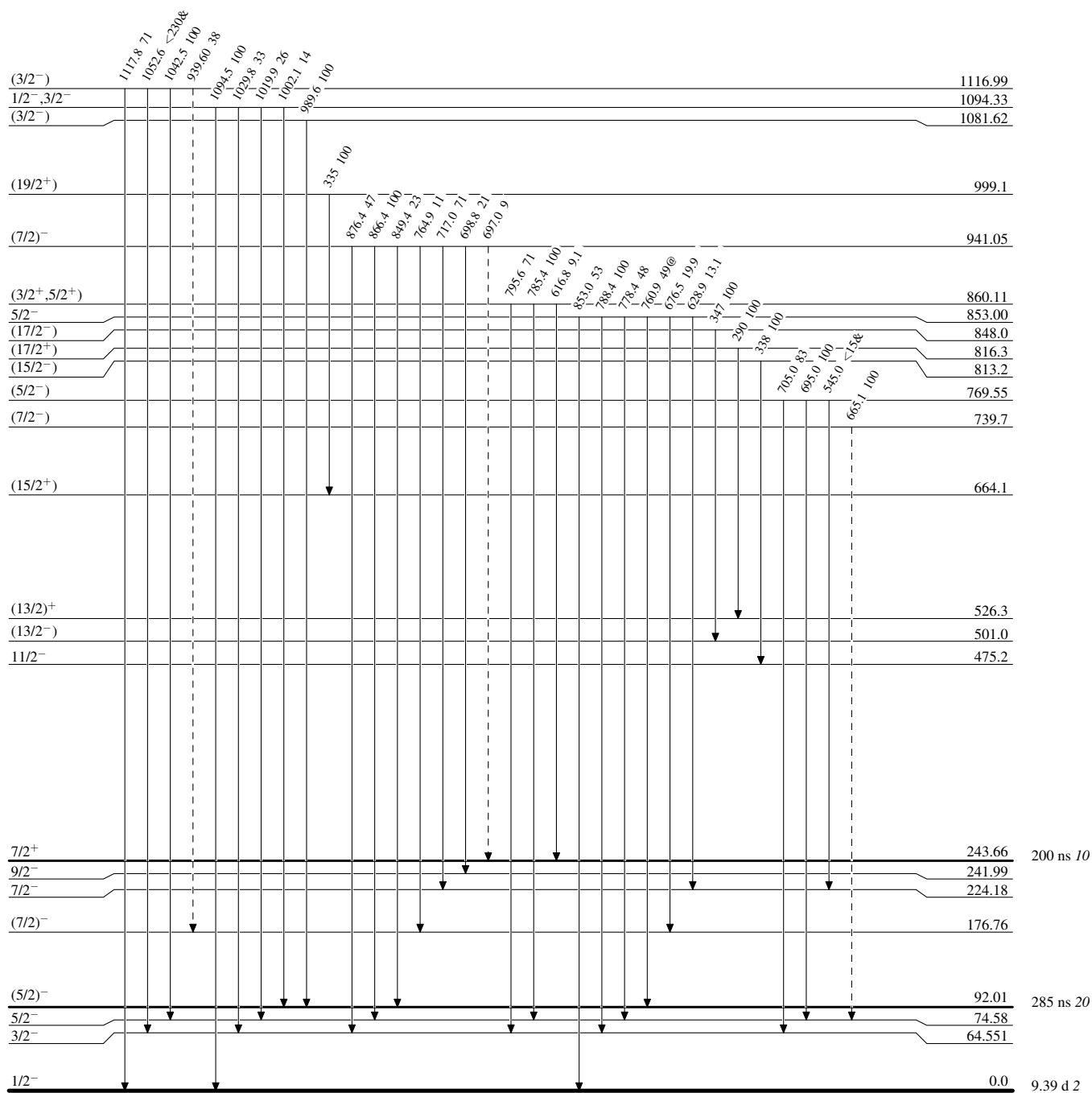
285 ns 20

9.39 d 2

Adopted Levels, Gammas**Level Scheme (continued)**

Legend

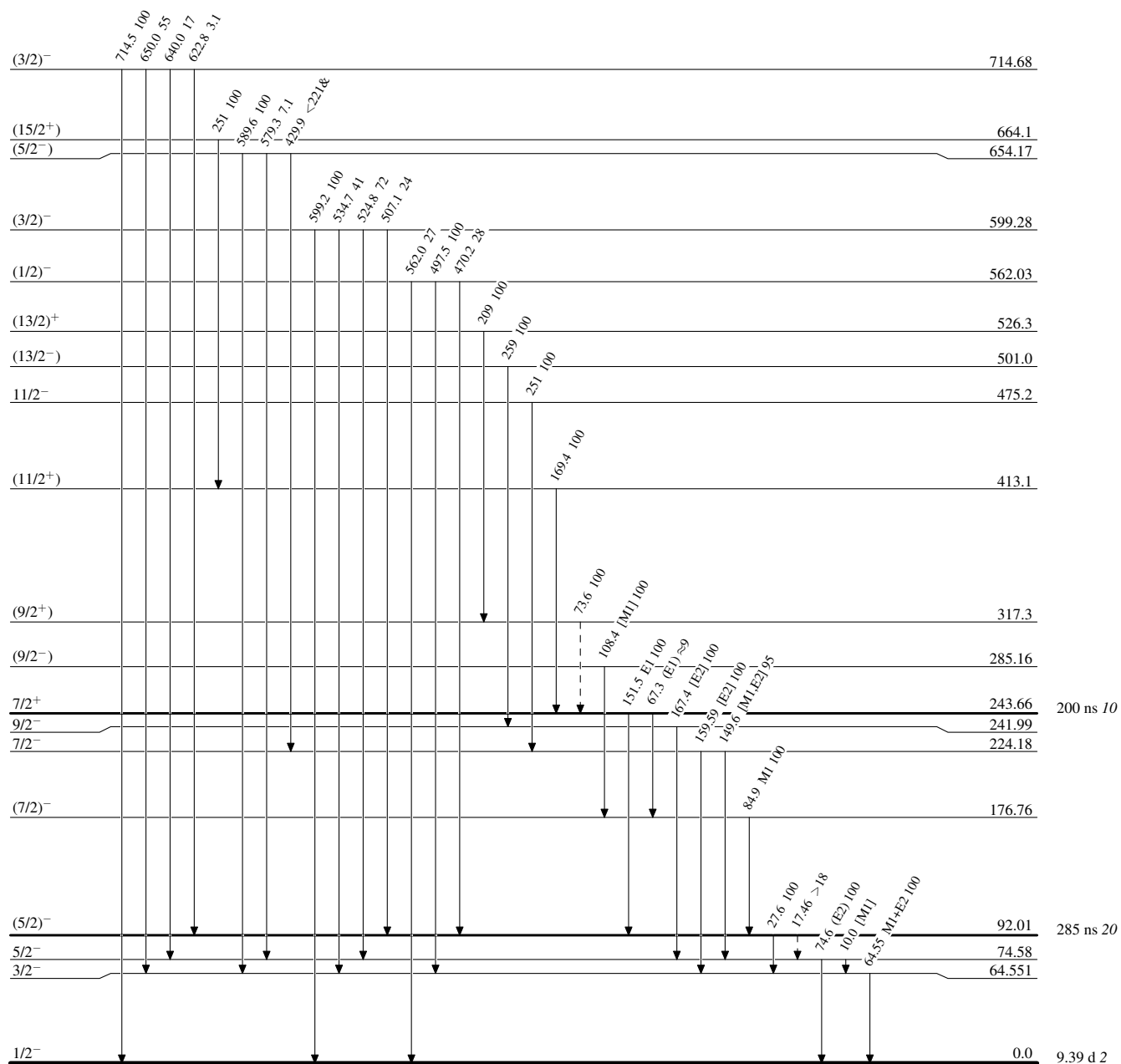
Intensities: Relative photon branching from each level
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided

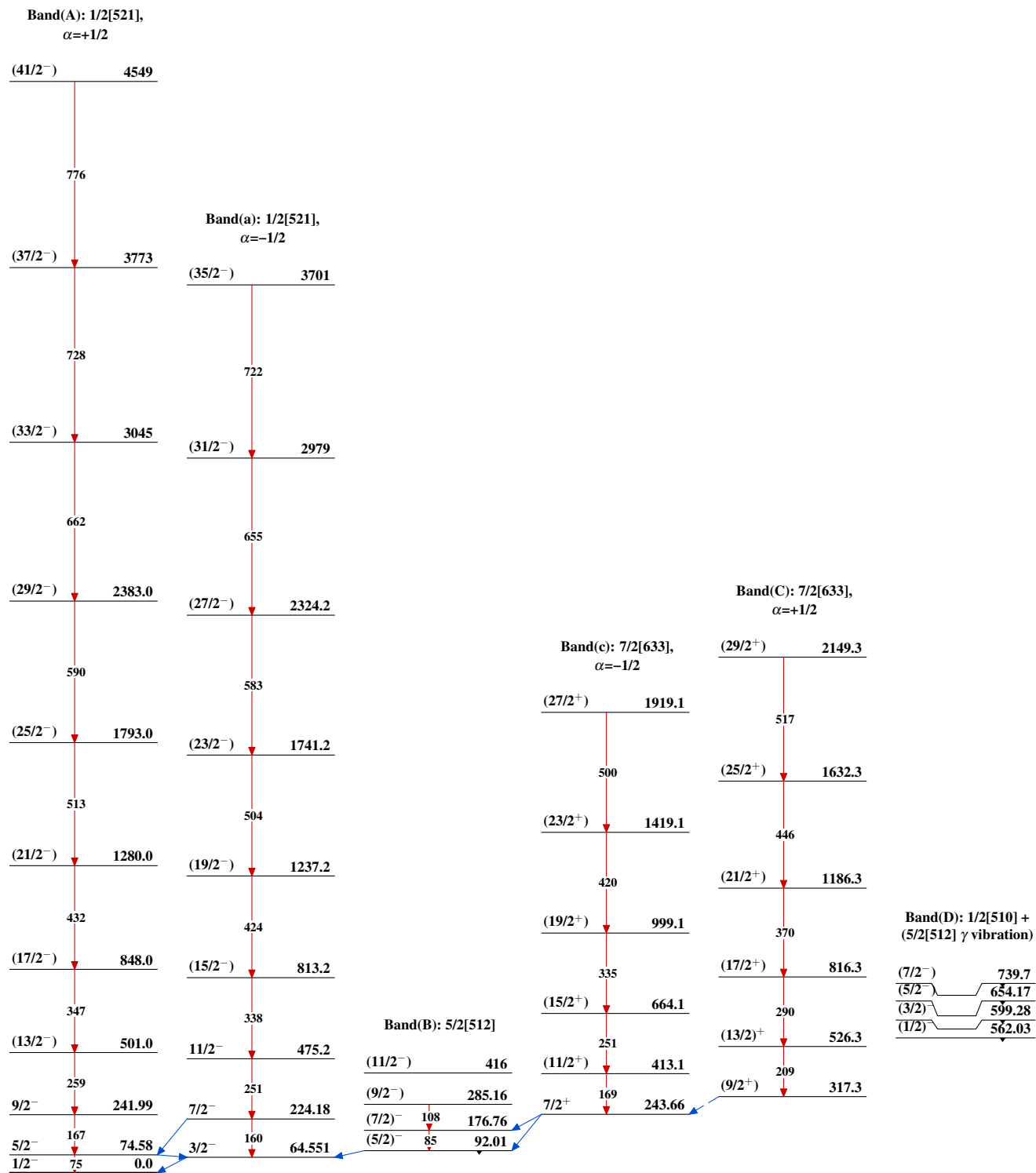
-----► γ Decay (Uncertain) $^{169}_{68}\text{Er}_{101}$

Adopted Levels, Gammas**Level Scheme (continued)**

Legend

Intensities: Relative photon branching from each level
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided

-----► γ Decay (Uncertain) $^{169}_{68}\text{Er}_{101}$

Adopted Levels, Gammas $^{169}_{68}\text{Er}_{101}$

$^{169}_{68}\text{Er}_{101}$

Adopted Levels, Gammas (continued)

Band(K): 3/2[402]		Band(L): 1/2[400]	
<u>(3/2⁺)</u>	<u>1529</u>	<u>(1/2⁺)</u>	<u>1647.2</u>

¹⁶⁹₆₈Er₁₀₁

^{169}Ho β^- decay [1971Ha42](#)

Parent: ^{169}Ho : $E=0.0$; $J^\pi=7/2^-$; $T_{1/2}=4.7$ min I ; $Q(\beta^-)=2125$ 20; $\% \beta^-$ decay=100.0

$^{169}\text{Ho}-Q(\beta^-)$: from [2021Wa16](#).

The decay scheme and data are from [1971Ha42](#), except where noted.

[1971Ha42](#): Sources from $^{170}\text{Er}(\gamma, p)$, $E(\text{bremsstrahlung})=70$ MeV; Er metal (natural) and Er oxide (>98% ^{170}Er enrichment) targets; measured E_γ , I_γ (Ge(Li), FWHM=1.8 keV at 100 keV, 2.5 keV at 1 MeV). Some data are from [1963Mi17](#), [1966Fu09](#), and [1970Mu15](#).

 ^{169}Er Levels

<u>E(level)[†]</u>	<u>J^π[‡]</u>	<u>$T_{1/2}$[‡]</u>	<u>E(level)[†]</u>	<u>J^π[‡]</u>	<u>$T_{1/2}$[‡]</u>	<u>E(level)[†]</u>	<u>J^π[‡]</u>
0.0	$1/2^-$	9.39 d 2	176.72 13	$(7/2)^-$		317.3? 5	$(9/2^+)$
64.550 20	$3/2^-$		224.13 8	$7/2^-$		769.56 9	$(5/2^-)$
74.59 7	$5/2^-$		242.01 12	$9/2^-$		852.99 7	$5/2^-$
91.93 12	$(5/2)^-$	285 ns 20	243.66 19	$7/2^+$	200 ns 10	941.04 13	$(7/2)^-$

[†] From a least-squares fit to the γ -ray energies.

[‡] From Adopted Levels.

 β^- radiations

<u>E(decay)</u>	<u>E(level)</u>	<u>$I\beta^-$^{†‡}</u>	<u>Log ft</u>
(1184 20)	941.04	≈ 12.2	≈ 5.5
(1272 20)	852.99	≈ 60	≈ 4.9
(1355 20)	769.56	≈ 2.7	≈ 6.4
(1808 [#] 20)	317.3?		
(1881 20)	243.66	≈ 7.2	≈ 6.5
(1948 20)	176.72	≈ 1.8	≈ 7.1
(2033 [#] 20)	91.93		

[†] [1963Mi17](#) report two β^- groups: ≈ 1.20 MeV to ≈ 915 level (75%), and ≈ 1.95 MeV (25%), with both groups feeding close-lying levels. The β^- feedings to the 769.6, 853.0, and 941.0 levels were estimated by dividing the 75% intensity in proportion to the total $I(\gamma+\text{ce})$ deexciting each level. Because γ -ray intensity data are incomplete, it was not possible to determine β^- feedings to all levels.

[‡] Absolute intensity per 100 decays.

[#] Existence of this branch is questionable.

 $\gamma(^{169}\text{Er})$

I_γ normalization: from $I\beta$ to 853.0 level $\approx 60\%$ (see general comment on β^- data above). A serious discrepancy is apparent if one calculates the normalization from $\Sigma I(\gamma+\text{ce})$ to g.s.=100% (β^- to g.s. not expected because $\Delta J=3$, total $I_\gamma(73.6\gamma+74.6\gamma)$ assumed for 74.6 γ). The resulting $I\beta$ to 853.0 level is 95%.

All unplaced γ rays could alternatively be assigned to ^{168}Ho decay.

$I_\gamma(\text{Er K x ray}) \approx 530$, relative to $I_\gamma=100$ for 761.0 γ ([1966Fu09](#)).

<u>E_γ</u>	<u>$E_i(\text{level})$</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.[†]</u>	<u>α[#]</u>	<u>Comments</u>
(10.0)	74.59	$5/2^-$	64.550	$3/2^-$	[M1]	69.1	Placement proposed by 1963Mi17 .
(17.3)	91.93	$(5/2)^-$	74.59	$5/2^-$			E_γ : deduced from energy difference between 74.6 and 64.6 levels. E_γ : deduced from energy difference between 91.9 and 74.6 levels.

Continued on next page (footnotes at end of table)

$^{169}\text{Ho} \beta^-$ decay **1971Ha42** (continued) $\gamma(^{169}\text{Er})$ (continued)

E_γ	$I_\gamma^\ddagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	$\delta^\dagger$	$\alpha^\#$	Comments
(27.6 [†] 2)		91.93	(5/2) ⁻	64.550	3/2 ⁻	[M1]		20.0 5	
64.55 [†] 2	≈ 28	64.550	3/2 ⁻	0.0	1/2 ⁻	M1+E2	0.61	11.86 17	$I_\gamma=33$ for 64.6 γ and 67.3 γ combined (1966Fu09); evaluator estimates $I_\gamma(64.6\gamma)/I_\gamma(67.3\gamma)\approx 5$ from spectrum in 1971Ha42 .
67.3 3	≈ 5	243.66	7/2 ⁺	176.72	(7/2) ⁻	(E1)		0.917 17	I_γ : see comment with 64.6 γ .
73.6 [@] 5		317.3?	(9/2 ⁺)	243.66	7/2 ⁺				$I_\gamma=13$ for 73.6 γ and 74.6 γ combined (1966Fu09).
74.6 [†] 1		74.59	5/2 ⁻	0.0	1/2 ⁻	(E2)		9.23 14	I_γ : see comment with 73.6 γ from 317.3 keV level.
84.9 [†] 1	13	176.72	(7/2) ⁻	91.93	(5/2) ⁻	M1		4.56 7	I_γ : from 1966Fu09 .
149.6 [†] 2	14 3	224.13	7/2 ⁻	74.59	5/2 ⁻	[M1,E2]		0.79 11	
151.5 [†] 2	54 6	243.66	7/2 ⁺	91.93	(5/2) ⁻	E1		0.1079 16	
159.59 [†] 9	13 4	224.13	7/2 ⁻	64.550	3/2 ⁻	[E2]		0.542 8	
167.4 [†] 1	7.4 21	242.01	9/2 ⁻	74.59	5/2 ⁻	[E2]		0.460 7	
^x 579.6 5	7.2 7								
^x 609.6 5	5.2 5								
628.9 3	27 4	852.99	5/2 ⁻	224.13	7/2 ⁻				
^x 656.4 5	5.2 5								
^x 663.4 5	1.8 4								
676.5 2	41 4	852.99	5/2 ⁻	176.72	(7/2) ⁻				
695.0 2	13 4	769.56	(5/2) ⁻	74.59	5/2 ⁻				
697.0 [@] 5	4 2	941.04	(7/2) ⁻	243.66	7/2 ⁺				
698.8 4	9 3	941.04	(7/2) ⁻	242.01	9/2 ⁻				
705.0 1	13 3	769.56	(5/2) ⁻	64.550	3/2 ⁻				
717.0 2	30.5 21	941.04	(7/2) ⁻	224.13	7/2 ⁻				
761.0 2	100	852.99	5/2 ⁻	91.93	(5/2) ⁻				
764.9 6	4.8 15	941.04	(7/2) ⁻	176.72	(7/2) ⁻				
^x 773.3 5	12 3								
778.4 1	98 6	852.99	5/2 ⁻	74.59	5/2 ⁻				
788.4 1	206 21	852.99	5/2 ⁻	64.550	3/2 ⁻				
849.4 6	10.1 13	941.04	(7/2) ⁻	91.93	(5/2) ⁻				
852.9 2	109 13	852.99	5/2 ⁻	0.0	1/2 ⁻				
866.4 2	43 6	941.04	(7/2) ⁻	74.59	5/2 ⁻				
876.4 3	20 4	941.04	(7/2) ⁻	64.550	3/2 ⁻				I_γ : the evaluator assumes $I_\gamma=202$ in 1971Ha42 (Table 2) to be a misprint of $I_\gamma=20.2$ (see authors' figures 4 and 11).
^x 1373 1	5.2 5								
^x 1442 1	1.6 2								
^x 1517 1	1.4 3								
^x 1678 1	1.3 3								
^x 1769 1	0.9 2								
^x 1850 1	2.1 2								

[†] From Adopted Gammas.[‡] For absolute intensity per 100 decays, multiply by ≈ 0.1037 .[#] Total theoretical internal conversion coefficients, calculated using the BrIcc code (**2008Ki07**) with "Frozen Orbitals" approximation based on γ -ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

Continued on next page (footnotes at end of table)

 ^{169}Ho β^- decay **1971Ha42** (continued)

 $\gamma(^{169}\text{Er})$ (continued)

@ Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

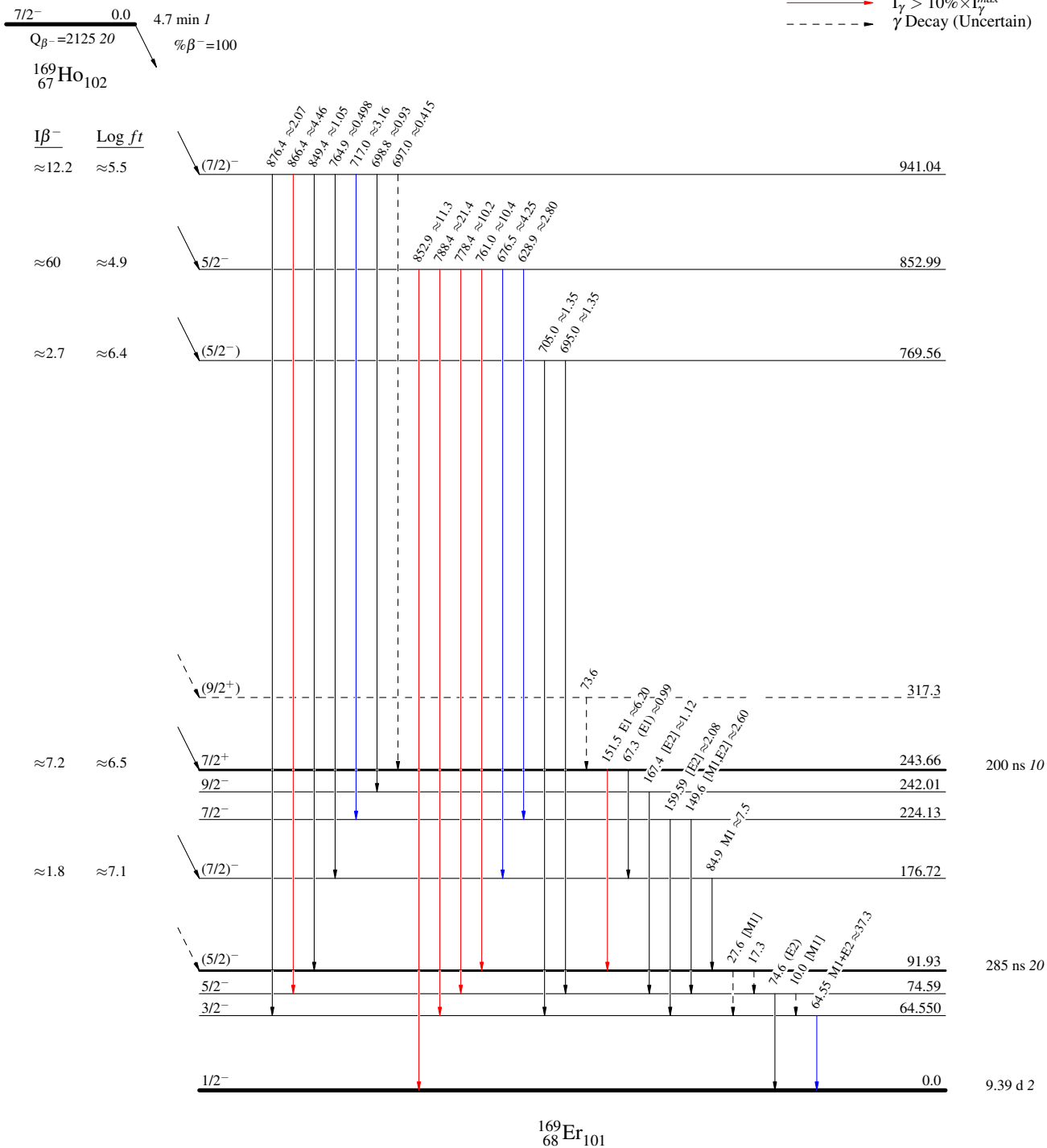
^{169}Ho β^- decay **1971Ha42**

Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays

Legend

- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$
- - - - - γ Decay (Uncertain)



$^{167}\text{Er}(\text{t,p})$ 1985Lo19 $J^\pi(^{167}\text{Er})=7/2^+$.

$E(\text{t})=15$ MeV, isotope separated ^{167}Er (>99% enrichment) embedded in carbon foil; $E(\text{t})=17$ MeV, metallic Er targets enriched to 95.6% in ^{167}Er ; $\theta=7.5^\circ$ to 67.5° (7.5° intervals); measured $E(\text{level})$ (mag spect, $\text{FWHM}\approx 15$ keV), angular distributions, absolute cross sections; used multistep CCBA calculations to interpret levels. Triton beams were obtained from the McMaster University tandem Van de Graaff accelerator.

 ^{169}Er Levels

<u>$E(\text{level})$</u>	<u>$L^\dagger$</u>	<u>Comments</u>
244 ‡ 5	0	$7/2^+$ 7/2[633] state. $d\sigma/d\Omega=187$ $\mu\text{b/sr}$ at 30° .
319 ‡ 5		$9/2^+$ 7/2[633] state (weakly populated). $d\sigma/d\Omega=11$ $\mu\text{b/sr}$ at 30° .
413 ‡ 5	(2)	$11/2^+$ 7/2[633] state (weakly populated). $d\sigma/d\Omega=10$ $\mu\text{b/sr}$ at 30° .
525 ‡ 5		$13/2^+$ 7/2[633] state (weakly populated). $d\sigma/d\Omega=7$ $\mu\text{b/sr}$ at 30° .
592 5		$d\sigma/d\Omega=4$ $\mu\text{b/sr}$ at 30° .
848 5	2	$d\sigma/d\Omega=9$ $\mu\text{b/sr}$ at 30° .
905 5	0	Strength=31, relative to 100 for 244 level for $L=0$. $d\sigma/d\Omega=45$ $\mu\text{b/sr}$ at 30° .
971 5	(4)	$d\sigma/d\Omega=3$ $\mu\text{b/sr}$ at 30° .
988 5	(2)	$d\sigma/d\Omega=13$ $\mu\text{b/sr}$ at 30° .
1056 5		$d\sigma/d\Omega=2$ $\mu\text{b/sr}$ at 30° .
1085 5		$d\sigma/d\Omega=3$ $\mu\text{b/sr}$ at 30° .
1113 5		$d\sigma/d\Omega=9$ $\mu\text{b/sr}$ at 30° .
1137 5	(4)	$d\sigma/d\Omega=19$ $\mu\text{b/sr}$ at 30° .
1221 5	(2)	$d\sigma/d\Omega=14$ $\mu\text{b/sr}$ at 30° .
1238 5		$d\sigma/d\Omega=4$ $\mu\text{b/sr}$ at 60° .
1278 5		$d\sigma/d\Omega=2$ $\mu\text{b/sr}$ at 60° .
1296 5		$d\sigma/d\Omega=7$ $\mu\text{b/sr}$ at 30° .
1434 5		$d\sigma/d\Omega=3$ $\mu\text{b/sr}$ at 30° .
1456 5		$d\sigma/d\Omega=4$ $\mu\text{b/sr}$ at 30° .
1482 5		$d\sigma/d\Omega=4$ $\mu\text{b/sr}$ at 30° .
1547 5		$d\sigma/d\Omega=2$ $\mu\text{b/sr}$ at 30° .
1619 5		$d\sigma/d\Omega=4$ $\mu\text{b/sr}$ at 60° .
1654 5		$d\sigma/d\Omega=3$ $\mu\text{b/sr}$ at 60° .
1675 5		$d\sigma/d\Omega=3$ $\mu\text{b/sr}$ at 60° .
1743 5		$d\sigma/d\Omega=10$ $\mu\text{b/sr}$ at 30° .
1773 5		$d\sigma/d\Omega=4$ $\mu\text{b/sr}$ at 30° .
1827 5		$d\sigma/d\Omega=8$ $\mu\text{b/sr}$ at 30° .
1856 5		$d\sigma/d\Omega=11$ $\mu\text{b/sr}$ at 30° .
1952 5		$d\sigma/d\Omega=9$ $\mu\text{b/sr}$ at 30° .
2049 5		$d\sigma/d\Omega=5$ $\mu\text{b/sr}$ at 30° .
2094 5		$d\sigma/d\Omega=5$ $\mu\text{b/sr}$ at 30° .
2216 5		$d\sigma/d\Omega=10$ $\mu\text{b/sr}$ at 30° .
2482 5		$d\sigma/d\Omega=4$ $\mu\text{b/sr}$ at 30° .

 † From the measured $d\sigma/d\Omega$ and DWBA analysis. ‡ Band(A): 7/2[633].

¹⁶⁷Er(t,p) **1985Lo19**

Band(A): 7/2[633]

525

413

319

244

¹⁶⁹Er₆₈101

¹⁶⁸Er(n,γ) E=thermal **1970Mu15**

$\sigma_n=2.74$ b 8 (**2018MuZZ**). % abundance(¹⁶⁸Er)=26.78 26.

Others: **2007ChZX** (supersedes **2003ChZS**), **1966Ko03**, **1974Sh03** (E=5-70 keV; measured $\sigma(E)$), **1978Ta25** (E=0.0253 eV, deduced $\sigma(E)$).

1970Mu15; Er oxide targets enriched to 99.987% in ¹⁶⁸Er; measured E γ , I γ for primary and secondary transitions; Si(Li), FWHM=0.45 keV at 25 keV, 0.75 keV at 100 keV; Ge(Li) (singly and in pair mode), FWHM $\approx$ 3 keV at 500 keV, $\approx$ 7 keV at 6 MeV.

¹⁶⁹Er Levels

E(level) [†]	J π @	E(level) [†]	J π @	E(level) [†]	J π @
0.0	1/2 ⁻	1142.8 6	1/2,3/2	1867.2 9	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾
64.552 20	3/2 ⁻	1144.67 12	(5/2 ⁻)	1897.7 8	1/2,3/2
74.56 7	5/2 ⁻	1360.02 18	1/2 ⁽⁺⁾	1928.8 8	1/2 ⁻ ,3/2 ⁻
92.01 10	(5/2 ⁻)	1386.97 14	1/2 ⁻ ,3/2 ⁻	1948.0 15	1/2 ⁻ ,3/2 ⁻
176.79 13	(7/2 ⁻)	1470.7 8	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾	1955.3 23	1/2 ⁻ ,3/2 ⁻
224.15 8	7/2 ⁻	1483.9 18	1/2,3/2	1978.9 8	1/2,3/2
241.96 12	9/2 ⁻	1488.0 12	1/2 ⁻ ,3/2 ⁻	1997.0 8	1/2,3/2
243.47 20	7/2 ⁺	1529.6 8	1/2 ⁻ ,3/2 ⁻	2029.3 9	1/2 ⁻ ,3/2 ⁻
285.19 24	(9/2 ⁻)	1553.7 8	1/2 ⁻ ,3/2 ⁻	2047.1 14	1/2,3/2
562.03 9	(1/2 ⁻)	1647.2 7	(1/2 ⁺)	2063.0 9	1/2,3/2
599.28 9	(3/2 ⁻)	1667.5 17	1/2,3/2	2112.5 10	1/2,3/2
654.05 12	(5/2 ⁻)	1680.0 10	1/2,3/2	2125.2 8	1/2 ⁻ ,3/2 ⁻
714.67 11	(3/2 ⁻)	1710.1 8	1/2,3/2	2141 [‡] 3	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾
739.7? 7	(7/2 ⁻)	1783.6 8	1/2,3/2	2165.5 17	1/2 ⁻ ,3/2 ⁻
769.49 15	(5/2 ⁻)	1795.3 10	1/2,3/2	2180.4 8	1/2 ⁻ ,3/2 ⁻
852.86 15	5/2 ⁻	1806.3 19	1/2,3/2	2185.2 9	1/2,3/2
860.08 14	(3/2 ⁺ ,5/2 ⁺)	1819.7 17	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾	2219.4 8	1/2,3/2
1081.60 22	(3/2 ⁻)	1826.0 12	1/2,3/2	2225.3 12	1/2 ⁻ ,3/2 ⁻
1094.34 11	1/2 ⁻ ,3/2 ⁻	1839.3 9	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾	2237.9 9	1/2,3/2
1117.21 16	(3/2 ⁻)	1848.4 9	1/2 ⁻ ,3/2 ⁻	(6003.19 [#] 19)	1/2 ⁺ &

[†] From least-squares fit to E γ , omitting transitions with uncertain placements.

[‡] The apparent discrepancy between E γ =3861.9 and E(level)=2131.2 (see table 3 in **1970Mu15**) is resolved if E γ is taken as correct and E(level) changed to 2141.2. This level probably corresponds to E(level)=2139.1 in ¹⁶⁸Er(n,γ) E=res.

[#] Neutron capture state(s) cf. S(n)=6003.25 15 (**2021Wa16**).

@ Adopted values, except where otherwise noted.

& s-wave capture by even-even nucleus.

$\gamma(^{169}\text{Er})$

I γ normalization: 0.74 is deduced from $\sigma_n=2.74$ b 8 (**2018MuZZ**) compared to the normalization given in **1970Mu15** based on $\sigma_n=2.03$ b 41. Additional uncertainty introduced by the latest cross section is negligible. However, one gets normalization factors of 0.88 7 for $\Sigma(I(\gamma+ce)$ out of capture state)=100 and 1.04 10 for $\Sigma(I(\gamma+ce)$ to g.s.)=100 with respect to $\sigma_n=2.74$ b 8 (**2018MuZZ**). Absolute elemental cross section data from **2007ChZX** (Budapest measurements) are inconsistent with these factors; they imply normalization factors that vary widely from one transition to another and are typically at least an order of magnitude larger. New measurements are called for in order to resolve these normalization discrepancies. Note that forty four gammas are not placed in the level scheme.

E γ [†]	I γ ^{&e}	E _i (level)	J π _i	E _f	J π _f
27.6 2	1.4 4	92.01	(5/2 ⁻)	64.552	3/2 ⁻
64.55 [‡] 2	12.6 25	64.552	3/2 ⁻	0.0	1/2 ⁻

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$^{168}\text{Er}(n,\gamma)$ E=thermal **1970Mu15** (continued) $\gamma(^{169}\text{Er})$ (continued)

E_γ †	I_γ & e	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
74.6 1	2.5 5	74.56	5/2 ⁻	0.0	1/2 ⁻	
84.9 1	0.53 11	176.79	(7/2) ⁻	92.01	(5/2) ⁻	Other E_γ : 84.74 12 (2007ChZX; Budapest data).
^x 99.3 # @ 4	0.36 10					
108.4 2	0.21 4	285.19	(9/2) ⁻	176.79	(7/2) ⁻	
149.6 2	3.7 9	224.15	7/2 ⁻	74.56	5/2 ⁻	
151.5 2	4.4 11	243.47	7/2 ⁺	92.01	(5/2) ⁻	
159.59 ‡ 9	4.1 8	224.15	7/2 ⁻	64.552	3/2 ⁻	
167.4 1	0.57 12	241.96	9/2 ⁻	74.56	5/2 ⁻	
^x 174.7 3	0.16 4					
^x 209.3 3	0.17 4					
^x 219.9 4	0.16 4					
^x 254.5 # 4	0.09 4					
292.6 3	0.11 4	1386.97	1/2 ⁻ , 3/2 ⁻	1094.34	1/2 ⁻ , 3/2 ⁻	
^x 368.8 # 6	0.28 10					
^x 422.8 2	0.25 6					
429.9 f 1	5.3 f 11	654.05	(5/2) ⁻	224.15	7/2 ⁻	
429.9 f 1	5.3 f 11	1144.67	(5/2) ⁻	714.67	(3/2) ⁻	
^x 439.9 # 4	0.20 5					
470.2 4	2.4 6	562.03	(1/2) ⁻	92.01	(5/2) ⁻	
^x 477.6 5	1.0 4					
497.5 1	8.6 17	562.03	(1/2) ⁻	64.552	3/2 ⁻	
507.1 2	0.95 22	599.28	(3/2) ⁻	92.01	(5/2) ⁻	
524.8 1	2.8 6	599.28	(3/2) ⁻	74.56	5/2 ⁻	
534.7 2	1.6 3	599.28	(3/2) ⁻	64.552	3/2 ⁻	
545.0 f 6	0.27 f 8	769.49	(5/2) ⁻	224.15	7/2 ⁻	
545.0 f 6	0.27 f 8	1144.67	(5/2) ⁻	599.28	(3/2) ⁻	
562.0 2	2.3 5	562.03	(1/2) ⁻	0.0	1/2 ⁻	Other E_γ : 563.3 3 (2007ChZX; Budapest data).
579.3 4	0.17 4	654.05	(5/2) ⁻	74.56	5/2 ⁻	
589.6 3	2.4 5	654.05	(5/2) ⁻	64.552	3/2 ⁻	
599.2 2	3.9 8	599.28	(3/2) ⁻	0.0	1/2 ⁻	
616.8 4	0.32 9	860.08	(3/2 ⁺ , 5/2 ⁺)	243.47	7/2 ⁺	
622.8 6	0.15 6	714.67	(3/2) ⁻	92.01	(5/2) ⁻	Other E_γ : 623.0 6 (2007ChZX; Budapest data).
^x 631.5 4	0.27 8					
640.0 2	0.84 18	714.67	(3/2) ⁻	74.56	5/2 ⁻	
650.0 2	2.7 6	714.67	(3/2) ⁻	64.552	3/2 ⁻	
^x 663.0 6	0.64 23					
665.1 h 7	0.46 22	739.7?	(7/2) ⁻	74.56	5/2 ⁻	
^x 682.4 2	1.19 25					
695.0 2	2.4 5	769.49	(5/2) ⁻	74.56	5/2 ⁻	Other E_γ : 694.6 4 (2007ChZX; Budapest data).
704.9 2	2.0 4	769.49	(5/2) ⁻	64.552	3/2 ⁻	
714.5 2	4.9 10	714.67	(3/2) ⁻	0.0	1/2 ⁻	
732.2 h 2	4.3 9	1386.97	1/2 ⁻ , 3/2 ⁻	654.05	(5/2) ⁻	
^x 756.5 3	0.40 9					
760.7 g 2	0.48 g c 9	852.86	5/2 ⁻	92.01	(5/2) ⁻	
760.7 g 2	<0.28 g c	1360.02	1/2 ⁽⁺⁾	599.28	(3/2) ⁻	
^x 768.0 4	0.75 17					
^x 772.1 3	1.43 a 30					
779.4 5	0.52 13	852.86	5/2 ⁻	74.56	5/2 ⁻	Other E_γ : 779.34 19 (2007ChZX; Budapest data).
785.4 2	3.5 8	860.08	(3/2 ⁺ , 5/2 ⁺)	74.56	5/2 ⁻	
787.9 g 3	0.99 g d 19	852.86	5/2 ⁻	64.552	3/2 ⁻	
787.9 g 3	0.6 g d 4	1386.97	1/2 ⁻ , 3/2 ⁻	599.28	(3/2) ⁻	

Continued on next page (footnotes at end of table)

$^{168}\text{Er}(n,\gamma)$ E=thermal **1970Mu15** (continued) $\gamma(^{169}\text{Er})$ (continued)

E_γ [†]	I_γ ^{&e}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
795.6 2	2.5 5	860.08	(3/2 ⁺ , 5/2 ⁺)	64.552	3/2 ⁻	Other E_γ : 795.0 3 (2007ChZX ; Budapest data).
798.6 5	0.69 19	1360.02	1/2 ⁽⁺⁾	562.03	(1/2) ⁻	
^x 821.7 9	0.11 6					
^x 823.4 2	1.11 23					
^x 836.7 2	1.4 3					
853.2 3	0.48 11	852.86	5/2 ⁻	0.0	1/2 ⁻	
^x 858.7 3	0.32 8					
^x 870.5 3	0.98 23					
^x 896.1 2	1.01 21					
^x 915.0 5	0.31 10					
^x 918.5 2	1.16 25					
^x 936.5 3	0.55 12					
939.60 ^h 25	0.34 9	1117.21	(3/2 ⁻)	176.79	(7/2) ⁻	
^x 944.4 3	0.31 8					
968.4 2	0.83 17	1144.67	(5/2 ⁻)	176.79	(7/2) ⁻	
^x 978.5 2	0.53 11					
989.6 2	5.4 11	1081.60	(3/2 ⁻)	92.01	(5/2) ⁻	
^x 998.2 3	0.57 14					
1002.1 2	1.00 23	1094.34	1/2 ⁻ , 3/2 ⁻	92.01	(5/2) ⁻	
^x 1013.8 2	2.5 5					
1019.9 2	1.8 4	1094.34	1/2 ⁻ , 3/2 ⁻	74.56	5/2 ⁻	Other E_γ : 1019.92 20 (2007ChZX ; Budapest data).
1029.8 2	2.3 5	1094.34	1/2 ⁻ , 3/2 ⁻	64.552	3/2 ⁻	
1042.5 3	0.89 19	1117.21	(3/2 ⁻)	74.56	5/2 ⁻	Other E_γ : 1030.0 5 (2007ChZX ; Budapest data).
^x 1046.6 5	0.46 11					
1052.6 ^f 2	2.0 ^f 4	1117.21	(3/2 ⁻)	64.552	3/2 ⁻	
1052.6 ^f 2	2.0 ^f 4	1144.67	(5/2 ⁻)	92.01	(5/2) ⁻	
1069.8 ^{#h} 10	0.20 11	1144.67	(5/2 ⁻)	74.56	5/2 ⁻	
^x 1078.5 3	0.93 21					
1094.5 3	6.9 14	1094.34	1/2 ⁻ , 3/2 ⁻	0.0	1/2 ⁻	
1117.8 4	0.63 13	1117.21	(3/2 ⁻)	0.0	1/2 ⁻	
^x 1121.9 5	0.23 6					
^x 1270.1 11	0.13 7					
^x 1275.3 7	0.42 18					
^x 1277.6 10	0.25 15					
^x 1291.9 7	0.19 6					
1295.5 ^f 5	0.31 ^f 8	1360.02	1/2 ⁽⁺⁾	64.552	3/2 ⁻	
1295.5 ^f 5	0.31 ^f 8	1386.97	1/2 ⁻ , 3/2 ⁻	92.01	(5/2) ⁻	
1312.1 3	0.52 12	1386.97	1/2 ⁻ , 3/2 ⁻	74.56	5/2 ⁻	
^x 1315.4 6	0.23 7					
1322.5 3	0.45 10	1386.97	1/2 ⁻ , 3/2 ⁻	64.552	3/2 ⁻	
^x 1330.8 4	0.30 8					
^x 1356.0 7	0.35 8					
1359.6 5	0.47 11	1360.02	1/2 ⁽⁺⁾	0.0	1/2 ⁻	
1387.0 4	0.34 8	1386.97	1/2 ⁻ , 3/2 ⁻	0.0	1/2 ⁻	
^x 1393.3 6	0.28 8					
^x 1396.5 5	0.38 10					
^x 1407.9 4	0.42 10					
^x 1412.7 3	1.5 3					
^x 1417.8 6	0.30 ^b 9					
^x 1423.2 3	0.84 18					
3765.2 8	0.36 10	(6003.19)	1/2 ⁺	2237.9	1/2, 3/2	
3777.8 11	0.17 6	(6003.19)	1/2 ⁺	2225.3	1/2 ⁻ , 3/2 ⁻	

Continued on next page (footnotes at end of table)

$^{168}\text{Er}(n,\gamma)$ E=thermal **1970Mu15** (continued) $\gamma(^{169}\text{Er})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^{\&e}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
3783.7 7	0.55 14	(6003.19)	$1/2^+$	2219.4	$1/2, 3/2$	
3817.9 8	0.41 12	(6003.19)	$1/2^+$	2185.2	$1/2, 3/2$	Other E_γ : 3818.9 5 (2007ChZX ; Budapest data).
3822.7 7	1.7 4	(6003.19)	$1/2^+$	2180.4	$1/2^-, 3/2^-$	
3837.6 16	0.05 2	(6003.19)	$1/2^+$	2165.5	$1/2^-, 3/2^-$	
3861.9 26	0.07 3	(6003.19)	$1/2^+$	2141	$1/2^{(-)}, 3/2^{(-)}$	
3877.9 7	1.5 3	(6003.19)	$1/2^+$	2125.2	$1/2^-, 3/2^-$	
3890.6 9	0.18 5	(6003.19)	$1/2^+$	2112.5	$1/2, 3/2$	
3940.1 8	0.33 8	(6003.19)	$1/2^+$	2063.0	$1/2, 3/2$	
3956.0 13	0.10 4	(6003.19)	$1/2^+$	2047.1	$1/2, 3/2$	
3973.8 8	0.24 6	(6003.19)	$1/2^+$	2029.3	$1/2^-, 3/2^-$	Other E_γ : 3972.1 9 (2007ChZX ; Budapest data).
4006.1 7	0.82 17	(6003.19)	$1/2^+$	1997.0	$1/2, 3/2$	
4024.2 7	0.22 5	(6003.19)	$1/2^+$	1978.9	$1/2, 3/2$	
4047.8 23	0.09 5	(6003.19)	$1/2^+$	1955.3	$1/2^-, 3/2^-$	
4055.1 14	0.14 5	(6003.19)	$1/2^+$	1948.0	$1/2^-, 3/2^-$	
4074.3 7	2.3 5	(6003.19)	$1/2^+$	1928.8	$1/2^-, 3/2^-$	
4105.4 7	0.61 13	(6003.19)	$1/2^+$	1897.7	$1/2, 3/2$	Other E_γ : 4103.6 4 (2007ChZX ; Budapest data).
4135.9 8	0.27 7	(6003.19)	$1/2^+$	1867.2	$1/2^{(-)}, 3/2^{(-)}$	
4154.7 8	0.31 8	(6003.19)	$1/2^+$	1848.4	$1/2^-, 3/2^-$	
4163.8 8	0.29 7	(6003.19)	$1/2^+$	1839.3	$1/2^{(-)}, 3/2^{(-)}$	
4177.1 11	0.19 6	(6003.19)	$1/2^+$	1826.0	$1/2, 3/2$	
4183.4 17	0.09 3	(6003.19)	$1/2^+$	1819.7	$1/2^{(-)}, 3/2^{(-)}$	
4196.8 19	0.05 2	(6003.19)	$1/2^+$	1806.3	$1/2, 3/2$	
4207.8 9	0.18 5	(6003.19)	$1/2^+$	1795.3	$1/2, 3/2$	
4219.5 7	0.39 9	(6003.19)	$1/2^+$	1783.6	$1/2, 3/2$	
4293.0 7	0.27 6	(6003.19)	$1/2^+$	1710.1	$1/2, 3/2$	Other E_γ : 4292.5 4 (2007ChZX ; Budapest data).
4323.1 9	0.11 3	(6003.19)	$1/2^+$	1680.0	$1/2, 3/2$	
4335.6 16	0.05 2	(6003.19)	$1/2^+$	1667.5	$1/2, 3/2$	
4355.9 6	0.42 9	(6003.19)	$1/2^+$	1647.2	$(1/2^+)$	
4449.4 7	0.36 13	(6003.19)	$1/2^+$	1553.7	$1/2^-, 3/2^-$	
4473.5 7	0.34 8	(6003.19)	$1/2^+$	1529.6	$1/2^-, 3/2^-$	
4515.1 11	0.30 10	(6003.19)	$1/2^+$	1488.0	$1/2^-, 3/2^-$	
4519.2 18	0.14 10	(6003.19)	$1/2^+$	1483.9	$1/2, 3/2$	
4532.4 7	0.44 10	(6003.19)	$1/2^+$	1470.7	$1/2^{(-)}, 3/2^{(-)}$	
4616.5 4	6.0 12	(6003.19)	$1/2^+$	1386.97	$1/2^-, 3/2^-$	
4860.3 5	0.18 4	(6003.19)	$1/2^+$	1142.8	$1/2, 3/2$	
4887.1 15	0.31 13	(6003.19)	$1/2^+$	1117.21	$(3/2^-)$	
4908.8 4	10.3 21	(6003.19)	$1/2^+$	1094.34	$1/2^-, 3/2^-$	
4922.4 15	0.27 11	(6003.19)	$1/2^+$	1081.60	$(3/2^-)$	
5142.9 7	0.76 16	(6003.19)	$1/2^+$	860.08	$(3/2^+, 5/2^+)$	
5289.0 8	0.12 3	(6003.19)	$1/2^+$	714.67	$(3/2^-)$	
5441.0 4	3.0 6	(6003.19)	$1/2^+$	562.03	$(1/2^-)$	
5938.2 4	6.6 14	(6003.19)	$1/2^+$	64.552	$3/2^-$	
6002.4 7	0.12 3	(6003.19)	$1/2^+$	0.0	$1/2^-$	

† From [1970Mu15](#), except where otherwise noted.

‡ From $^{167}\text{Er}(n,\gamma)$ (seen as impurity) ([1966Ko03](#)); value used by [1970Mu15](#) for energy calibration.

Uncertain assignment to ^{169}Er .

@ Includes components from 99.0 γ and 99.3 γ in ^{168}Er .

& Relative I_γ ([1970Mu15](#)); uncertainties include 20% assumed overall uncertainty. Corrected by authors for target self-absorption.

See comment with normalization to obtain absolute intensities.

^a Reported uncertainty of 0.03 is most probably 0.30.

^b Evaluator assumes that $I_\gamma=0.3$ 9, as reported by [1970Mu15](#), was intended to be $I_\gamma=0.30$ 9.

Continued on next page (footnotes at end of table)

 $^{168}\text{Er}(\text{n},\gamma)$ E=thermal **1970Mu15** (continued)

 $\gamma(^{169}\text{Er})$ (continued)

^c Deduced from $I\gamma=0.54$ 11 (total for both placements of 760.7 γ) and adopted relative branching from 853.0 level.

^d Deduced from $I\gamma=1.6$ 4 (total for both placements of 787.9 γ) and adopted relative branching from 853.0 level.

^e For intensity per 100 neutron captures, multiply by 0.74.

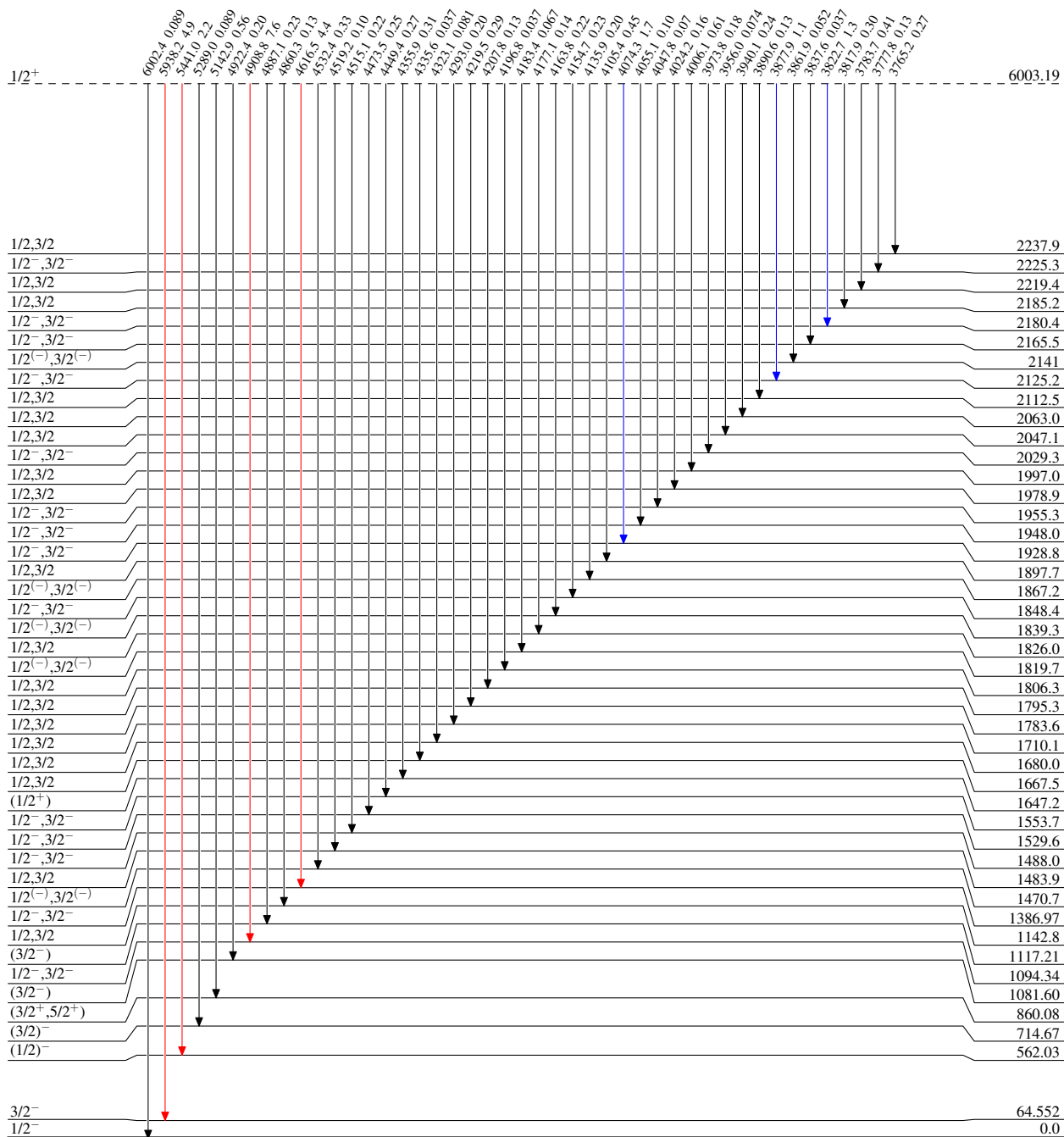
^f Multiply placed with undivided intensity.

^g Multiply placed with intensity suitably divided.

^h Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

 $I_\gamma < 2\% \times I_\gamma^{\max}$
 $I_\gamma < 10\% \times I_\gamma^{\max}$
 $I_\gamma > 10\% \times I_\gamma^{\max}$

 $^{169}_{68}\text{Er}_{101}$

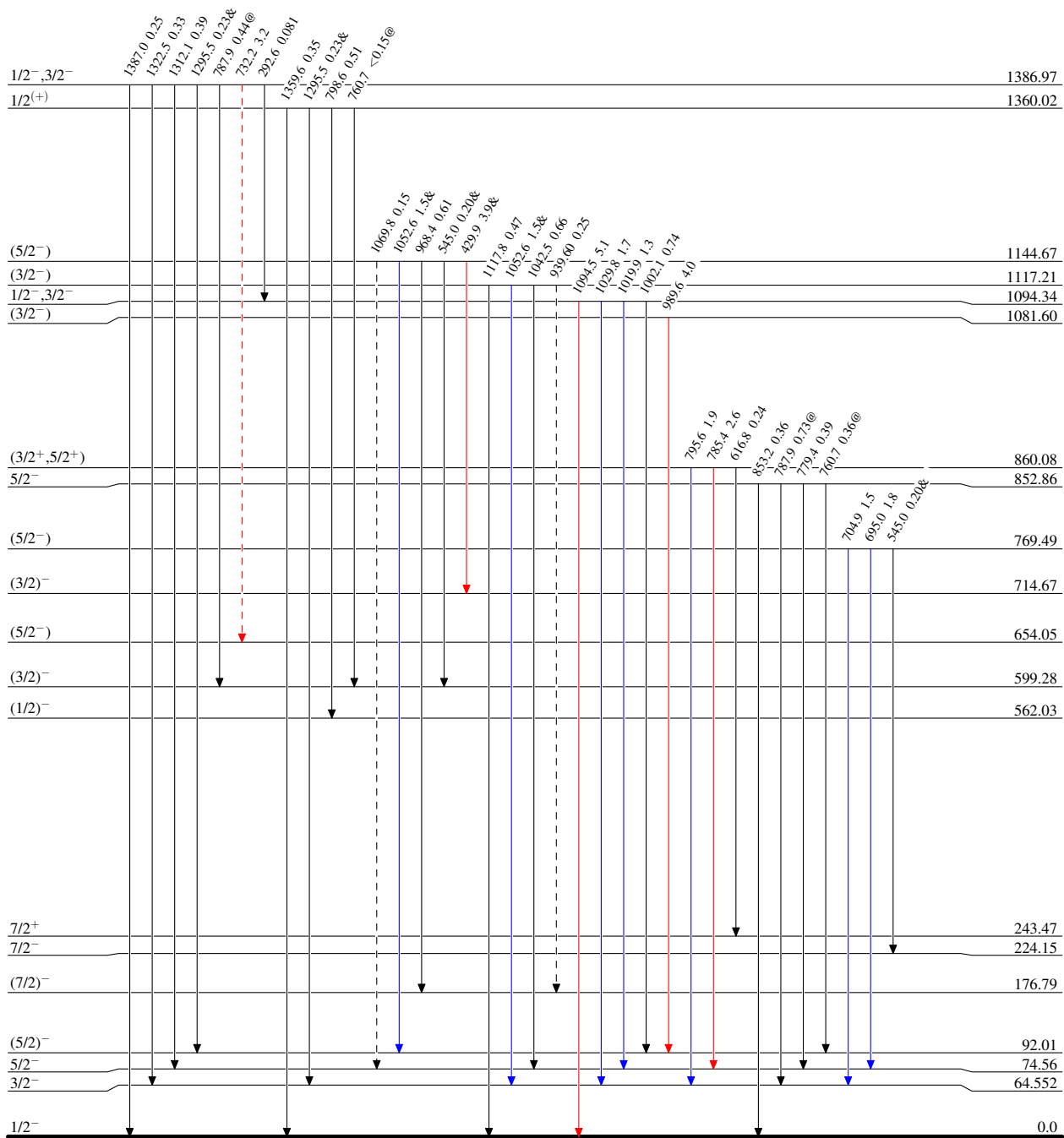
$^{168}\text{Er}(n,\gamma)$ E=thermal 1970Mu15

Level Scheme (continued)

Intensities: I_γ per 100 neutron captures
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\cdots\cdots\cdots$ γ Decay (Uncertain)

 $^{169}_{68}\text{Er}_{101}$

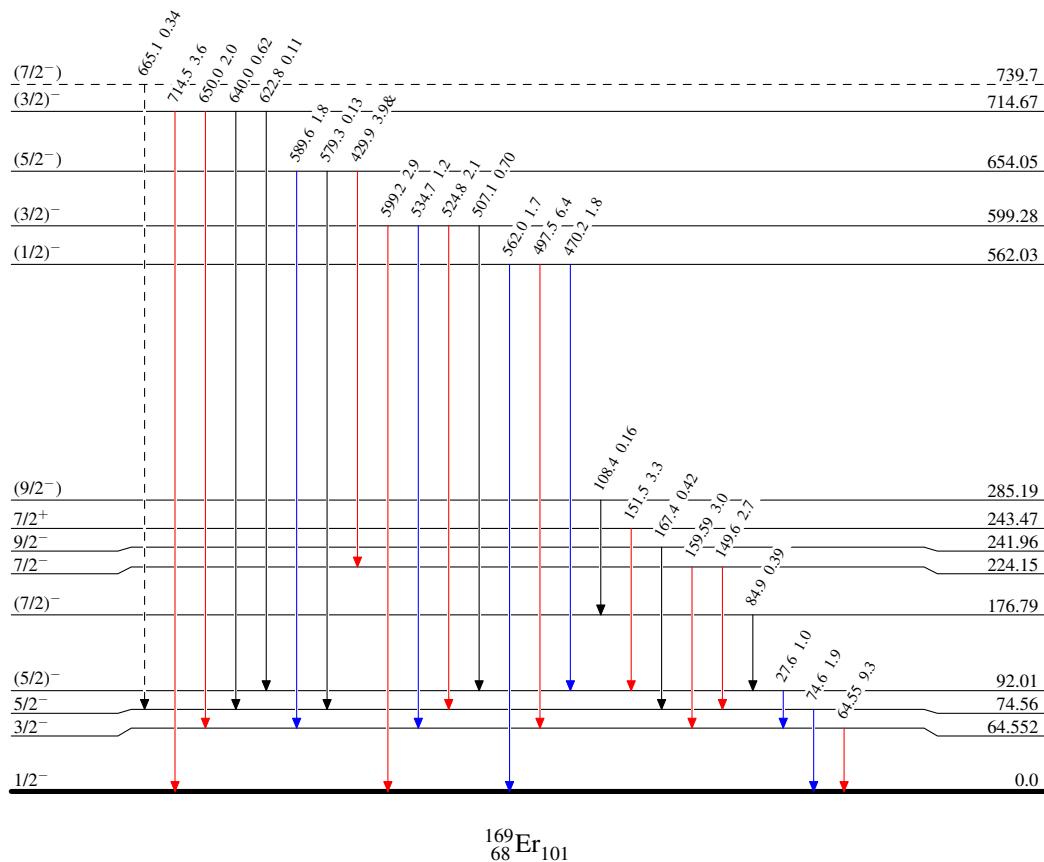
$^{168}\text{Er}(n,\gamma) \text{E=thermal}$ 1970Mu15

Level Scheme (continued)

Intensities: I_γ per 100 neutron captures
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\text{max}}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\text{max}}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\text{max}}$
 $-\cdots-\cdots$ γ Decay (Uncertain)

 $^{169}_{68}\text{Er}_{101}$

$^{168}\text{Er}(\text{n},\gamma)$ E=resonance **1976Ga05**

Others: [1967Mu17](#), [1968Ka17](#), [1970Bo29](#), [1972Li08](#), [1972Ra26](#), [1978Ko04](#) (E=5-350 keV; measured $\sigma(\text{E})$).

[1976Ga05](#): E(res)=79, 189, 244, 312, 527, 830, 1005 eV; Er oxide targets enriched to 95.47% in ^{168}Er ; measured resonance properties and γ -ray spectra for individual resonances (Ge(Li), FWHM=6 keV at 7.6 MeV); deduced average resonance widths.

 ^{169}Er Levels

E(level) [†]	J^π [‡]	Comments
0.0	$1/2^-$ [#]	
64.1 5	$3/2^-$ [#]	
561.7 5	$(1/2)^-$ [#]	
599.2 5	$(3/2)^-$ [#]	
714.2 5	$(3/2)^-$ [#]	
859.3 5	$(3/2^+, 5/2^+)$ [#]	
1053.2 5	$1/2^-, 3/2^-$	
1079.7 5	$1/2^{(-)}, 3/2^{(-)}$	
1093.2 5	$1/2^-, 3/2^-$	
1386.2 5	$1/2^-, 3/2^-$	
1469.9 5	$1/2^{(-)}, 3/2^{(-)}$	
1487.0 5	$1/2^-, 3/2^-$	
1529.9 5	$1/2^-, 3/2^-$	
1554.2 5	$1/2^-, 3/2^-$	
1572.4 5	$1/2^{(-)}, 3/2^{(-)}$	
1781	$1/2, 3/2$	
1794	$1/2, 3/2$	
1821.6 5	$1/2^{(-)}, 3/2^{(-)}$	
1839.6 5	$1/2^{(-)}, 3/2^{(-)}$	
1848.5 5	$1/2^-, 3/2^-$	
1868.3 5	$1/2^{(-)}, 3/2^{(-)}$	
1896	$1/2, 3/2$	
1929.4 5	$1/2^-, 3/2^-$	
1947.7 5	$1/2^-, 3/2^-$	
1955.6 5	$1/2^-, 3/2^-$	
1966.9	$1/2, 3/2$	
1998	$1/2, 3/2$	
2023.0 5	$1/2^-, 3/2^-$	Large average Γ_γ suggests populating transition is a doublet. E(level): the apparent discrepancy between $E_\gamma=3980.2$ and $E(\text{level})=2012.8$ (see table 1 in 1976Ga05) is resolved if E_γ is taken as correct and E(level) is adjusted accordingly. There is a reference to 3980.2 γ in the text.
2029.7 5	$1/2^-, 3/2^-$	
2098	$1/2, 3/2$	
2124.3 5	$1/2^-, 3/2^-$	
2139.2 5	$1/2^{(-)}, 3/2^{(-)}$	
2165.2 5	$1/2^-, 3/2^-$	
2180.2 5	$1/2^-, 3/2^-$	
2222.6 5	$1/2^-, 3/2^-$	
2264.5 10	$1/2, 3/2$	
(6003.25 15)	$1/2^+$	E(level): composite state (includes all studied resonances). From S(n)=6003.25 15 in 2021Wa16 . J^π : the resonances studied all have $J^\pi=1/2^+$ (2018MuZZ).

[†] Deduced from E_γ for primary transitions; values correspond to S(n)=6003.25 15 ([2021Wa16](#)).

[‡] Assigned by the evaluator from population by E1 (or probable E1) transition from $1/2^+$ (multipolarity was determined from average resonance widths), except where otherwise noted.

[#] From Adopted Levels.

$^{168}\text{Er}(\text{n},\gamma)$ E=resonance **1976Ga05** (continued) $\gamma(^{169}\text{Er})$

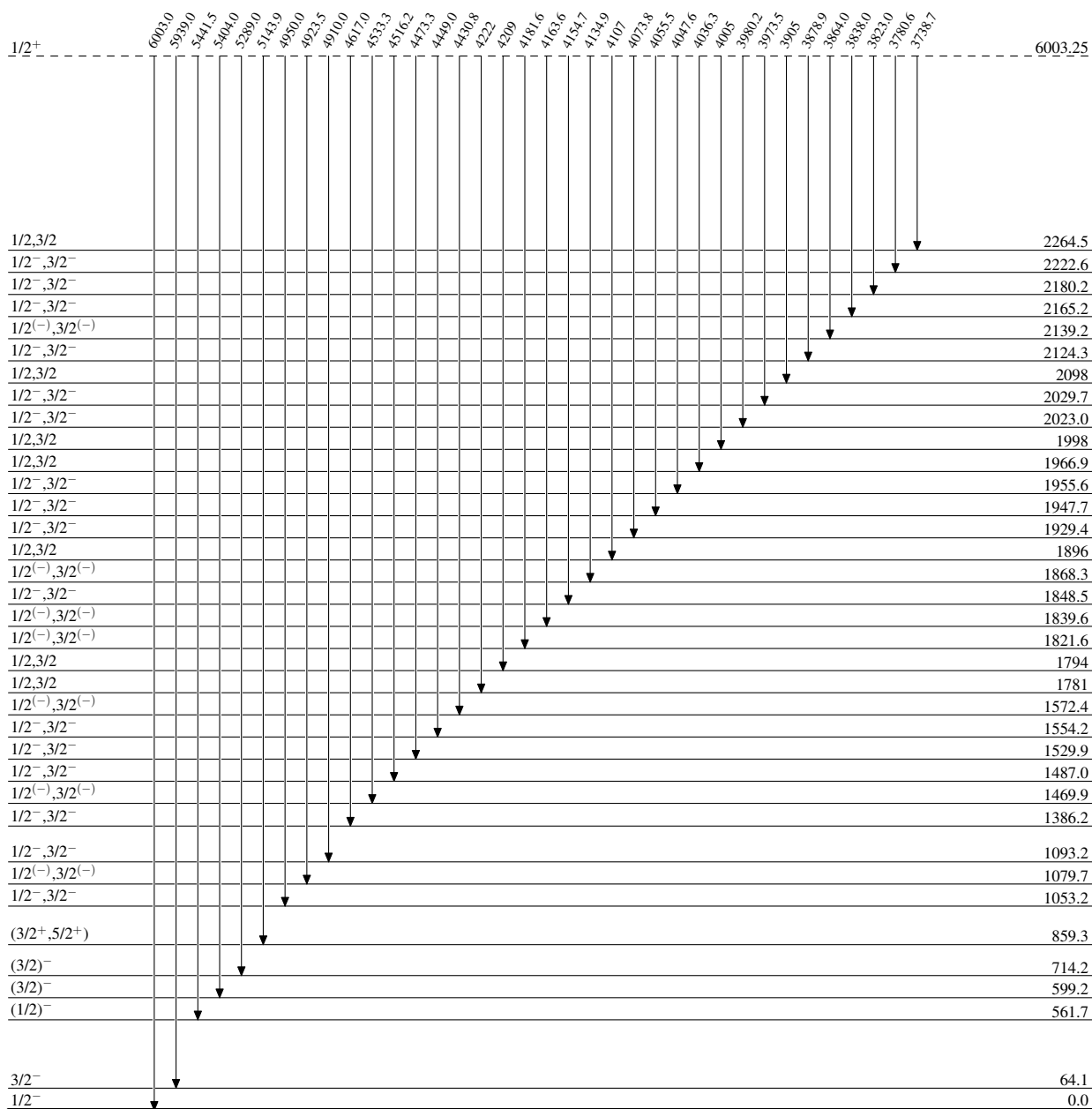
$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π
3738.7 ‡	(6003.25)	1/2 ⁺	2264.5	1/2,3/2	4181.6 5	(6003.25)	1/2 ⁺	1821.6	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾
3780.6 5	(6003.25)	1/2 ⁺	2222.6	1/2 ⁻ ,3/2 ⁻	4209 ‡	(6003.25)	1/2 ⁺	1794	1/2,3/2
3823.0 5	(6003.25)	1/2 ⁺	2180.2	1/2 ⁻ ,3/2 ⁻	4222 ‡	(6003.25)	1/2 ⁺	1781	1/2,3/2
3838.0 5	(6003.25)	1/2 ⁺	2165.2	1/2 ⁻ ,3/2 ⁻	4430.8 5	(6003.25)	1/2 ⁺	1572.4	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾
3864.0 5	(6003.25)	1/2 ⁺	2139.2	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾	4449.0 5	(6003.25)	1/2 ⁺	1554.2	1/2 ⁻ ,3/2 ⁻
3878.9 5	(6003.25)	1/2 ⁺	2124.3	1/2 ⁻ ,3/2 ⁻	4473.3 5	(6003.25)	1/2 ⁺	1529.9	1/2 ⁻ ,3/2 ⁻
3905 ‡	(6003.25)	1/2 ⁺	2098	1/2,3/2	4516.2 5	(6003.25)	1/2 ⁺	1487.0	1/2 ⁻ ,3/2 ⁻
3973.5 5	(6003.25)	1/2 ⁺	2029.7	1/2 ⁻ ,3/2 ⁻	4533.3 5	(6003.25)	1/2 ⁺	1469.9	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾
3980.2 5	(6003.25)	1/2 ⁺	2023.0	1/2 ⁻ ,3/2 ⁻	4617.0 5	(6003.25)	1/2 ⁺	1386.2	1/2 ⁻ ,3/2 ⁻
4005 ‡	(6003.25)	1/2 ⁺	1998	1/2,3/2	4910.0 5	(6003.25)	1/2 ⁺	1093.2	1/2 ⁻ ,3/2 ⁻
4036.3 ‡	(6003.25)	1/2 ⁺	1966.9	1/2,3/2	4923.5 5	(6003.25)	1/2 ⁺	1079.7	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾
4047.6 5	(6003.25)	1/2 ⁺	1955.6	1/2 ⁻ ,3/2 ⁻	4950.0 5	(6003.25)	1/2 ⁺	1053.2	1/2 ⁻ ,3/2 ⁻
4055.5 5	(6003.25)	1/2 ⁺	1947.7	1/2 ⁻ ,3/2 ⁻	5143.9 5	(6003.25)	1/2 ⁺	859.3	(3/2 ⁺ ,5/2 ⁺)
4073.8 5	(6003.25)	1/2 ⁺	1929.4	1/2 ⁻ ,3/2 ⁻	5289.0 5	(6003.25)	1/2 ⁺	714.2	(3/2) ⁻
4107 ‡	(6003.25)	1/2 ⁺	1896	1/2,3/2	5404.0 5	(6003.25)	1/2 ⁺	599.2	(3/2) ⁻
4134.9 5	(6003.25)	1/2 ⁺	1868.3	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾	5441.5 5	(6003.25)	1/2 ⁺	561.7	(1/2) ⁻
4154.7 5	(6003.25)	1/2 ⁺	1848.5	1/2 ⁻ ,3/2 ⁻	5939.0 5	(6003.25)	1/2 ⁺	64.1	3/2 ⁻
4163.6 5	(6003.25)	1/2 ⁺	1839.6	1/2 ⁽⁻⁾ ,3/2 ⁽⁻⁾	6003.0 5	(6003.25)	1/2 ⁺	0.0	1/2 ⁻

† From Table I (**1976Ga05**), except where otherwise noted. Energy calibration was done from the known γ -ray background lines.

‡ From text in **1976Ga05**, seen to the 79 eV resonance.

$^{168}\text{Er}(\text{n},\gamma) \text{E=resonance}$ 1976Ga05

Level Scheme

 $^{169}_{68}\text{Er}_{101}$

$^{168}\text{Er}(\text{d,p}), ^{170}\text{Er}(\text{d,t})$ **1970Mu15, 1969Tj01**

Others: **1963Is01** ($E(\text{d})=15$ MeV, FWHM=80 keV, $\theta(\text{lab})=9^\circ$ to 90° (12 angles)); **1968Ha10** ($E(\text{d})\approx 12.0$ MeV, $\theta(\text{lab})=45^\circ, 65^\circ, 133^\circ$, energy resolution 0.08%); **1984Pe03** (reanalysis of selected data from **1969Tj01**).
1970Mu15: $E(\text{d})=12$ MeV; single-gap, broad-range magnetic spectrograph with array of 3 nuclear emulsion plates; >99.9% ^{168}Er target;
1969Tj01: $E(\text{d})=12.1$ MeV; $\theta=60^\circ, 90^\circ, 125^\circ$; isotope separated targets; measured $E(\text{level})$ (mag spect, FWHM ≈ 6 keV for (d,t), ≈ 12 keV for (d,p)), angular distributions, differential cross sections.

 ^{169}Er Levels

$E(\text{level})^\dagger$	$J^\pi b$	Comments
0.0 ^c	1/2 ⁻	$d\sigma/d\Omega(\text{d,t})=100$.
65 ^{&c}	2 3/2 ⁻	$E(\text{level})$: others: 69 10 (1968Ha10), 65 4 (d,t) (1970Mu15).
74 ^{&c}	3 5/2 ⁻	$E(\text{level})$: others: 79 5 (1968Ha10), 75 3 (d,t) (1970Mu15). $d\sigma/d\Omega(\text{d,t})=16$ I.
93 ^{&d}	4 5/2 ⁻	$E(\text{level})$: others: 88 10 (1968Ha10), 95 4 (d,t) (1970Mu15). $d\sigma/d\Omega(\text{d,t})=3$ I.
177 ^{&d}	2 7/2 ⁻	$E(\text{level})$: others: 179 10 (1968Ha10), 177 3 (d,t) (1970Mu15). $d\sigma/d\Omega(\text{d,t})=47$ 2.
225 ^{ac}	2 7/2 ⁻	$E(\text{level})$: others: 227 10 (1968Ha10), 224 2 (d,p) (1970Mu15). $d\sigma/d\Omega(\text{d,t})=32$ 2.
244 ^{&c}	2 9/2 ⁻	$d\sigma/d\Omega(\text{d,t})=4$ I. $E(\text{level})$: May include component from 7/2 ⁺ 7/2[633] state ($E(\text{level})=243.66$ in ^{169}Er Adopted Levels). Other: 244 2 (d,t) (1970Mu15).
285 ^{ad}	3 9/2 ⁻	$d\sigma/d\Omega(\text{d,t})=2$ I. $E(\text{level})$: other: 285 4 (d,p) (1970Mu15).
320 ^{ae}	2 9/2 ⁺	$E(\text{level})$: others: 319 10 (1968Ha10), 318 3 (d,p) (1970Mu15). $d\sigma/d\Omega(\text{d,t})=10$ 8. $E(\text{level})$: other: 318 3 (d,p) (1970Mu15).
416 ^{ad}	3 11/2 ⁻	$E(\text{level})$: others: 420 10 (1968Ha10), 415 3 (d,p) (1970Mu15). May include component from 11/2 ⁺ 7/2[633] state ($E(\text{level})=413$ in ^{169}Er Adopted Levels). $d\sigma/d\Omega(\text{d,t})=1$ I.
475 ^{ac}	4 11/2 ⁻	$E(\text{level})$: others: 472 10 (1968Ha10 – also (485), (504), (555)) 473 5 (d,p) (1970Mu15). $d\sigma/d\Omega(\text{d,t})=1$ I.
528 ^{&e}	2 13/2 ⁺	$d\sigma/d\Omega(\text{d,t})=11$ 8. $E(\text{level})$: other: 531 3 (d,t) (1970Mu15).
557 ^{&}	4	$E(\text{level})$: others: (555) (1968Ha10), 558 8 (d,t) (1970Mu15). $E(\text{level})$: reported in 1970Mu15 and possibly in 1968Ha10 too.
565 ^f	3 1/2 ⁻	$E(\text{level})$: not observed by 1970Mu15 ; may be the 557 level in 1970Mu15 . Seen only in (d,p).
602 ^f	2 3/2 ⁻	$d\sigma/d\Omega(\text{d,t})=9$ I. $E(\text{level})$: mean value from 600 2 (d,p) and 604 2 (d,t) in 1970Mu15 . 599 from 1969Tj01 ; 600 10 from (1968Ha10).
654 ^{&f}	2 5/2 ⁻	$d\sigma/d\Omega(\text{d,t})=6$ I. $E(\text{level})$: others: 659 2 in (d,t) (1970Mu15), 654 (1969Tj01); 655 10 (1968Ha10), 659 2 (d,t) (1970Mu15).
717 ^g	3 3/2 ⁻	$d\sigma/d\Omega(\text{d,t})=41$ 9. $E(\text{level})$: unweighted average of 714 3 in (d,p) and 720 2 in (d,t) (1970Mu15). Others: 713 (1969Tj01); 715 10 (1968Ha10).
741 ^{af}	2 7/2 ⁻	$d\sigma/d\Omega(\text{d,t})=3$ I. $E(\text{level})$: others: (743) (1968Ha10), 740 2 (d,t) (1970Mu15).
768 ^g	3 (5/2 ⁻)	
822 ^{±ah}	2 7/2 ⁻	$d\sigma/d\Omega(\text{d,t})=1$ I. $E(\text{level})$: others: 824 10 (1968Ha10), 823 3 (d,t) (1970Mu15).
852 ^g	3 7/2 ⁻	$d\sigma/d\Omega(\text{d,t})=26$ I. $E(\text{level})$: 849 3 in (d,p) and 856 3 in (d,t) (1970Mu15); possibly different states are favored in these two reactions. 850 10 (1968Ha10).

Continued on next page (footnotes at end of table)

$^{168}\text{Er}(\text{d,p}), ^{170}\text{Er}(\text{d,t})$ **1970Mu15,1969Tj01 (continued)** ^{169}Er Levels (continued)

E(level) [†]	J ^π ^b	Comments
		May include component from 5/2 ⁻ 5/2[523] state (E(level)=853.0 in ^{169}Er Adopted Levels); this state is expected to have similar energy to the 7/2 ⁻ 3/2[521] state, but its (d,t) cross section is expected to be relatively small.
927 ^{ah} 3	9/2 ⁻	dσ/dΩ(d,t)=3 I. E(level): other: 931 4 in (d,p) (1970Mu15), 927 (1969Tj01), and 927 10 (1968Ha10).
940 ^{ai} 2	7/2 ⁻	dσ/dΩ(d,t)=10 I.
≈947 ^g	9/2 ⁻	
990 ^a 3		dσ/dΩ(d,t)=1 I.
1051 ^h 5	11/2 ⁻	
1052 ^{ai} 2	9/2 ⁻	dσ/dΩ(d,t)=7 I.
1077 ^{ag} 2	11/2 ⁻	dσ/dΩ(d,t)=5 I.
1083 ^{&j} 3	3/2 ⁻	E(level): other: 1082 10 (1968Ha10).
1095 ^a 3		dσ/dΩ(d,t)=2 I.
1112 ^a 4		dσ/dΩ(d,t)=1 I. Other E: 1116 from (1969Tj01). May be the same level as that reported at 1118 3 in (d,t) in 1970Mu15 .
1118 ^{&} 3		
1136 ^a 3		dσ/dΩ(d,t)=2 I.
1145 ^{&j} 3	5/2 ⁻	E(level): others: 1141 reported by 1969Tj01 may be for a doublet. 1147 10 (1968Ha10).
1168 ^{&} 2		
1186 ^{ai} 4	11/2 ⁻	dσ/dΩ(d,t)=1 I.
1218 ^a 4		dσ/dΩ(d,t)=3 I. E(level): other: 1217 10 (1968Ha10).
1232 ^{&j} 3	7/2 ⁻	E(level): others: 1233 10 (1968Ha10).
1234 ^a 3		dσ/dΩ(d,t)=8 I. E(level): others: 1239 (1969Tj01), 1233 10 (1968Ha10), 1232 3 (d,p) (1970Mu15).
1273 ^a 3		dσ/dΩ(d,t)=2 I.
1341 ^h 5	9/2 ⁻	E(level): other: 1321 10 (1968Ha10).
1359 ^a 3		dσ/dΩ(d,t)=9 I.
1364 ^h 5		Level might be same as 1359 level seen in (d,t).
1388 ^{&} 2		E(level): other: 1386 5 (1968Ha10).
1394 ^{ak} 2	11/2 ⁻	dσ/dΩ(d,t)=7 I.
1415 ^h 5		
1415 ^{&} 2		dσ/dΩ(d,t)=2 I. E(level): 1413 7 (d,t) (1970Mu15). E(level): Level might be same as 1415 level seen in (d,p). 1411 7 (1968Ha10).
1459 ^{&} 2		
1462 ^a 2		dσ/dΩ(d,t)=11 I. Level might be same as 1457 level seen in (d,p). E(level): other: 1452 10 (1968Ha10).
1471 [#] 5		
1484 ^a 2		dσ/dΩ(d,t)=26 I.
1489 ^{&} 2		E(level): other: 1489 10 (1968Ha10).
1529 ^{al} 2	3/2 ⁺	dσ/dΩ(d,t)=39 2. Groups of levels between 1526 and 1564 in (d,t) not resolved by 1969Tj01 .
1535 ^h 5		
1554 ^h 5		E(level): other: 1559 10 (1968Ha10).
1564 [#] 5		
1570 ^h 5		E(level): other: 1572 10 (1968Ha10).
1601 [#] 5		

Continued on next page (footnotes at end of table)

$^{168}\text{Er}(\text{d,p}), ^{170}\text{Er}(\text{d,t})$ **1970Mu15,1969Tj01** (continued) ^{169}Er Levels (continued)

E(level) [†]	J ^π ^b	Comments
1608 [‡] ₅		E(level): other: 1605 <i>10</i> (1968Ha10).
1622 [‡] ₅		
1623 [#] ₅		Level might be same as 1622 level seen in (d,p).
1644 ^{#m} ₅	1/2 ⁺	
1650 [‡] ₅		E(level): other: 1654 <i>10</i> (1968Ha10).
1677 [#] ₅		
1681 [‡] ₅		
1699 [‡] ₅		E(level): other: 1696 <i>10</i> (1968Ha10).
1702 [#] ₅		E(level): Level might be same as 1699 level seen in (d,p).
1715 [‡] ₅		
1718 [#] ₅		E(level): Level might be same as 1715 level seen in (d,p). other: 1722 <i>10</i> (1968Ha10).
1727 [‡] ₅		
1755 [‡] ₅		E(level): other: 1756 <i>10</i> (1968Ha10).
1776 [‡] ₅		
1790 [#] ₅		E(level): other: 1798 <i>10</i> (1968Ha10).
1823 [‡] ₅		
1825 [#] ₅		Level might be same as 1823 level seen in (d,p).
1844 [‡] ₅		E(level): other: 1845 <i>10</i> (1968Ha10).
1857 [#] ₅		
1867 [‡] ₅		E(level): other: 1864 <i>10</i> (1968Ha10).
1886 [#] ₅		E(level): other: 1883 <i>10</i> (1968Ha10).
1899 [‡] ₅		
1904 [#] ₅		E(level): Level might be same as 1899 level seen in (d,p). other: 1907 <i>10</i> (1968Ha10).
1913 [‡] ₅		
1924 [#] ₅		
1929 [‡] ₅		E(level): Groups of levels between 1929 and 2053 in (d,p) not resolved (1969Tj01). other: 1907 <i>10</i> (1968Ha10).
1958 [#] ₅		E(level): other: 1957 <i>15</i> (1968Ha10).
1974 [#] ₅		
1994 [#] ₅		
2018 [#] ₅		
2031 [#] ₅		E(level): other: 2038 <i>15</i> (1968Ha10).
2053 [‡] ₅		
2057 [#] ₅		Level might be same as 2053 level seen in (d,p).
2092 [‡] ₅		E(level): other: 2091 <i>15</i> (1968Ha10).
2123 [‡] ₅		Groups of levels between 2123 and 2184 in (d,p) not resolved (1969Tj01). Other: 2155 <i>15</i> (1968Ha10).
2184 [‡] ₅		E(level): other: 2181 <i>15</i> (1968Ha10).
2204 [‡] ₅		E(level): other: 2198 <i>15</i> (1968Ha10).
2228 [‡] ₅		E(level): other: 2243 <i>15</i> (1968Ha10).
2255 [‡] ₅		
2272 [‡] ₅		
2295 [‡] ₅		
2336 [‡] ₅		E(level): other: 2328 <i>15</i> (1968Ha10).
2382 [‡] ₅		E(level): other: 2379 <i>15</i> (1968Ha10).

Continued on next page (footnotes at end of table)

$^{168}\text{Er}(\text{d,p}), ^{170}\text{Er}(\text{d,t})$ **1970Mu15,1969Tj01** (continued) ^{169}Er Levels (continued)

E(level) [†]	Comments
2420 [‡] 5	E(level): other: 2419 15 (1968Ha10).
2440 [‡] 5	E(level): other: 2438 15 (1968Ha10).
2484 ^{‡@} 15	
2522 ^{‡@} 15	
2582 ^{‡@} 15	

[†] From 1969Tj01 for the reaction with the larger cross section, except as noted. ΔE is not explicitly stated, but assumed to be 3 keV below 1 MeV (5 keV above 1 MeV), as in similar work by the same authors (1967Tj01).

[‡] Seen only in (d,p).

Seen only in (d,t).

@ From (d,p) (1968Ha10).

& From (d,p) (1970Mu15).

^a From (d,t) (1970Mu15).

^b From 1969Tj01 based on combined analysis of the relative populations of band members, of absolute cross sections, and of angular distributions in the two reactions. These values are consistent with those in Adopted Levels, but some adopted values are given in parentheses.

^c Band(A): 1/2[521]. Observed (d,p) cross sections for J=1/2 through 7/2 band members match calculated fingerprint for 1/2[521] band (1968Ha10).

^d Band(B): 5/2[512].

^e Band(C): 7/2[633].

^f Band(D): 1/2[510]. Includes contribution from K-2 γ vibration built on 5/2[512] (1968Ha10).

^g Band(E): 3/2[521].

^h Band(F): 7/2[514].

ⁱ Band(G): 5/2[523]. Includes contribution from K+2 γ vibration built on 1/2[521] (1968Ha10).

^j Band(H): 3/2[512].

^k Band(I): 11/2[505].

^l Band(J): 3/2[402].

^m Band(K): 1/2[400].

$^{168}\text{Er}(\text{d,p}), ^{170}\text{Er}(\text{d,t})$ 1970Mu15,1969Tj01

		Band(E): 3/2[521]		Band(F): 7/2[514]	
		<u>11/2⁻</u>	<u>1077</u>	<u>11/2⁻</u>	<u>1051</u>
		<u>9/2⁻</u>	<u>≈947</u>	<u>9/2⁻</u>	<u>927</u>
		<u>7/2⁻</u>	<u>852</u>	<u>7/2⁻</u>	<u>822</u>
		Band(D): 1/2[510]			
		<u>7/2⁻</u>	<u>741</u>	<u>(5/2⁻)</u>	<u>768</u>
				<u>3/2⁻</u>	<u>717</u>
		<u>5/2⁻</u>	<u>654</u>		
		<u>3/2⁻</u>	<u>602</u>		
		Band(C): 7/2[633]			
		<u>13/2⁺</u>	<u>528</u>	<u>1/2⁻</u>	<u>565</u>
Band(A): 1/2[521]					
<u>11/2⁻</u>	<u>475</u>				
		Band(B): 5/2[512]			
		<u>11/2⁻</u>	<u>416</u>		
		<u>9/2⁺</u>	<u>320</u>		
		<u>9/2⁻</u>	<u>285</u>		
<u>9/2⁻</u>	<u>244</u>				
<u>7/2⁻</u>	<u>225</u>				
		<u>7/2⁻</u>	<u>177</u>		
		<u>5/2⁻</u>	<u>93</u>		
<u>5/2⁻</u>	<u>74</u>				
<u>3/2⁻</u>	<u>65</u>				
<u>1/2⁻</u>	<u>0.0</u>				

¹⁶⁸Er(d,p), ¹⁷⁰Er(d,t) 1970Mu15,1969Tj01 (continued)

Band(K): 1/2[400]

1/2⁺ 1644

Band(J): 3/2[402]

3/2⁺ 1529

Band(I): 11/2[505]

11/2⁻ 1394

Band(H): 3/2[512]

9/2⁻ 1341

7/2⁻ 1232

Band(G): 5/2[523]

11/2⁻ 1186

5/2⁻ 1145

3/2⁻ 1083

9/2⁻ 1052

7/2⁻ 940

$^{168}\text{Er}(\text{d},\text{p}\gamma)$ **1969BoZP**

No significant changes compared to that in the previous evaluation (2008Ba31) by C.M. Baglin.

E(d)=8 MeV (pulsed beam); measured E γ , I γ (semi), E(ce), Ice (mag spect), prompt and delayed p γ coin and p-ce coin.

 ^{169}Er Levels

E(level) [†]	J π [‡]	T _{1/2} [#]
0.0	1/2 ⁻	
63.9 7	3/2 ⁻	
74.1 7	5/2 ⁻	
91.5 8	(5/2) ⁻	285 ns 20
175.5 11	(7/2) ⁻	
241.0 11	7/2 ⁺	200 ns 10
283.5 15	(9/2) ⁻	

[†] From least-squares fit to E γ , assigning 1 keV uncertainty to data for which authors do not state uncertainty.

[‡] From Adopted Levels.

[#] From p γ (t), p-ce(t).

 $\gamma(^{169}\text{Er})$

E γ	I γ [‡]	E _i (level)	J π _i	E _f	J π _f	Mult. [#]	δ [#]	α [@]	Comments
(10.0 [†])		74.1	5/2 ⁻	63.9	3/2 ⁻				
(17.46 12)		91.5	(5/2) ⁻	74.1	5/2 ⁻				I γ : I γ (17.3 γ)/I γ (27.6 γ)>0.18.
(27.6 2)		91.5	(5/2) ⁻	63.9	3/2 ⁻				I γ : I γ (17.3 γ)/I γ (27.6 γ)>0.18.
64	20.5	63.9	3/2 ⁻	0.0	1/2 ⁻	M1+E2	0.61	12.21 17	α (K)exp=7.85, α (L)exp + α (M)exp=5.7. δ : deduced from α (K)exp and α (L)exp + α (M)exp data using the BriccMixing code.
65.5	35	241.0	7/2 ⁺	175.5	(7/2) ⁻	(E1)		0.983 14	Mult.: from α (exp) $\approx$ 0.94 (value required by intensity balance of 65.5 γ -84 γ cascade), compared with α (E1 theory)=0.983.
74	15	74.1	5/2 ⁻	0.0	1/2 ⁻	(E2)		9.54 13	α (K)exp=5.4, α (L)exp + α (M)exp=2.3.
84	12	175.5	(7/2) ⁻	91.5	(5/2) ⁻	M1		4.70 7	α (L)exp + α (M)exp=0.71.
108		283.5	(9/2) ⁻	175.5	(7/2) ⁻				
^x 130									
^x 147.5									
149.5	100	241.0	7/2 ⁺	91.5	(5/2) ⁻	E1		0.1118 16	K/L=5.9 15. Mult.: from restriction to E1 or M1 by K/L, and elimination of M1 by low I γ (Er K x ray) (M1 for 149.5 γ would require I γ (Er K x ray)>800, compared with I γ (exp)=326).
^x 157.5									
^x 165									

[†] From Adopted Gammas.

[‡] Arbitrary units, relative to I γ =100 for 149.5 γ . On this scale, I γ (Er K x ray)=326.

[#] From α (L)exp + α (M)exp, except where noted. The photon and ce intensity scales were normalized through (α (L) + α (M))=0.0174 (E1 theory) for 149.5 γ .

[@] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with "Frozen Orbitals" approximation based on γ -ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

^x γ ray not placed in level scheme.

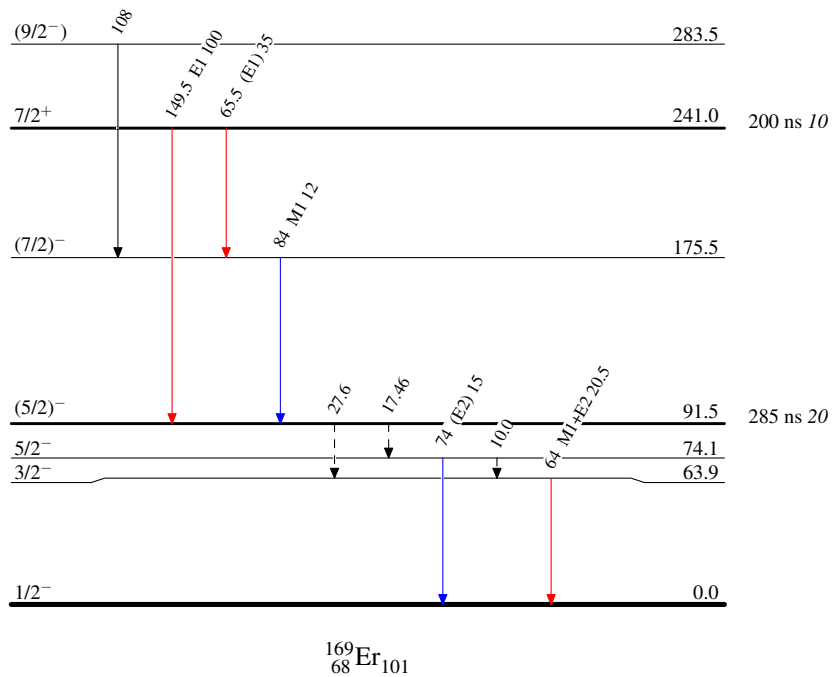
$^{168}\text{Er}(\text{d,p}\gamma)$ **1969BoZP**

Legend

Level Scheme

 Intensities: Relative I_γ

- $I_\gamma < 2\% \times I_\gamma^{\text{max}}$
- $I_\gamma < 10\% \times I_\gamma^{\text{max}}$
- $I_\gamma > 10\% \times I_\gamma^{\text{max}}$
- - - - - γ Decay (Uncertain)



$^{168}\text{Er}(^{16}\text{O}, ^{15}\text{O}), (^{12}\text{C}, ^{11}\text{C})$ **1981Bo16**

$E(^{16}\text{O})=120$ MeV, $E(^{12}\text{C})=95$ MeV from the Brookhaven National Laboratory tandem facility; $\theta=42^\circ$; enriched ^{168}Er targets; measured particle spectra (Q3D mag spect, FWHM=100-150 keV (for ^{16}O), 80-120 keV (for ^{11}C)), relative populations in ($^{16}\text{O}, ^{15}\text{O}\gamma$) and ($^{12}\text{C}, ^{11}\text{C}\gamma$) (L+1/2 final states strongly favored for ^{16}O ; L+1/2 and L-1/2 states comparably favored for ^{12}C).

 ^{169}Er Levels

<u>E(level)[†]</u>	<u>Jπ[‡]</u>	<u>Comments</u>
180 20	(7/2) ⁻	
510 20	(13/2) ⁺	
940 20	(9/2) ⁻	E(level): populated in ($^{12}\text{C}, ^{11}\text{C}\gamma$).
1150 20	(13/2) ⁺	J π : from relative population strengths in the two reactions; 13/2 ⁺ consistent with systematics for position of 13/2 ⁺ 9/2[624] state in Er isotopes.
2300		E(level): represents peak labeled on spectrum for ($^{16}\text{O}, ^{15}\text{O}\gamma$), but not discussed in text by 1981Bo16 .
≈ 3400		Very broad peak observed only in ($^{16}\text{O}, ^{15}\text{O}\gamma$); strength can be attributed to Er, but origin is not understood (1981Bo16).

[†] Populated both in ($^{16}\text{O}, ^{15}\text{O}$) and ($^{12}\text{C}, ^{11}\text{C}$) reactions, except where otherwise noted.

[‡] Adopted values, except where noted.

$^{170}\text{Er}(^3\text{He},\alpha)$ 1972Lo20

$E(^3\text{He})=25.5$ MeV; $\theta=40^\circ, 60^\circ$; erbium metal targets enriched to $>95\%$ in ^{170}Er ; measured E(level) (mag spect, photographic emulsions, $\text{FWHM}\approx 40$ keV), absolute cross sections at two angles; used $(^3\text{He},\alpha)/(d,t)$ ((d,t) data from 1970Mu15) and $(^3\text{He},\alpha)(40^\circ)/(^3\text{He},\alpha)(60^\circ)$ cross-section ratios and DWBA calculations to interpret levels populated.

 ^{169}Er Levels

$d\sigma/d\Omega$ ($\mu\text{b/sr}$) uncertainty 5% to 30% (1972Lo20).

<u>E(level)[†]</u>	<u>J^π[‡]</u>	<u>L[#]</u>	<u>Comments</u>
527	$(13/2)^+$	6	$d\sigma/d\Omega=135$ $\mu\text{b/sr}$ at 40° and 98 $\mu\text{b/sr}$ at 60° .
847 15	$(7/2^-)$		$d\sigma/d\Omega=21$ $\mu\text{b/sr}$.
927 15	$(9/2^-)$		$d\sigma/d\Omega=25$ $\mu\text{b/sr}$.
1051 15	$(9/2^-)$		$d\sigma/d\Omega=17$ $\mu\text{b/sr}$.
1222 15	$(7/2^-)$		$d\sigma/d\Omega=31$ $\mu\text{b/sr}$.
1397 15	$(11/2^-)$		$d\sigma/d\Omega=128$ $\mu\text{b/sr}$ at 40° and 110 $\mu\text{b/sr}$ at 60° .
1553 15	$11/2^+, 13/2^+$	6	$d\sigma/d\Omega=88$ $\mu\text{b/sr}$ at 40° and 93 $\mu\text{b/sr}$ at 60° .

[†] Determined by 1972Lo20 relative to $E=527$ for the $13/2^+$ state. Population of the g.s. was too weak to permit absolute energy determination. Experimental uncertainty is about 15 keV, noted in the text.

[‡] From Adopted Levels.

[#] From $(^3\text{He},d)/(d,t)$ cross-section ratio systematics and comparison with DWBA calculations.

$^{170}\text{Er}(^{238}\text{U}, ^{238}\text{U}'\text{n}\gamma)$ 2004Wu05

No significant changes compared to that in the previous evaluation (2008Ba31) by C.M. Baglin.

$E(^{238}\text{U})=1358$ MeV; GAMMASPHERE detector array (100 Compton-suppressed Ge detectors, no heavy-metal shield for BGO components), CHICO highly-segmented parallel-plate avalanche counter array; measured scattering angles and tof difference for both recoiling reaction products, $E\gamma$, $I\gamma$, recoil- γ - γ coin, $\gamma\gamma\gamma$ coin.

 ^{169}Er Levels

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}$	Comments
0.0 [#]	1/2 ⁻		
64.551 [@] 20	3/2 ⁻		E(level): from Adopted Levels.
74.58 [#] 6	5/2 ⁻		E(level): from Adopted Levels.
224.6 [@] 10	7/2 ⁻		
241.6 [#] 10	9/2 ⁻		
243.66 ^{&} 16	7/2 ⁺	200 ns 10	E(level), $T_{1/2}$: from Adopted Levels.
317.3 ^a 5	9/2 ⁺		E(level): from Adopted Levels.
413.1 ^{&} 5	11/2 ⁺		
475.6 [@] 14	11/2 ⁻		
500.6 [#] 14	13/2 ⁻		
526.3 ^a 10	13/2 ⁺		
664.1 ^{&} 11	15/2 ⁺		
813.6 [@] 17	15/2 ⁻		
816.3 ^a 14	17/2 ⁺		
847.6 [#] 17	17/2 ⁻		
999.1 ^{&} 15	19/2 ⁺		
1186.3 ^a 17	21/2 ⁺		
1237.6 [@] 20	19/2 ⁻		
1279.6 [#] 20	21/2 ⁻		
1419.1 ^{&} 18	23/2 ⁺		
1632.3 ^a 20	25/2 ⁺		
1741.6 [@] 23	23/2 ⁻		
1792.6 [#] 23	25/2 ⁻		
1919.1 ^{&} 21	27/2 ⁺		
2149.3 ^a 23	29/2 ⁺		
2324.6 [@] 25	27/2 ⁻		
2382.6 [#] 25	29/2 ⁻		
2980 [@] 3	31/2 ⁻		
3045 [#] 3	33/2 ⁻		
3702 [@] 3	35/2 ⁻		
3773 [#] 3	37/2 ⁻		
4549 [#] 3	41/2 ⁻		

[†] From least-squares fit to $E\gamma$, 1 keV uncertainty to all $E\gamma$ data assigned in 2004Wu05, except as noted.

[‡] Authors' values; based on band structure known from the literature and extended in this study on the basis of $E\gamma$, $I\gamma$ and $\gamma\gamma$ coin.

[#] Band(A): ν 1/2[521], $\alpha=+1/2$.

[@] Band(a): ν 1/2[521], $\alpha=-1/2$.

[&] Band(b): ν 7/2[633], $\alpha=-1/2$.

^a Band(B): ν 7/2[633], $\alpha=+1/2$.

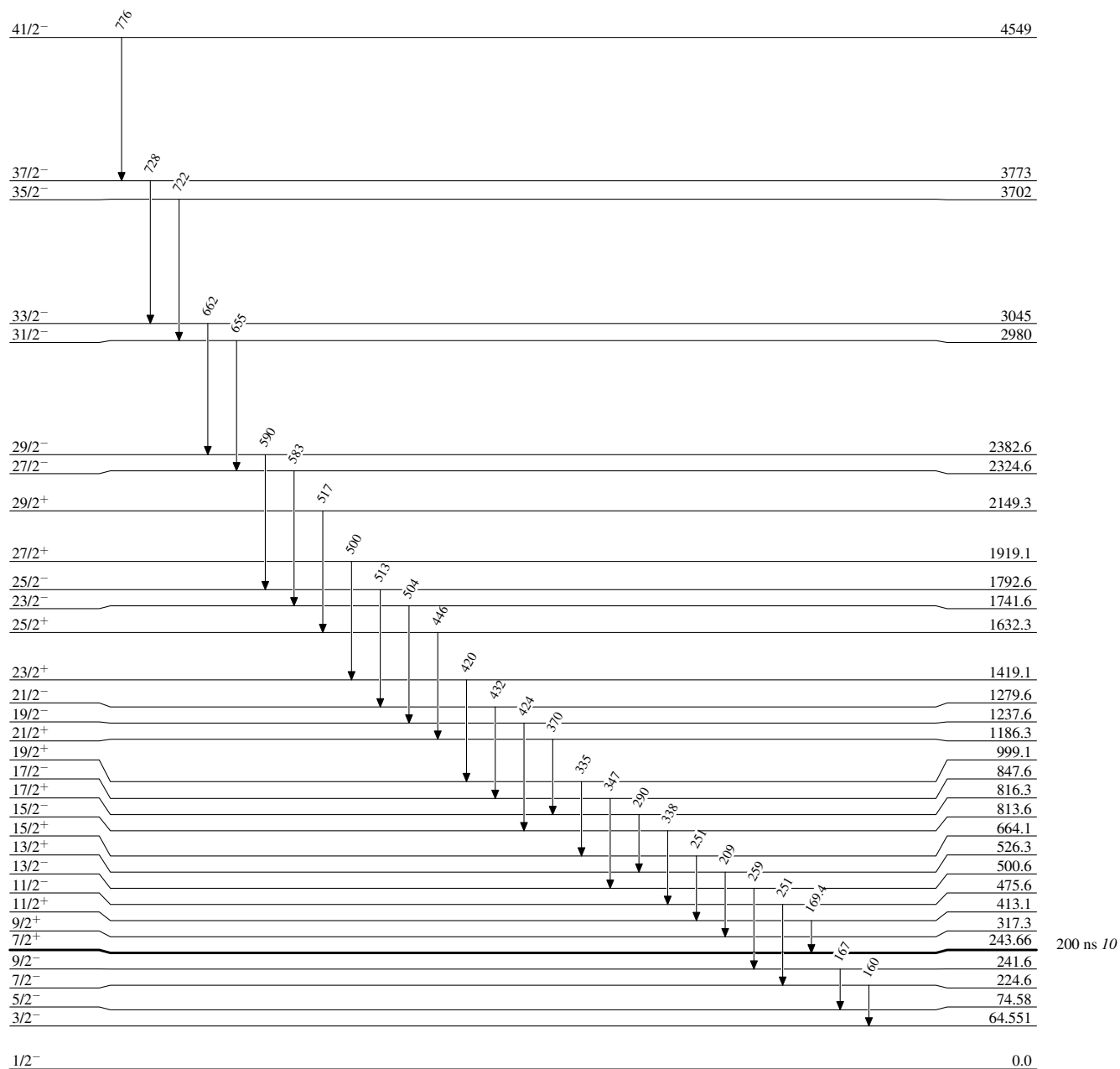
$^{170}\text{Er}(^{238}\text{U}, ^{238}\text{U}'\text{n}\gamma)$ **2004Wu05 (continued)** $\gamma(^{169}\text{Er})$

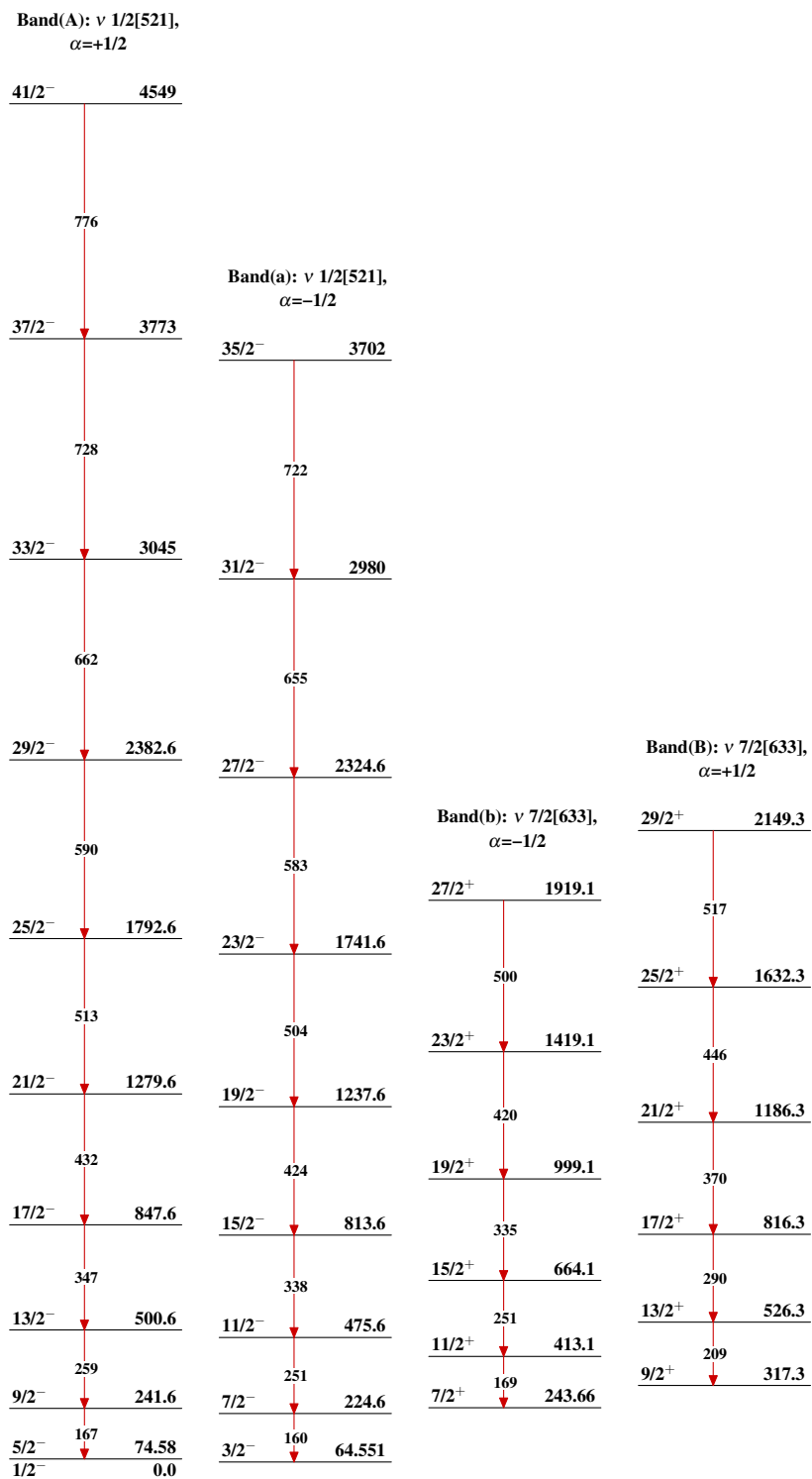
$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π
160	224.6	7/2 ⁻	64.551	3/2 ⁻	432	1279.6	21/2 ⁻	847.6	17/2 ⁻
167	241.6	9/2 ⁻	74.58	5/2 ⁻	446	1632.3	25/2 ⁺	1186.3	21/2 ⁺
169.4 [‡]	413.1	11/2 ⁺	243.66	7/2 ⁺	500	1919.1	27/2 ⁺	1419.1	23/2 ⁺
209	526.3	13/2 ⁺	317.3	9/2 ⁺	504	1741.6	23/2 ⁻	1237.6	19/2 ⁻
251	475.6	11/2 ⁻	224.6	7/2 ⁻	513	1792.6	25/2 ⁻	1279.6	21/2 ⁻
251	664.1	15/2 ⁺	413.1	11/2 ⁺	517	2149.3	29/2 ⁺	1632.3	25/2 ⁺
259	500.6	13/2 ⁻	241.6	9/2 ⁻	583	2324.6	27/2 ⁻	1741.6	23/2 ⁻
290	816.3	17/2 ⁺	526.3	13/2 ⁺	590	2382.6	29/2 ⁻	1792.6	25/2 ⁻
335	999.1	19/2 ⁺	664.1	15/2 ⁺	655	2980	31/2 ⁻	2324.6	27/2 ⁻
338	813.6	15/2 ⁻	475.6	11/2 ⁻	662	3045	33/2 ⁻	2382.6	29/2 ⁻
347	847.6	17/2 ⁻	500.6	13/2 ⁻	722	3702	35/2 ⁻	2980	31/2 ⁻
370	1186.3	21/2 ⁺	816.3	17/2 ⁺	728	3773	37/2 ⁻	3045	33/2 ⁻
420	1419.1	23/2 ⁺	999.1	19/2 ⁺	776	4549	41/2 ⁻	3773	37/2 ⁻
424	1237.6	19/2 ⁻	813.6	15/2 ⁻					

[†] Uncertainty ≈ 1 keV (2004Wu05).[‡] Unstated; value from authors' level energy difference.

$^{170}\text{Er}(^{238}\text{U}, ^{238}\text{U}'\text{n}\gamma)$ 2004Wu05

Level Scheme

 $^{169}_{68}\text{Er}_{101}$

$^{170}\text{Er}(^{238}\text{U}, ^{238}\text{U}'\text{n}\gamma)$ 2004Wu05

Adopted Levels, Gammas

$Q(\beta^-) = -899.1$ 8; $S(n) = 8033.6$ 15; $S(p) = 5574.4$ 8; $Q(\alpha) = 1198.4$ 10 2021Wa16

$S(2n) = 14874.2$ 10, $S(2p) = 13573$ 5 (2021Wa16).

For hfs and/or isotope-shift data see, e.g., 1985Pf01, 1986Al32, 1986Pf03, 1987Mi31, 1988Al04, 1993Ji03, 1995Kr23, 1997Kr16.

For muonic isomer shift data, see 1974Ba77.

For discussion of anapole moment of ¹⁶⁹Tm, see 1999KaZU.

Muonic atom: 1970Ba74, 1974Ba77, 1974En08.

¹⁶⁹Tm Levels

Cross Reference (XREF) Flags

A	¹⁶⁹ Er β^- decay (9.39 d)	E	¹⁶⁹ Tm(γ, γ): Mossbauer effect	I	¹⁶⁹ Tm(³ He, ³ He')
B	¹⁶⁹ Yb ε decay (32.016 d)	F	¹⁶⁹ Tm(γ, γ')	J	¹⁶⁹ Tm(³² S, ³² S' γ)
C	¹⁶⁸ Er(p, p) IAR	G	¹⁶⁹ Tm(e, e' p) IAR	K	Coulomb excitation
D	¹⁶⁸ Er(³ He, d), (α , t)	H	¹⁶⁹ Tm(n, n' γ), (pol n, n)	L	¹⁷⁰ Er(p, 2n γ), (d, 3n γ)

E(level) [†]	J ^π	T _{1/2}	XREF	Comments
0.0 ^{&}	1/2 ⁺	stable	AB DEF H JKL	$\mu = -0.2310$ 15 No α decay observed ($T_{1/2}(\alpha) > 5 \times 10^{16}$ y if $1.5 \leq E(\alpha) \leq 3.7$, 1956Po16). μ : atomic beam (direct) (1967Gi04, 2019StZV). Other: (-0.234 ± 0.003) (1965Be34). $\langle r^2 \rangle^{1/2}(\text{charge}) = 5.226$ fm 4 (2013An02). J^π : $J = 1/2$ from EPR, optical spectroscopy (1976Fu06); parity from configuration ($\pi 1/2[411]$) based on decoupling parameter of -0.78 . $\mu = +0.513$ 5; $Q = -1.2$ 1 $\langle r^2 \rangle^{1/2}(\text{charge}) = 0.019$ fm 10 (from $r^2 = (0.36 \text{ fm}^2 \pm 0.12) \times 10^{-3}$) (1967Sc42). μ : Mossbauer (1980Da27, 2020StZV). Other: 0.73 ± 0.16 (1963No01). Q : Mossbauer (1964Co08, 2021StZZ); value includes polarization correction. Other: -1.1 ± 0.1 (1963Hu08). E(level): from ¹⁶⁹ Yb ε decay. J^π : M1+E2 8.4γ to $1/2^+$ g.s.. $T_{1/2}$: weighted average of $4.04 \text{ ns} \pm 0.06$ ($\beta\text{ce}(t)$ in ¹⁶⁹ Er β^- decay, 1972TuZV), $4.22 \text{ ns} \pm 0.11$ (1987AbZY; $\text{cey}(t)$), $4.10 \text{ ns} \pm 0.21$ (1974Fu01), $4.13 \text{ ns} \pm 0.12$ (1966Mc08 – earlier data $4.36 \text{ ns} \pm 0.17$ in 1963Mc13) in ¹⁶⁹ Yb ε decay, and $3.7 \text{ ns} \pm 0.5$ (1958Be79). Uncertainty is the lowest of the input value. Others (from ¹⁶⁹ Er β^- decay and/or ¹⁶⁹ Yb ε decay) (outliers): $3.24 \text{ ns} \pm 0.17$ (1961B113), $6.6 \text{ ns} \pm 0.10$ (1961Ha44), $3.53 \text{ ns} \pm 0.20$ (1963B114), $3.45 \text{ ns} \pm 0.25$ (1963Su06), $5.1 \text{ ns} \pm 0.3$ (1966Be51, 1967Be68), $7 \text{ ns} \pm 2$ (1961Sc21), and $4.96 \text{ ns} \pm 0.10$ (1978AlZX).
118.18945 ^{&} 4	5/2 ⁺ [#]	62.4 ps 28	AB D F H JKL	$\mu = +0.74$ 5 μ : IPAC (1969Gu01, 2020StZV). g factor = 0.20 ± 0.06 (1960Ma38). $T_{1/2}$: from microwave-pulsed beam measurements in Coulomb excitation (1960B110 – $\tau = (9.0 \times 10^{-11} \text{ s} \pm 4)$ – earlier value $T_{1/2} = 62 \text{ ps} \pm 10$ in 1959B115). Other: $63 \text{ ps} \pm 7$ (1966Mc08).
138.93316 ^a 5	7/2 ⁺ [#]	302 ps 9	B D H JKL	$\mu = +1.32$ 7 μ : IPAC (1969Gu01, 2020StZV). $T_{1/2}$: $302 \text{ ps} \pm 2$ from recoil-shadow measurements in Coulomb excitation (1979BaYN); uncertainty includes only statistical component – total uncertainty is most certainly larger. The evaluator considers 3% systematic uncertainty. Others (from ¹⁶⁹ Yb ε decay): $290 \text{ ps} \pm 70$ (1959B115), $321 \text{ ps} \pm 14$ (1964Su06), $289 \text{ ps} \pm 24$ (1966Mc08), and an expected value of 370 ps (1960Be28).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Tm Levels (continued)

E(level) [†]	J ^π	T _{1/2}	XREF	Comments
316.14633 ^b 5	7/2 ⁺	660 ns 3	B D H J L	Weighted average of 302 ps 9 with other data yields 306 ps 7. μ=+0.156 8 μ: DPAC (from 1972Ni03 and g=0.044 2. Not available in 2020StZV). Other: g=0.045 5 (1969NiZW). J ^π : M1+E2 177γ to 7/2 ⁺ ; E2 308γ to 3/2 ⁺ ; J=7/2 uniquely consistent with γγ(θ) data in ¹⁶⁹ Yb ε decay (32.016 d). T _{1/2} : weighted average of 665 ns 5 (1974En09), 658 ns 3 (1950Fu63), 660 ns 5 (1994De01) (γγ(t) in ¹⁶⁹ Yb ε decay (32.016 d)). Other: 640 ns 14 (1972Mo23).
332.111 ^{&} 11	9/2 ⁺ #	18.8 ps 5	B H JKL	μ=1.56 9 (1999Ro03,2020StZV) μ: From J=9/2 and g-factor=+0.347 20 (1999Ro03) in Coulomb excitation. T _{1/2} : from recoil-distance measurements in Coulomb excitation (1977Ta10).
341.94 ^c 4	(1/2 ⁻)		D H L	J ^π : band assignment; γ to 1/2 ⁺ and to 3/2 ⁺ .
345.028 ^c 3	5/2 ⁻		B D H L	J ^π : E1 206γ to 7/2 ⁺ ; E1(+M2) 337γ to 3/2 ⁺ .
367.66 ^a 5	11/2 ⁺ #	41.6 ps 21	B H JKL	μ=2.28 14 (1999Ro03,2020StZV) μ: From J=11/2 and g-factor=+0.414 26 (1999Ro03) in Coulomb excitation. T _{1/2} : from recoil-distance measurements in Coulomb excitation (1977Ta10).
379.26679 ^e 6	7/2 ⁻	50.5 ns 16	B J L	μ=+3.04 14 (1997De02,2020StZV) μ: g-factor=+0.87 4 from DPAC. Other: 0.96 8 (1989Ra17, from 1967NiZZ, differential delay reversed field method). J ^π : E1 63γ to 7/2 ⁺ , E1+M2 261 γ to 5/2 ⁺ ; 7/2 ⁻ 7/2[523] and 9/2 ⁻ 7/2[523] assignments to 379.3 and 472.9 levels lead to excellent energy fits for band up to J=21/2. T _{1/2} : unweighted average of 49.8 ns 15 (1974Bo30), 54.1 ns 5 (1974En09), 51.6 ns 3 (1974Vi05), and 46.4 ns 15 (1997De02), all from γγ(t) in ¹⁶⁹ Yb ε decay (32.016 d).
430.122 ^c 11	(9/2 ⁻)		B D H J L	J ^π : E1 291γ to 7/2 ⁺ ; band assignment.
433.513 ^b 18	(9/2 ⁺)		B L	J ^π : M1 473γ to 7/2 ⁺ ; band assignment.
472.88128 ^f 10	9/2 ⁻	0.14 ns 7	B J L	J ^π : M1+E2 94γ to 7/2 ⁻ and E1 105γ to 11/2 ⁺ . See also comment with 379.3 level. T _{1/2} : from Auger electron-ce(t) in ¹⁶⁹ Yb ε decay (32.016 d) (1960Be28). Others: <3 ns (1958Ha31), <50 ns (1958Na06).
474.968 ^d 9	(3/2 ⁻)		B D H L	J ^π : L=1 in ¹⁶⁸ Er(³ He,d); 357γ to 5/2 ⁺ .
570.834 ^g 11	3/2 ⁺	10 ps 6	B D H KL	J ^π : M1+E2 453γ to 5/2 ⁺ , M1+E2 571γ to 1/2 ⁺ g.s.. (³ He,d)/(α,t) cross-section ratio consistent with 3/2 ⁺ 3/2[411] assignment. T _{1/2} : deduced from B(E2) in Coulomb excitation and adopted Eγ, transition branching.
575.38 ^b 4	(11/2 ⁺)		L	J ^π : γs to (9/2 ⁺) and to 7/2 ⁺ ; band assignment.
588.20 ^e 5	11/2 ⁻		D J L	J ^π : D+Q 115γ to 9/2 ⁻ and 209γ to 7/2 ⁻ ; band assignment.
603.19 ^c 8	(13/2 ⁻)		J L	J ^π : D(+Q) 235γ to 11/2 ⁺ ; intraband 173γ to (9/2 ⁻); band assignment.
633.292 ^g 3	5/2 ⁺	0.27 ps +33-12	B D H KL	J ^π : M1 494γ to 7/2 ⁺ ; M1 625γ to 3/2 ⁺ . (³ He,d)/(α,t) cross-section ratio consistent with 5/2 ⁺ 3/2[411] assignment. T _{1/2} : from B(E2)↑=0.0039 27 in Coulomb excitation and adopted γ properties (Eγ, transition branching).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Tm Levels (continued)

E(level) [†]	J ^π	T _{1/2}	XREF	Comments
637.01 ^{& 7}	13/2 ⁺ ^{‡#}	5.4 ps 3	JKL	$\mu=2.37$ 14 (1999Ro03,2020StZV) μ : From J=13/2 and g-factor=+0.365 22 (1999Ro03) in Coulomb excitation. T _{1/2} : from recoil-distance measurements in Coulomb excitation (1977Ta10).
646.758 ^{d 10}	(7/2 ⁻)	8.1 ps 3	B D H L	J ^π : γ 's to (3/2) ⁻ and 9/2 ⁺ ; 7/2 ⁻ consistent with band assignment.
690.97 ^{a 9}	15/2 ⁺ [#]		JKL	$\mu=3.2$ 3 (1999Ro03,2020StZV) μ : from J=15/2 and g-factor=+0.42 4 (1999Ro03) in Coulomb excitation. T _{1/2} : from recoil-distance measurements in Coulomb excitation (1977Ta10).
718.786 ^{g 4}	(7/2 ⁺)	1.91 ps 17	B H KL	J ^π : γ 's to 3/2 ⁺ and 9/2 ⁺ ; 7/2 ⁺ consistent with band assignment.
725.46 ^{f 7}	13/2 ⁻		J L	J ^π : D+Q 137 γ to 11/2 ⁻ and 252.5 γ to 9/2 ⁻ ; band assignment.
741.23 ^{b 5}	(13/2 ⁺)		L	J ^π : γ s to (11/2 ⁺) and to (9/2 ⁺); band assignment.
781.796 ^{h 5}	(5/2 ⁺)		B D H L	XREF: D(785) J ^π : L(³ He,d)=2; 781.6 γ to 1/2 ⁺ g.s.; band assignment.
832.39 ^{g 7}	(9/2 ⁺)		B H L	J ^π : γ s to 11/2 ⁺ , to 9/2 ⁺ , and to 7/2 ⁺ ; band assignment.
865.74 ^{c 16}	(17/2 ⁻)		J L	J ^π : γ s to (13/2 ⁻) and to 15/2 ⁺ ; band assignment.
878.35 ^{h 10}	(7/2 ⁺)		B H	J ^π : γ s to 3/2 ⁺ and to 5/2 ⁺ ; band assignment.
883.59 ^{e 17}	15/2 ⁻		J L	J ^π : γ s to 13/2 ⁻ and to 11/2 ⁻ ; band assignment.
884.62 ^{d 20}	(11/2 ⁻)		D L	J ^π : γ s to (9/2) ⁻ and to (13/2) ⁻ ; band assignment.
≈900?			K	
929.60 ^{b 15}	(15/2 ⁺)	1.94 ps 21	L	J ^π : γ s to (13/2 ⁺) and to (13/2 ⁺); band assignment.
938 2			D	
964.0 ^{g 4}	(11/2 ⁺)		L	J ^π : γ s to 11/2 ⁺ and to 9/2 ⁺ ; band assignment.
1027.66 ^{& 10}	17/2 ⁺ ^{‡#}		JKL	$\mu=3.2$ 3 (1999Ro03,2020StZV) μ : From J=17/2 and g-factor=+0.37 4 (1999Ro03) from Coulomb excitation. T _{1/2} : from Doppler-broadened line shape measurements in Coulomb excitation (1977Ta10).
1039.95 15			L	J ^π : 565.2 γ to (3/2) ⁻ , 694.7 γ to 5/2 ⁻ .
1058.54 21		1.94 ps 21	L	J ^π : 716.6 γ to (1/2 ⁻).
1063.45 ^{f 21}	17/2 ⁻		J L	J ^π : γ s to 15/2 ⁻ and to 13/2 ⁻ ; band assignment.
1103.73 ^{a 13}	19/2 ⁺ [#]		JKL	$\mu=4.2$ 8 (1999Ro03,2020StZV) μ : From J=19/2 and g-factor=+0.44 8 (1999Ro03) in Coulomb excitation. T _{1/2} : from Doppler-broadened line shape measurements in Coulomb excitation (1977Ta10).
1112.6? 5			L	J ^π : 682.5 γ to (9/2) ⁻ .
1135.93 20		1.94 ps 21	L	J ^π : 790.9 γ to 5/2 ⁻ .
1140.56 ^{b 15}	(17/2 ⁺)		L	J ^π : γ s to (15/2 ⁺) and to (13/2 ⁺); band assignment.
1152 ^{i 2}	(11/2 ⁻)		D	J ^π : level energy, large spectroscopic factors in ¹⁶⁸ Er(³ He,d), (α ,t), and (³ He,d)/(α ,t) cross-section ratio fit regional systematics for 11/2 ⁻ 9/2[514] state.
1189.09 ^{d 22}	(15/2 ⁻)		L	J ^π : γ s to 13/2 ⁺ and to (13/2 ⁻); band assignment.
1190 20	⁺	1.94 ps 21	K	B(E2) $\uparrow$ =0.040 9 J ^π : E2 excitation in Coulomb excitation. B(E2) $\uparrow$ from Coulomb excitation.
1218.01 ^{c 20}	(21/2 ⁻)		J L	J ^π : γ to (17/2 ⁻); band assignment.
1223.04 15			L	J ^π : 877.9 γ to 5/2 ⁻ , 881.2 γ to (1/2 ⁻).
1243 2			D	
1261.83 ^{e 23}	19/2 ⁻		J L	J ^π : γ s to 17/2 ⁻ and to 15/2 ⁻ ; band assignment.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Tm Levels (continued)

E(level) [†]	J ^π	T _{1/2}	XREF	Comments
1300.6 ^g 5	(15/2 ⁺)		L	J ^π : γ to 15/2 ⁺ ; band assignment.
1372 2	1/2 ⁺		D	J ^π : L=0 in $^{168}\text{Er}(^3\text{He},\text{d})$.
1372.3 ^b 6	(19/2 ⁺)		L	J ^π : γ to (15/2 ⁺); band assignment.
1400 2			D	
1482.7 ^f 3	21/2 ⁻		J L	J ^π : γs to 19/2 ⁻ and to 17/2 ⁻ ; band assignment.
1497.96 ^{&} 24	21/2 ⁺ ‡#	0.87 ps 9	JKL	T _{1/2} : from Doppler-broadened line shape measurements in Coulomb excitation (1977Ta10).
1510.6 [@] 10	(1/2,3/2) ⁺ @		F	B(M1,E1)↑(W.u.)=0.078 18.
1515 2			D	
1527.5 [@] 10	(1/2,3/2) ⁺ @		F	B(M1,E1)↑(W.u.)=0.050 17.
1548.4 ^d 7	(19/2 ⁻)		L	J ^π : γ to (17/2 ⁻); band assignment.
1598.12 ^a 21	(23/2 ⁺)		JKL	J ^π : 23/2 ⁺ consistent with coincidence data in Coulomb excitation and structure of g.s. band.
1625.0 ^b 6	(21/2 ⁺)		L	J ^π : γ to (17/2 ⁺); band assignment.
1658.0 ^c 3	(25/2 ⁻)		J L	J ^π : γ to (21/2 ⁻); band assignment.
1706.5 ^e 4	23/2 ⁻		J L	E(level): other: 1716.9 in (p,2nγ),(d,3nγ) due to a 233γ placement. Adopted Eγ=223.8γ. J ^π : γs to 21/2 ⁻ and to 19/2 ⁻ ; band assignment.
1864.6 [@] 7	(1/2,3/2) ⁺ @		F	
1910.5 [@] 6	(1/2,3/2) ⁺ @		F	
1922.3 [@] 7	(1/2,3/2) ⁺ @		F	
1957.4 ^{&} 4	(25/2 ⁺)		J	J ^π : γs to (23/2 ⁺) and to 21/2 ⁺ ; band assignment.
1963.7 [@] 10	(1/2,3/2) [@]		F	
1978.4 [@] 10	(1/2,3/2) [@]		F	
1991.7 [@] 7	(1/2,3/2) ⁺ @		F	
2024.8 ^c 4	(29/2 ⁻)		J	J ^π : γ to (25/2 ⁻); band assignment.
2035.0 ^a 3	(27/2 ⁺)		J	J ^π : γ to (23/2 ⁺); band assignment.
2075.5 [@] 7	(1/2,3/2) ⁺ @		F	
2168.7 [@] 7	(1/2,3/2) ⁺ @		F	
2190.6 [@] 10	(1/2,3/2) [@]		F	
2215.3 [@] 10	(1/2,3/2) [@]		F	
2236.1 [@] 7	(1/2,3/2) ⁺ @		F	
2262.5 [@] 7	(1/2,3/2) ⁺ @		F	
2293.8 [@] 10	(1/2,3/2) [@]		F	
2306.3 [@] 10	(1/2,3/2) [@]		F	
2312.2 [@] 7	(1/2,3/2) ⁺ @		F	
2386.6 [@] 10	(1/2,3/2) [@]		F	
2421.6 ^{&} 4	(29/2 ⁺)		J	J ^π : γ to 25/2 ⁺ ; band assignment.
2455.8 [@] 7	(1/2,3/2) [@]		F	
2466.0 [@] 10	(1/2,3/2) [@]		F	
2466.4 ^a 4	(31/2 ⁺)		J	J ^π : γ to 27/2 ⁺ ; band assignment.
2492.0 [@] 7	(1/2,3/2) ⁺ @		F	
2553.4 [@] 7	(1/2,3/2) [@]		F	
2571.4 [@] 10	(1/2,3/2) [@]		F	
2598.6 [@] 10	(1/2,3/2) ⁺ @		F	
2602.8 [@] 10	(1/2,3/2) [@]		F	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Tm Levels (continued)

E(level) [†]	J ^π	XREF
2687.0 @ 10	(1/2,3/2) @	F
2749.4 @ 7	(1/2,3/2) ⁺ @	F
2756.4 @ 10	(1/2,3/2) @	F
2769.1 @ 7	(1/2,3/2) ⁺ @	F
2786.5 @ 10	(1/2,3/2) @	F
2814.2 @ 7	(1/2,3/2) @	F
2818.6 @ 10	(1/2,3/2) @	F
2843.1 @ 10	(1/2,3/2) @	F
2861.1 @ 10	(1/2,3/2) ⁺ @	F
2943.3 @ 6	(1/2,3/2) ⁺ @	F
2996.2 @ 7	(1/2,3/2) ⁺ @	F
3127.6 @ 10	(1/2,3/2) @	F
3175.6 @ 10	(1/2,3/2) @	F
3185.0 @ 10	(1/2,3/2) @	F
3187.5 @ 10	(1/2,3/2) @	F
3191.3 @ 7	(1/2,3/2) ⁺ @	F
3199.7 @ 10	(1/2,3/2) ⁺ @	F
3204.8 @ 7	(1/2,3/2) ⁺ @	F
3254.6 @ 7	(1/2,3/2) @	F
3274.5 @ 10	(1/2,3/2) ⁺ @	F
3286.5 @ 10	(1/2,3/2) ⁺ @	F
3299.6 @ 7	(1/2,3/2) ⁺ @	F
3308.4 @ 10	(1/2,3/2) @	F
3341.2 @ 7	(1/2,3/2) ⁺ @	F
3376.4 @ 7	(1/2,3/2) ⁺ @	F
3383.9 @ 10	(1/2,3/2) @	F
3419.2 @ 10	(1/2,3/2) @	F
3436.3 @ 7	(1/2,3/2) @	F
3442.0 @ 10	(1/2,3/2) @	F
3458.6 @ 10	(1/2,3/2) @	F
3475.7 @ 7	(1/2,3/2) ⁺ @	F
3480.3 @ 10	(1/2,3/2) @	F
3497.0 @ 10	(1/2,3/2) @	F
3527.0 @ 7	(1/2,3/2) @	F
3538.7 @ 10	(1/2,3/2) @	F
3541.9 @ 7	(1/2,3/2) ⁺ @	F
3573.3 @ 10	(1/2,3/2) @	F
3613.0 @ 10	(1/2,3/2) @	F
3624.8 @ 6	(1/2,3/2) ⁺ @	F
3724.7 @ 7	(1/2,3/2) ⁺ @	F
3736.2 @ 10	(1/2,3/2) @	F
3741.7 @ 10	(1/2,3/2) @	F

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Adopted Levels, Gammas (continued) ^{169}Tm Levels (continued)

E(level) [†]	J^π	XREF	Comments
3766.3 @ 10	(1/2,3/2) @	F	
3795.8 @ 7	(1/2,3/2) @	F	
3806.7 @ 10	(1/2,3/2) @	F	
3862.5 @ 10	(1/2,3/2) @	F	
3875.3 @ 10	(1/2,3/2) @	F	
3916.8 @ 10	(1/2,3/2) @	F	
3950.2 @ 10	(1/2,3/2) @	F	
4103.6 @ 10	(1/2,3/2) @	F	
4190.2 @ 7	(1/2,3/2) @	F	
4279.7 @ 10	(1/2,3/2) @	F	
4764.5 @ 10	(1/2,3/2) @	F	
4789.8 @ 10	(1/2,3/2) @	F	
4853.0 @ 10	(1/2,3/2) @	F	
4865.5 @ 7	(1/2,3/2) @	F	
4954.0 @ 10	(1/2,3/2) @	F	
5211.5 @ 10	(1/2,3/2)+ @	F	
5507.1 @ 10	(1/2,3/2) @	F	
5529.9 @ 10	(1/2,3/2)+ @	F	
5593.3 @ 7	(1/2,3/2) @	F	
5598.3 @ 10	(1/2,3/2) @	F	
1.20×10^4 5		I	$\Gamma = 6.2 \times 10^3$ keV, $d\sigma/d\Omega(25^\circ) = 2.5$ mb/sr 10 (1975Ho05) from ($^3\text{He}, ^3\text{He}'$).
1.47×10^4 3		I	E(level): GMR; %EWSR=51 12, $\Gamma = 2.5 \times 10^3$ keV 3 (1980Bu16) from ($^3\text{He}, ^3\text{He}'$).
1.576×10^4 13		G	
16104	$1/2^-$	C	J^π : Analog of $1/2^-$ ^{169}Er (g.s.). Other E: 15760 130 in (e,e'p).
1.634×10^4 14	$(1/2)^-$	G	J^π : Analog of $(1/2)^-$ ^{169}Er (562 level).

[†] From least-squares fit to the adopted E_γ , except where noted. 8.41017 keV level energy was held fixed.

[‡] Based on coincidence data, rotational structure, and γ -ray angular distributions in $^{170}\text{Er}(p,2n\gamma)$, ($d,3n\gamma$), except where noted.

Definite J^π is assigned to members of bands defined by a cascade of transitions having regularly changing energies provided the J^π of at least one member and the multipolarity of at least one intraband transition have been independently determined.

Definite J^π for g.s. band established from intraband M1+E2 and E2 transitions.

@ From $^{169}\text{Tm}(\gamma, \gamma')$. D excitation from $1/2^+$ is assumed by 1999Hu01 in (γ, γ') so $J=(1/2,3/2)$ is assigned; further, $\pi=+$ is assigned whenever B(E1)(W.u.) significantly exceeds RUL.

& Band(A): $1/2[411]$, $\alpha=+1/2$. Band parameters: $A=12.5$, $B=-4.8$, $a=-0.78$ ($1/2$, $3/2$, $5/2$, $7/2$, $9/2$ levels).

^a Band(a): $1/2[411]$, $\alpha=-1/2$.

^b Band(B): $7/2[404]$. Band parameters: $A=13.3$, $B=-6.7$ ($7/2$, $9/2$, $11/2$, $13/2$ levels).

^c Band(C): $1/2[541]$, $\alpha=+1/2$. Band parameters: $A=9.1$, $B=+0.8$, $a=+3.8$ ($J=1/2$ through $21/2$ levels); however, parameters vary significantly depending on which levels are included in the fit.

^d Band(c): $1/2[541]$, $\alpha=-1/2$. See comment on signature partner band.

^e Band(D): $7/2[523]$, $\alpha=-1/2$. Band parameters: $A=10.3$, $B=3.7$ ($7/2$, $9/2$, $11/2$, $13/2$ levels).

^f Band(d): $7/2[523]$, $\alpha=+1/2$.

^g Band(E): $3/2[411] + 1/2[411]$ γ vibration. Band parameters: $A=12.6$, $B=-11.9$ ($3/2$, $5/2$, $7/2$, $9/2$ levels). Configuration includes contribution from K-2 γ vibration built on $1/2[411]$ orbital.

^h Band(F): $5/2[402]$. Band parameter: $A=13.8$ ($5/2$, $7/2$ levels).

ⁱ Band(G): $9/2[514]$.

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Tm})$									Comments
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [†]	$\delta^\dagger$	α^c	
8.41017	3/2 ⁺	8.41017 15	100	0.0	1/2 ⁺	M1+E2	0.0323 10	260 7	B(M1)(W.u.)=0.0346 11; B(E2)(W.u.)=237 16 E _γ : from level energy differences. Mult.,δ: from subshell ratios in β [−] decay. Other δ: 0.037 +7−8 from α(exp) in (γ,γ): Mossbauer effect.
118.18945	5/2 ⁺	109.77924 ^{&} 4	100.0 4	8.41017	3/2 ⁺	M1+E2	−0.153 11	2.368 33	B(M1)(W.u.)=0.0714 +35−32; B(E2)(W.u.)=64 10 δ: unweighted average of −0.116 4 and −0.146 16 in Coulomb excitation; −0.145 14, 0.143 5, −0.160 16, 0.149 3 and −0.21 6 in ε decay. Discrepant dataset. Without the outliers 0.116 4, 0.0160 16, and 0.21 6 as of Chauvent's criterion, the dataset becomes consistent and the weighted average is 0.147 3. Note that '−' sign was not used to take the unweighted and weighted averages.
		118.18940 ^{&} 14	10.78 4	0.0	1/2 ⁺	E2		1.642 23	B(E2)(W.u.)=209 10 I _γ : from ε decay. However, I _γ =10.21 5 (1999Ro03) in Coulomb excitation is not consistent with this. Other I(118γ)/I(110γ): 11 2 (1967Se09) and 11.0 10 (1977Ta10) in Coulomb excitation; 11 3 in β [−] decay.
138.93316	7/2 ⁺	20.7439 3	1.73 2	118.18945	5/2 ⁺	M1+E2	0.0280 15	54.7 8	B(M1)(W.u.)=0.0455 14; B(E2)(W.u.)=38.4 43 Other I _γ : 1.68 13 in Coulomb excitation.
		130.52293 ^{&} 6	100.0 3	8.41017	3/2 ⁺	E2		1.143 16	B(E2)(W.u.)=287 9
316.14633	7/2 ⁺	177.21307 ^{&} 6	62.01 21	138.93316	7/2 ⁺	M1+E2	−0.30 13	0.594 18	B(M1)(W.u.)=1.25×10 ^{−6} +7−10; B(E2)(W.u.)=0.0017 +15−11
		197.95675 ^{&} 7	100	118.18945	5/2 ⁺	M1+E2	−0.326 6	0.433 6	B(M1)(W.u.)=1.430×10 ^{−6} 11; B(E2)(W.u.)=1.80×10 ^{−3} 6
		307.73586 ^{&} 10	27.96 9	8.41017	3/2 ⁺	E2		0.0662 9	B(E2)(W.u.)=5.755×10 ^{−4} 40
332.111	9/2 ⁺	193.11 4	100.0 [@]	138.93316	7/2 ⁺	M1+E2 [@]	−0.126 [@] 21	0.479 7	B(M1)(W.u.)=0.0791 23; B(E2)(W.u.)=16 +6−5 E _γ : weighted average of 193.15 5 from ¹⁶⁹ Yb ε decay, 193.2 6 from (n,n'γ), 192.9 1 from (³² S, ³² S'γ), 193.12 5 from (p,2nγ), and 193.0 3 from Coulomb excitation.
		213.935 17	45.1 13	118.18945	5/2 ⁺	E2		0.2080 29	δ: unweighted average of −0.146 3 (1999Ro03), −0.105 11 (1977Ta10) in Coulomb excitation. B(E2)(W.u.)=270 9 I _γ : weighted average of 38.6 29 from ¹⁶⁹ Yb ε

Adopted Levels, Gammas (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	$\gamma(^{169}\text{Tm})$ (continued)				α^c	Comments
				E_f	J_f^π	Mult. [†]	$\delta^\ddagger$		
									decay, 43.8 from (p,2n γ), and 45.6.8 from Coulomb excitation. Other: 41.55.8 from ($^{32}\text{S}, ^{32}\text{S}'\gamma$). Mult.: from Coulomb excitation.
341.94	(1/2 ⁻)	333.53 [#] 5	100 [#] 50	8.41017	3/2 ⁺				
		341.95 [#] 5	55 [#] 28	0.0	1/2 ⁺				
345.028	5/2 ⁻	206.04 4	36 9	138.93316	7/2 ⁺	E1		0.0497 7	E_γ : weighted average of 205.99.6 from ^{169}Yb ε decay, 205.7.6 from (n,n' γ), and 206.07.5 from (p,2n γ).
		226.79 [#] 5	2.6 [#] 13	118.18945	5/2 ⁺				
		336.618 3	100 3	8.41017	3/2 ⁺	E1(+M2)	≤ 0.66	0.07 6	
367.66	11/2 ⁺	228.71 [#] 5	100	138.93316	7/2 ⁺	E2 [@]		0.1673 23	B(E2)(W.u.)=336.17 Mult.: from $\gamma(\theta)$ and RUL in Coulomb excitation.
379.26679	7/2 ⁻	63.12044 ^{&} 4	100.0 4	316.14633	7/2 ⁺	E1		1.098 15	B(E1)(W.u.)=8.14 $\times 10^{-6}$ +28-26
		240.331 3	0.261 14	138.93316	7/2 ⁺	E1(+M2)	$< +0.12$	0.042 9	B(E1)(W.u.)=3.84 $\times 10^{-10}$ 40
		261.07712 ^{&} 9	3.850 16	118.18945	5/2 ⁺	E1+M2	-0.07 3	0.032 5	B(E1)(W.u.)=4.41 $\times 10^{-9}$ 15; B(M2)(W.u.)=0.0015 +15-10
		370.854 8	0.00202 21	8.41017	3/2 ⁺	[M2]		0.300 4	B(M2)(W.u.)=2.70 $\times 10^{-5}$ 29
		379.284 18	0.00068 26	0.0	1/2 ⁺	[E3]		0.1270 18	B(E3)(W.u.)=0.040 16
430.122	(9/2 ⁻)	84.9 ^{#d} 5	20 [#] 11	345.028	5/2 ⁻				Other I_γ : <67 in ε decay.
		291.188 [#] 11	100 [#] 9	138.93316	7/2 ⁺	E1		0.02068 29	
433.513	(9/2 ⁺)	101.41 ^d	<18	332.111	9/2 ⁺				E_γ from level scheme and I_γ limit from ε decay. Possibly this is the unplaced E_γ =101.0.5 γ seen in (p,2n γ); if so, I_γ =18.9.
		117.369 19	100 6	316.14633	7/2 ⁺	[M1,E2]		1.82 14	E_γ : weighted average of 117.376.19 from ^{169}Yb ε decay and 117.32.5 from (p,2n γ).
		294.54 11	2.4 6	138.93316	7/2 ⁺	M1		0.1522 21	
472.88128	9/2 ⁻	93.61447 ^{&} 8	100.0 6	379.26679	7/2 ⁻	M1+E2	+0.183 3	3.75 5	B(M1)(W.u.)=0.036 +32-12; B(E2)(W.u.)=6 $\times 10^1$ +6-2
		105.19 10	0.10 3	367.66	11/2 ⁺	E1		0.292 4	B(E1)(W.u.)=2.6 $\times 10^{-7}$ +25-11
		141.7 ^b 2	41 ^b 14	332.111	9/2 ⁺	[E1]		0.1326 19	B(E1)(W.u.)=5.7 $\times 10^{-5}$ 30
		156.724 11	0.383 10	316.14633	7/2 ⁺	E1		0.1016 14	B(E1)(W.u.)=3.0 $\times 10^{-7}$ +27-10
		333.963 13	0.0675 24	138.93316	7/2 ⁺	[E1]		0.01480 21	B(E1)(W.u.)=5.5 $\times 10^{-9}$ +49-19
474.968	(3/2 ⁻)	356.74 5	72 3	118.18945	5/2 ⁺				I_γ : other: 17.2.34 ($^{32}\text{S}, ^{32}\text{S}'$).
		466.2 2	10.0 11	8.41017	3/2 ⁺				E_γ : from (p,2n γ).
		474.970 9	100.0 22	0.0	1/2 ⁺				

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Tm})$ (continued)									Comments
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [†]	$\delta^\ddagger$	α^c	
570.834	3/2 ⁺	452.64 7	15 5	118.18945	5/2 ⁺	M1+E2 @	1.5 @ +9-4	0.030 4	B(M1)(W.u.)=0.0005 +6-3; B(E2)(W.u.)=2.6 +28-13 E _γ : weighted average of 452.62 8 from ¹⁶⁹ Yb ε decay, 452.2 6 from (n,n'γ), 452.7 2 from (p,2nγ), and 452.8 3 from Coulomb excitation.
		562.410 12	100.0 21	8.41017	3/2 ⁺	M1+E2 @	0.8 @ +5-4	0.022 4	B(M1)(W.u.)=0.0035 +39-18; B(E2)(W.u.)=3.3 +41-23
		570.890 27	94 6	0.0	1/2 ⁺	M1+E2 @	0.8 @ +5-4	0.021 4	B(M1)(W.u.)=0.0032 +36-16; B(E2)(W.u.)=2.9 +35-20
575.38	(11/2 ⁺)	141.85 [#] 5	100 [#] 10	433.513	(9/2) ⁺				
		259.23 [#] 5	96 [#] 48	316.14633	7/2 ⁺				
588.20	11/2 ⁻	115.32 [#] 5	100 ^b 3	472.88128	9/2 ⁻	(M1+E2)		1.93 13	Mult.: D+Q from (p,2nγ), Δπ=no from level scheme. I _γ : unweighted average of 21.4 21 from (³² S, ³² S'γ) and 10 5 from (p,2nγ).
		209.0 ^b 2	16 6	379.26679	7/2 ⁻				I _γ : other: 58.5 10 (³² S, ³² S').
603.19	(13/2 ⁻)	173.1 ^b 1	16 [#] 8	430.122	(9/2) ⁻				I _γ : other: 100.0 1 (³² S, ³² S').
		235.1 ^b 2	100 [#] 10	367.66	11/2 ⁺	(E1(+M2))		0.048 13	Mult.: D(+Q) from (p,2nγ), Δπ=yes from level scheme.
633.292	5/2 ⁺	494.357 8	29.9 5	138.93316	7/2 ⁺	M1		0.0389 5	B(M1)(W.u.)=0.09 +8-5
		515.101 6	84.7 12	118.18945	5/2 ⁺	M1		0.0350 5	B(M1)(W.u.)=0.23 +19-12
		624.881 4	100.0 29	8.41017	3/2 ⁺	M1		0.02140 30	B(M1)(W.u.)=0.15 +13-8
		633.32 10	0.140 9	0.0	1/2 ⁺	[E2]		0.00959 13	B(E2)(W.u.)=0.24 +20-12
637.01	13/2 ⁺	269.4 ^b 1	98.4 24	367.66	11/2 ⁺	M1+E2	-0.149 26	0.1916 28	B(M1)(W.u.)=0.090 6; B(E2)(W.u.)=12.7 +48-41 I _γ : weighted average of 99.6 12 (1999Ro03) and 93.7 24 (1977Ta10) in Coulomb excitation. Other I _γ : 100 10 in (p,2nγ); 79 8 (1967Se09) in Coulomb excitation; 100.00 16 in (³² S, ³² S').
		304.9 ^b 1	100 4	332.111	9/2 ⁺	E2		0.0680 10	Mult.: from Coulomb excitation. δ: unweighted average of -0.174 3 (1999Ro03), -0.123 14 (1977Ta10) in Coulomb excitation.
									B(E2)(W.u.)=320 +21-18
646.758	(7/2 ⁻)	171.6 [#] 5	10 [#] 5	474.968	(3/2) ⁻				I _γ , Mult.: from Coulomb excitation. Other: 83.5 2 (³² S, ³² S').
		216.4 [#] 2	5.0 [#]	430.122	(9/2) ⁻				
		301.6 [#] 2	5.6 [#]	345.028	5/2 ⁻				
		314.6 [#] 2	22 [#]	332.111	9/2 ⁺				
		507.8 3	1.2 7	138.93316	7/2 ⁺				I _γ : other: 41 20 (p,2nγ), (d,3nγ).

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Tm})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [†]	α^c	Comments
646.758	(7/2 ⁻)	528.569 10	100.0 [#] 24	118.18945	5/2 ⁺			
690.97	15/2 ⁺	87.7 ^b 1	11.20 ^b 12	603.19	(13/2 ⁻)	(E1) ^b	0.471 7	B(E1)(W.u.)=0.00371 14
		323.4 2	100.00 24	367.66	11/2 ⁺	E2	0.0571 8	Mult.: D in (³² S, ³² S' γ), (E1) from level scheme. B(E2)(W.u.)=291 11
								E_γ : other: 322.9 1 from (³² S, ³² S' γ) – underestimated uncertainty. I_γ : from (³² S, ³² S'). Mult.: from Coulomb Excitation.
718.786	(7/2 ⁺)	72.028 ^d	<186	646.758	(7/2 ⁻)			E_γ from level scheme and I_γ limit from ε decay. Possibly this is the unplaced E=72.0 5 γ seen in (p,2n γ); if so, $I_\gamma \approx 23$.
		386.671 13	17.4 4	332.111	9/2 ⁺	[M1,E2]	0.054 20	
		579.851 5	100.0 15	138.93316	7/2 ⁺	(M1)	0.0259 4	
		600.603 8	59.1 9	118.18945	5/2 ⁺	(M1)	0.02366 33	
		710.354 15	1.77 9	8.41017	3/2 ⁺			
725.46	13/2 ⁻	137.26 [#] 5	100 ^b 3	588.20	11/2 ⁻	(M1+E2)	1.11 15	Mult.: D+Q from (p,2n γ), $\Delta\pi$ =no from level scheme.
		252.5 [#] 2	23 6	472.88128	9/2 ⁻			I_γ : unweighted average of 17.7 10 from (³² S, ³² S' γ) and 29.0 30 from (p,2n γ).
741.23	(13/2 ⁺)	165.8 [#] 2	100 [#] 9	575.38	(11/2 ⁺)			
		307.74 [#] 5	<57 [#]	433.513	(9/2 ⁺)			E_γ : for multiplet in (p,2n γ).
781.796	(5/2 ⁺)	210.94 [#] 5	53 [#]	570.834	3/2 ⁺			
		465.65 6	91.2 10	316.14633	7/2 ⁺			E_γ : from (n,n' γ).
		642.873 9	36.5 9	138.93316	7/2 ⁺			
		663.599 7	92.3 26	118.18945	5/2 ⁺			
		773.386 14	100.0 15	8.41017	3/2 ⁺			
		781.64 8	1.44 12	0.0	1/2 ⁺			
832.39	(9/2 ⁺)	464.7	41 24	367.66	11/2 ⁺			
		500.27 11	100 9	332.111	9/2 ⁺			E_γ : weighted average of 500.35 10 from ¹⁶⁹ Yb ε decay, 499.9 6 from (n,n' γ), and 500.0 2 from (p,2n γ).
		693.46 8	98 5	138.93316	7/2 ⁺			
865.74	(17/2 ⁻)	174.7 2	28 13	690.97	15/2 ⁺	(E1)	0.0764 11	E_γ : weighted average of 174.6 2 from (³² S, ³² S' γ) and 175.0 5 from (p,2n γ).
								I_γ : unweighted average of 15.0 8 from (³² S, ³² S' γ) and 41 22 from (p,2n γ).
								Mult.: E1 in (³² S, ³² S' γ).
878.35	(7/2 ⁺)	262.7 [#] 5	100 ^b 3	603.19	(13/2 ⁻)	(E2)	0.1076 16	Mult.: E2 in (³² S, ³² S' γ).
		546.16 22	80 22	332.111	9/2 ⁺			
		739.42 11	100 12	138.93316	7/2 ⁺			
		760.24 24	45 12	118.18945	5/2 ⁺			

Adopted Levels, Gammas (continued)

<u>$\gamma(^{169}\text{Tm})$ (continued)</u>									
<u>$E_i(\text{level})$</u>	<u>J_i^π</u>	<u>$E_\gamma^\dagger$</u>	<u>$I_\gamma^\ddagger$</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.[†]</u>	<u>$\delta^\ddagger$</u>	<u>α^c</u>	<u>Comments</u>
883.59	15/2 ⁻	158.1 3	100 ^b 6	725.46	13/2 ⁻	(M1(+E2))		0.71 13	E _γ : weighted average of 157.8 2 from (³² S, ³² S'γ) and 158.3 2 from (p,2nγ). Mult.: D(+Q) from (p,2nγ), Δπ=no from level scheme. I _γ : weighted average of 66.7 30 from (³² S, ³² S'γ) and 71 7 from (p,2nγ).
		295.4 [#] 2	67 [#] 3	588.20	11/2 ⁻				
884.62	(11/2 ⁻)	281.7 ^{#d} 2		603.19	(13/2 ⁻)				
		454.5 [#] 2	100 10	430.122	(9/2 ⁻)				
		552.0 ^{#d} 2	<198	332.111	9/2 ⁺				
≈900?		≈900 ^{@d}	100	0.0	1/2 ⁺				
929.60	(15/2 ⁺)	188.7 [#] 5	37 [#] 21	741.23	(13/2 ⁺)				
		353.9 [#] 2	100 [#] 10	575.38	(11/2 ⁺)				
964.0	(11/2 ⁺)	595.9 [#] 5	100 [#]	367.66	11/2 ⁺				
		632.3 [#] 5	72 [#] 38	332.111	9/2 ⁺				
1027.66	17/2 ⁺	336.64 8	58.6 9	690.97	15/2 ⁺	M1+E2 [@]	-0.18 [@] 3	0.1047 16	B(M1)(W.u.)=0.102 +11-9; B(E2)(W.u.)=13.5 +49-42 E _γ : weighted average of 336.8 1 from (³² S, ³² S'γ) and 336.60 5 from (p,2nγ). I _γ : from 1999Ro03 in Coulomb excitation. Other I _γ : 52 5 (1977Ta10) in Coulomb excitation; 336 in (p,2nγ); 114 (1974Ba66) in (d,3nγ). δ: weighted average of -0.199 20 (1999Ro03), -0.127 35 (1977Ta10) in Coulomb excitation.
		390.7 ^b 1	100 5	637.01	13/2 ⁺	E2		0.0331 5	B(E2)(W.u.)=349 +35-30 I _γ , Mult.: from Coulomb excitation. Other I _γ : 100.0 3 (³² S, ³² S').
1039.95		565.2 [#] 2		474.968	(3/2 ⁻)				
		694.7 [#] 2		345.028	5/2 ⁻				
1058.54		716.6 [#] 2	100	341.94	(1/2 ⁻)				
1063.45	17/2 ⁻	179.6 [#] 2	90 [#] 9	883.59	15/2 ⁻				I _γ : other: 100 10 (³² S, ³² S').
		338.0 4	100 10	725.46	13/2 ⁻				E _γ : unweighted average of 337.6 2 from (³² S, ³² S'γ) and 338.3 2 from (p,2nγ). I _γ : from (p,2nγ), (d,3nγ). Other: 50 5 (³² S, ³² S').
1103.73	19/2 ⁺	237.9 ^b 2	2.0 ^b 4	865.74	(17/2 ⁻)	[E1] ^b		0.0344 5	B(E1)(W.u.)=1.62×10 ⁻⁴ +38-35
		412.8 [#] 1	100.0 ^{@b} 4	690.97	15/2 ⁺	E2 [@]		0.0285 4	B(E2)(W.u.)=4.2×10 ² +5-4 E _γ : weighted average of 412.7 1 from (³² S, ³² S'γ) and 413.0 2 from (p,2nγ).

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Tm})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [†]	α^c	Comments
1112.6?		682.5 ^{#d} 5	100	430.122	(9/2) ⁻			
1135.93		790.9 [#] 2	100	345.028	5/2 ⁻			
1140.56	(17/2 ⁺)	210.94 [#] 5	<39 [#]	929.60	(15/2 ⁺)			
		399.6 [#] 2	100 [#] 10	741.23	(13/2 ⁺)			
1189.09	(15/2 ⁻)	552.0 ^{#d} 2	<189 [#]	637.01	13/2 ⁺			
		585.9 [#] 2	100 [#] 10	603.19	(13/2 ⁻)			
1190	⁺	1190 [@] 20	100	0.0	1/2 ⁺			
1218.01	(21/2 ⁻)	352.3 2	100	865.74	(17/2 ⁻)			E_γ : weighted average of 352.4 2 from (³² S, ³² S' γ) and 352.2 2 from (p,2n γ).
1223.04		877.9 [#] 2		345.028	5/2 ⁻			
		881.2 [#] 2		341.94	(1/2 ⁻)			
1261.83	19/2 ⁻	197.7 3	100.0 ^b 12	1063.45	17/2 ⁻			E_γ : weighted average of 197.6 2 from (³² S, ³² S' γ) and 198.3 5 from (p,2n γ).
		378.5 2	2.9 ^b 6	883.59	15/2 ⁻			E_γ : weighted average of 378.3 2 from (³² S, ³² S' γ) and 378.7 2 from (p,2n γ).
1300.6	(15/2 ⁺)	609.6 [#] 5	100	690.97	15/2 ⁺			
1372.3	(19/2 ⁺)	442.7 [#] 5	100	929.60	(15/2 ⁺)			
1482.7	21/2 ⁻	220.8 3	100 10	1261.83	19/2 ⁻			E_γ : unweighted average of 221.1 2 from (³² S, ³² S' γ) and 220.5 2 from (p,2n γ).
		419.3 2	65 [#] 12	1063.45	17/2 ⁻			E_γ : weighted average of 419.2 2 from (³² S, ³² S' γ) and 419.4 2 from (p,2n γ).
								I_γ : unweighted average of 53 7 from (³² S, ³² S' γ) and 77 8 from (p,2n γ).
1497.96	21/2 ⁺	280.1 ^b 2	2.3 ^b 5	1218.01	(21/2 ⁻)			
		394.0 [#] 5	51.4 ^b 5	1103.73	19/2 ⁺	M1+E2 ^b	0.051 19	E_γ : other: 393.7 1 (³² S, ³² S') – underestimated uncertainty. I_γ : others: 50 26 from (p,2n γ). B(M1)(W.u.)=0.134 +15-13 if M1, B(E2)(W.u.)=403 +48-39 if E2.
		469.6 [#] 5	100.0 ^b 9	1027.66	17/2 ⁺	E2 [@]	0.02015 29	B(E2)(W.u.)=324 +38-31 E_γ : other: 469.9 1 (³² S, ³² S').
1510.6	(1/2,3/2) ⁺	1510.6 ^a	100 ^a	0.0	1/2 ⁺			
1527.5	(1/2,3/2) ⁺	1527.5 ^a	100 ^a	0.0	1/2 ⁺			
1548.4?	(19/2 ⁻)	682.5 ^{#d} 5	100	865.74	(17/2 ⁻)			
1598.12	(23/2 ⁺)	380.0 ^b 2	67 ^b 17	1218.01	(21/2 ⁻)			
		494.5 ^{b#} 2	100 ^b 17	1103.73	19/2 ⁺			

Adopted Levels, Gammas (continued)

<u>$\gamma(^{169}\text{Tm})$ (continued)</u>						Comments
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	
1625.0	(21/2 ⁺)	484.4 [#] 5	100	1140.56	(17/2 ⁺)	E _γ : from (³² S, ³² S'), assuming the 223.8γ depopulating the same 23/2 ⁻ state in 1974Ba66 , where a 233γ (in Fig. 2 (1974Ba66) (p,2nΓ),(d,3nγ)).
1658.0	(25/2 ⁻)	440.0 [#] 2	100	1218.01	(21/2 ⁻)	
1706.5	23/2 ⁻	223.8 2	100 25	1482.7	21/2 ⁻	
		445 ^d		1261.83	19/2 ⁻	E _γ : from (³² S, ³² S'). other: 454.5 2 multiple placement in (p,2nΓ),(d,3nγ). See the comments for 223.8γ from 23/2 ⁻ state.
1864.6	(1/2,3/2) ⁺	1856.2 ^a	100 ^a 26	8.41017	3/2 ⁺	
		1864.6 ^a	47 ^a	0.0	1/2 ⁺	
1910.5	(1/2,3/2) ⁺	1792.3 ^a	100 ^a 10	118.18945	5/2 ⁺	
		1902.1 ^a	46 ^a 5	8.41017	3/2 ⁺	
		1910.5 ^a	98 ^a	0.0	1/2 ⁺	
1922.3	(1/2,3/2) ⁺	1804.1 ^a	100 ^a 46	118.18945	5/2 ⁺	
		1922.3 ^a	79 ^a	0.0	1/2 ⁺	
1957.4	(25/2 ⁺)	359.0 ^{bd}		1598.12	(23/2 ⁺)	
		459.4 ^b 2	100 ^b 3	1497.96	21/2 ⁺	
1963.7	(1/2,3/2)	1963.7 ^a	100 ^a	0.0	1/2 ⁺	
1978.4	(1/2,3/2)	1978.4 ^a	100 ^a	0.0	1/2 ⁺	
1991.7	(1/2,3/2) ⁺	1983.3 ^a	79 ^a 36	8.41017	3/2 ⁺	
		1991.7 ^a	100 ^a	0.0	1/2 ⁺	
2024.8	(29/2 ⁻)	366.8 ^b 2	100	1658.0	(25/2 ⁻)	
2035.0	(27/2 ⁺)	436.9 ^b 2	100	1598.12	(23/2 ⁺)	
2075.5	(1/2,3/2) ⁺	2067.1 ^a	100 ^a 74	8.41017	3/2 ⁺	
		2075.5 ^a	89 ^a	0.0	1/2 ⁺	
2168.7	(1/2,3/2) ⁺	2160.3 ^a	100 ^a 38	8.41017	3/2 ⁺	
		2168.7 ^a	72 ^a	0.0	1/2 ⁺	
2190.6	(1/2,3/2)	2190.6 ^a	100 ^a	0.0	1/2 ⁺	
2215.3	(1/2,3/2)	2215.3 ^a	100 ^a	0.0	1/2 ⁺	
2236.1	(1/2,3/2) ⁺	2117.9 ^a	56 ^a 16	118.18945	5/2 ⁺	
		2236.1 ^a	100 ^a	0.0	1/2 ⁺	
2262.5	(1/2,3/2) ⁺	2144.3 ^a	100 ^a 31	118.18945	5/2 ⁺	
		2262.5 ^a	72 ^a	0.0	1/2 ⁺	
2293.8	(1/2,3/2)	2293.8 ^a	100 ^a	0.0	1/2 ⁺	
2306.3	(1/2,3/2)	2306.3 ^a	100 ^a	0.0	1/2 ⁺	
2312.2	(1/2,3/2) ⁺	2194.0 ^a	100 ^a 37	118.18945	5/2 ⁺	
		2312.2 ^a	92 ^a	0.0	1/2 ⁺	
2386.6	(1/2,3/2)	2386.6 ^a	100 ^a	0.0	1/2 ⁺	
2421.6	(29/2 ⁺)	464.2 ^b 2	100	1957.4	(25/2 ⁺)	

Adopted Levels, Gammas (continued)

 $\gamma(^{169}\text{Tm})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π
2455.8	(1/2,3/2)	2447.4 ^a	43 ^a 27	8.41017	3/2 ⁺	3254.6	(1/2,3/2)	3254.6 ^a	69 ^a	0.0	1/2 ⁺
		2455.8 ^a	100 ^a	0.0	1/2 ⁺	3274.5	(1/2,3/2) ⁺	3274.5 ^a	100 ^a	0.0	1/2 ⁺
2466.0	(1/2,3/2)	2466.0 ^a	100 ^a	0.0	1/2 ⁺	3286.5	(1/2,3/2) ⁺	3286.5 ^a	100 ^a	0.0	1/2 ⁺
2466.4	(31/2 ⁺)	431.4 ^b 2	100	2035.0	(27/2 ⁺)	3299.6	(1/2,3/2) ⁺	3291.2 ^a	100 ^a 75	8.41017	3/2 ⁺
2492.0	(1/2,3/2) ⁺	2373.8 ^a	47 ^a 13	118.18945	5/2 ⁺			3299.6 ^a	96 ^a	0.0	1/2 ⁺
		2492.0 ^a	100 ^a	0.0	1/2 ⁺	3308.4	(1/2,3/2)	3308.4 ^a	100 ^a	0.0	1/2 ⁺
2553.4	(1/2,3/2)	2435.2 ^a	100 ^a 43	118.18945	5/2 ⁺	3341.2	(1/2,3/2) ⁺	3332.8 ^a	47 ^a 18	8.41017	3/2 ⁺
		2553.4 ^a	64 ^a	0.0	1/2 ⁺			3341.2 ^a	100 ^a	0.0	1/2 ⁺
2571.4	(1/2,3/2)	2571.4 ^a	100 ^a	0.0	1/2 ⁺	3376.4	(1/2,3/2) ⁺	3368.0	100 33	8.41017	3/2 ⁺
2598.6	(1/2,3/2) ⁺	2598.6 ^a	100 ^a	0.0	1/2 ⁺			3376.4 ^a	96 ^a	0.0	1/2 ⁺
2602.8	(1/2,3/2)	2602.8 ^a	100 ^a	0.0	1/2 ⁺	3383.9	(1/2,3/2)	3383.9 ^a	100 ^a	0.0	1/2 ⁺
2687.0	(1/2,3/2)	2687.0 ^a	100 ^a	0.0	1/2 ⁺	3419.2	(1/2,3/2)	3419.2 ^a	100 ^a	0.0	1/2 ⁺
2749.4	(1/2,3/2) ⁺	2741.0 ^a	96 ^a 41	8.41017	3/2 ⁺	3436.3	(1/2,3/2)	3318.1 ^a	67 ^a 43	118.18945	5/2 ⁺
		2749.4 ^a	100 ^a	0.0	1/2 ⁺			3436.3 ^a	100 ^a	0.0	1/2 ⁺
2756.4	(1/2,3/2)	2756.4 ^a	100 ^a	0.0	1/2 ⁺	3442.0	(1/2,3/2)	3442.0 ^a	100 ^a	0.0	1/2 ⁺
2769.1	(1/2,3/2) ⁺	2760.7 ^a	41 ^a 11	8.41017	3/2 ⁺	3458.6	(1/2,3/2)	3458.6 ^a	100 ^a	0.0	1/2 ⁺
		2769.1 ^a	100 ^a	0.0	1/2 ⁺	3475.7	(1/2,3/2) ⁺	3467.3 ^a	100 ^a 41	8.41017	3/2 ⁺
2786.5	(1/2,3/2)	2786.5 ^a	100 ^a	0.0	1/2 ⁺			3475.7 ^a	47 ^a	0.0	1/2 ⁺
2814.2	(1/2,3/2)	2805.8 ^a	89 ^a 79	8.41017	3/2 ⁺	3480.3	(1/2,3/2)	3480.3 ^a	100 ^a	0.0	1/2 ⁺
		2814.2 ^a	100 ^a	0.0	1/2 ⁺	3497.0	(1/2,3/2)	3497.0 ^a	100 ^a	0.0	1/2 ⁺
2818.6	(1/2,3/2)	2818.6 ^a	100 ^a	0.0	1/2 ⁺	3527.0	(1/2,3/2)	3518.6 ^a	100 ^a 72	8.41017	3/2 ⁺
2843.1	(1/2,3/2)	2843.1 ^a	100 ^a	0.0	1/2 ⁺			3527.0 ^a	72 ^a	0.0	1/2 ⁺
2861.1	(1/2,3/2) ⁺	2861.1 ^a	100 ^a	0.0	1/2 ⁺	3538.7	(1/2,3/2)	3538.7 ^a	100 ^a	0.0	1/2 ⁺
2943.3	(1/2,3/2) ⁺	2825.1 ^a	63 ^a 56	118.18945	5/2 ⁺	3541.9	(1/2,3/2) ⁺	3423.7 ^a	100 ^a 42	118.18945	5/2 ⁺
		2934.9 ^a	100 ^a 70	8.41017	3/2 ⁺			3541.9 ^a	100 ^a	0.0	1/2 ⁺
		2943.3 ^a	70 ^a	0.0	1/2 ⁺	3573.3	(1/2,3/2)	3573.3 ^a	100 ^a	0.0	1/2 ⁺
2996.2	(1/2,3/2) ⁺	2878.0 ^a	100 ^a 26	118.18945	5/2 ⁺	3613.0	(1/2,3/2)	3613.0 ^a	100 ^a	0.0	1/2 ⁺
		2996.2 ^a	89 ^a	0.0	1/2 ⁺	3624.8	(1/2,3/2) ⁺	3506.6 ^a	100 ^a 26	118.18945	5/2 ⁺
3127.6	(1/2,3/2)	3127.6 ^a	100 ^a	0.0	1/2 ⁺			3616.4 ^a	86 ^a 23	8.41017	3/2 ⁺
3175.6	(1/2,3/2)	3175.6 ^a	100 ^a	0.0	1/2 ⁺			3624.8 ^a	100 ^a	0.0	1/2 ⁺
3185.0	(1/2,3/2)	3185.0 ^a	100 ^a	0.0	1/2 ⁺	3724.7	(1/2,3/2) ⁺	3606.5 ^a	100 ^a 26	118.18945	5/2 ⁺
3187.5	(1/2,3/2)	3187.5 ^a	100 ^a	0.0	1/2 ⁺			3724.7 ^a	100 ^a	0.0	1/2 ⁺
3191.3	(1/2,3/2) ⁺	3182.9 ^a	82 ^a 33	8.41017	3/2 ⁺	3736.2	(1/2,3/2)	3736.2 ^a	100 ^a	0.0	1/2 ⁺
		3191.3 ^a	100 ^a	0.0	1/2 ⁺	3741.7	(1/2,3/2)	3741.7 ^a	100 ^a	0.0	1/2 ⁺
3199.7	(1/2,3/2) ⁺	3199.7 ^a	100 ^a	0.0	1/2 ⁺	3766.3	(1/2,3/2)	3766.3 ^a	100 ^a	0.0	1/2 ⁺
3204.8	(1/2,3/2) ⁺	3086.6 ^a	56 ^a 19	118.18945	5/2 ⁺	3795.8	(1/2,3/2)	3787.3 ^a	1.0×10 ² ^a 13	8.41017	3/2 ⁺
		3204.8 ^a	100 ^a	0.0	1/2 ⁺			3795.7 ^a	61 ^a	0.0	1/2 ⁺
3254.6	(1/2,3/2)	3246.2 ^a	100 ^a 53	8.41017	3/2 ⁺	3806.7	(1/2,3/2)	3806.7 ^a	100 ^a	0.0	1/2 ⁺

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Tm})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π
3862.5	(1/2,3/2)	3862.5 ^a	100 ^a	0.0	1/2 ⁺	4853.0	(1/2,3/2)	4852.9 ^a	100 ^a	0.0	1/2 ⁺
3875.3	(1/2,3/2)	3875.3 ^a	100 ^a	0.0	1/2 ⁺	4865.5	(1/2,3/2)	4857.0 ^a	1.0×10 ^{2a} 11	8.41017	3/2 ⁺
3916.8	(1/2,3/2)	3916.8 ^a	100 ^a	0.0	1/2 ⁺			4865.4 ^a	69 ^a	0.0	1/2 ⁺
3950.2	(1/2,3/2)	3950.2 ^a	100 ^a	0.0	1/2 ⁺	4954.0	(1/2,3/2)	4953.9 ^a	100 ^a	0.0	1/2 ⁺
4103.6	(1/2,3/2)	4103.5 ^a	100 ^a	0.0	1/2 ⁺	5211.5	(1/2,3/2) ⁺	5211.4 ^a	100 ^a	0.0	1/2 ⁺
4190.2	(1/2,3/2)	4181.7 ^a	1.0×10 ^{2a} 10	8.41017	3/2 ⁺	5507.1	(1/2,3/2)	5507 ^a	100 ^a	0.0	1/2 ⁺
		4190.1 ^a	56 ^a	0.0	1/2 ⁺	5529.9	(1/2,3/2) ⁺	5529.8 ^a	100 ^a	0.0	1/2 ⁺
4279.7	(1/2,3/2)	4279.6 ^a	100 ^a	0.0	1/2 ⁺	5593.3	(1/2,3/2)	5584.8 ^a	69 ^a 81	8.41017	3/2 ⁺
4764.5	(1/2,3/2)	4764.4 ^a	100 ^a	0.0	1/2 ⁺			5593.2 ^a	100 ^a	0.0	1/2 ⁺
4789.8	(1/2,3/2)	4789.7 ^a	100 ^a	0.0	1/2 ⁺	5598.3	(1/2,3/2)	5598.2 ^a	100 ^a	0.0	1/2 ⁺

[†] From ¹⁶⁹Yb ε decay (32.016 d), except where noted.

[‡] Relative photon branching from each level; values are from ¹⁶⁹Yb ε decay (32.016 d), except where noted; upper limits are given for photon branching ratios affected by multiple placement or by presence of contaminant. In (³²S, ³²S'), data are too precise, see the comments in the dataset. In general these I_γ were not considered in weighted average.

From ¹⁷⁰Er(p,2n γ), (d,3n γ).

@ From Coulomb excitation.

& From the evaluation by 2000He14 (with energy scale based on $E_\gamma=411.80205$ keV 17 for the “Gold standard” (2⁺ to g.s. transition in ¹⁹⁸Hg)). ΔE quoted here includes the 0.3 ppm uncertainty arising from the energy-wavelength conversion. See ¹⁶⁹Yb ε decay (32.016 d) for uncertainties that do not have that systematic uncertainty included.

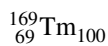
^a From ¹⁶⁹Tm(γ, γ').

^b From (³²S, ³²S').

^c Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with “Frozen Orbitals” approximation based on γ -ray energies, assigned multiplicities, and mixing ratios, unless otherwise specified.

^d Placement of transition in the level scheme is uncertain.

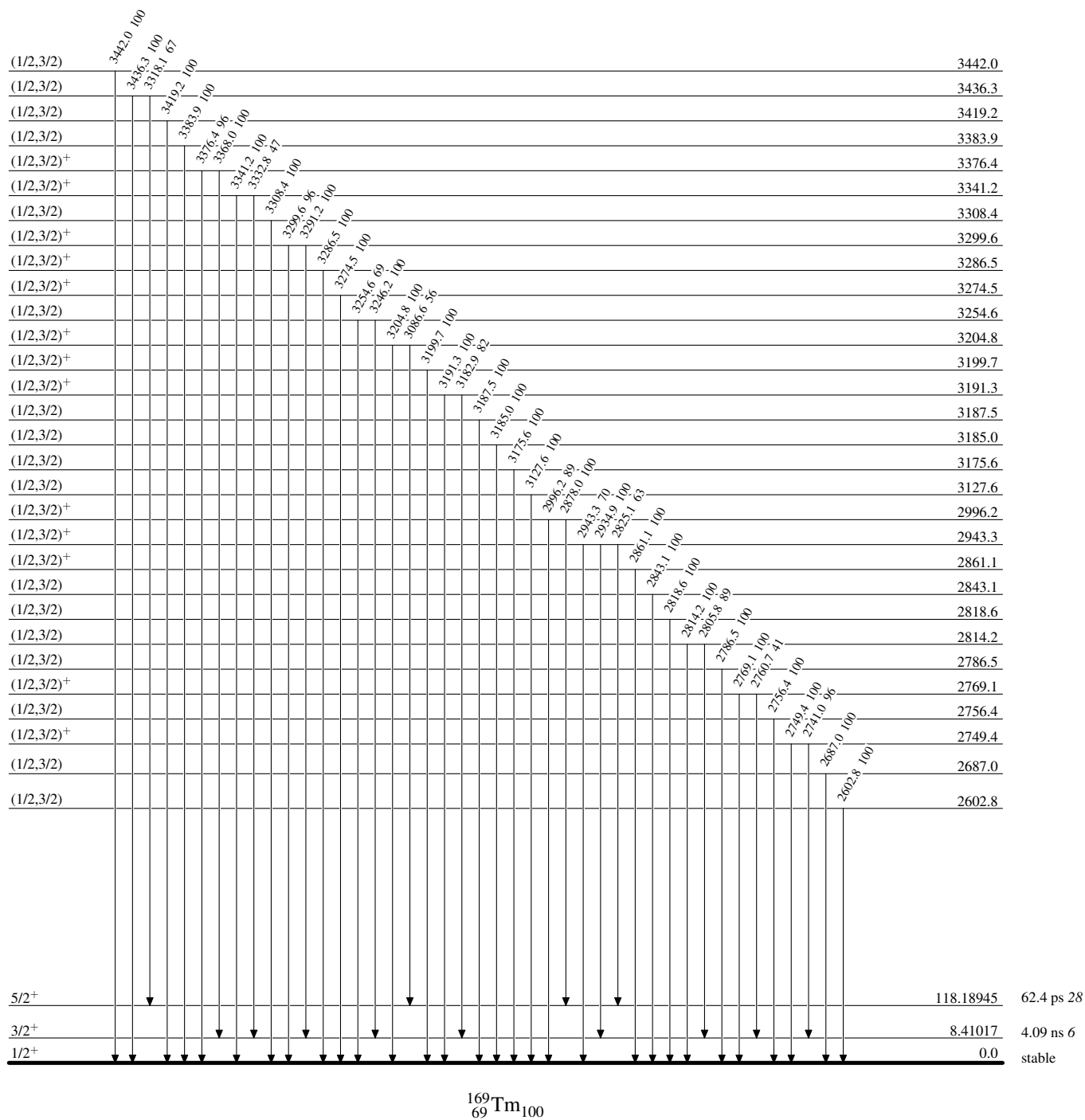
Intensities: Relative photon branching from each level



Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

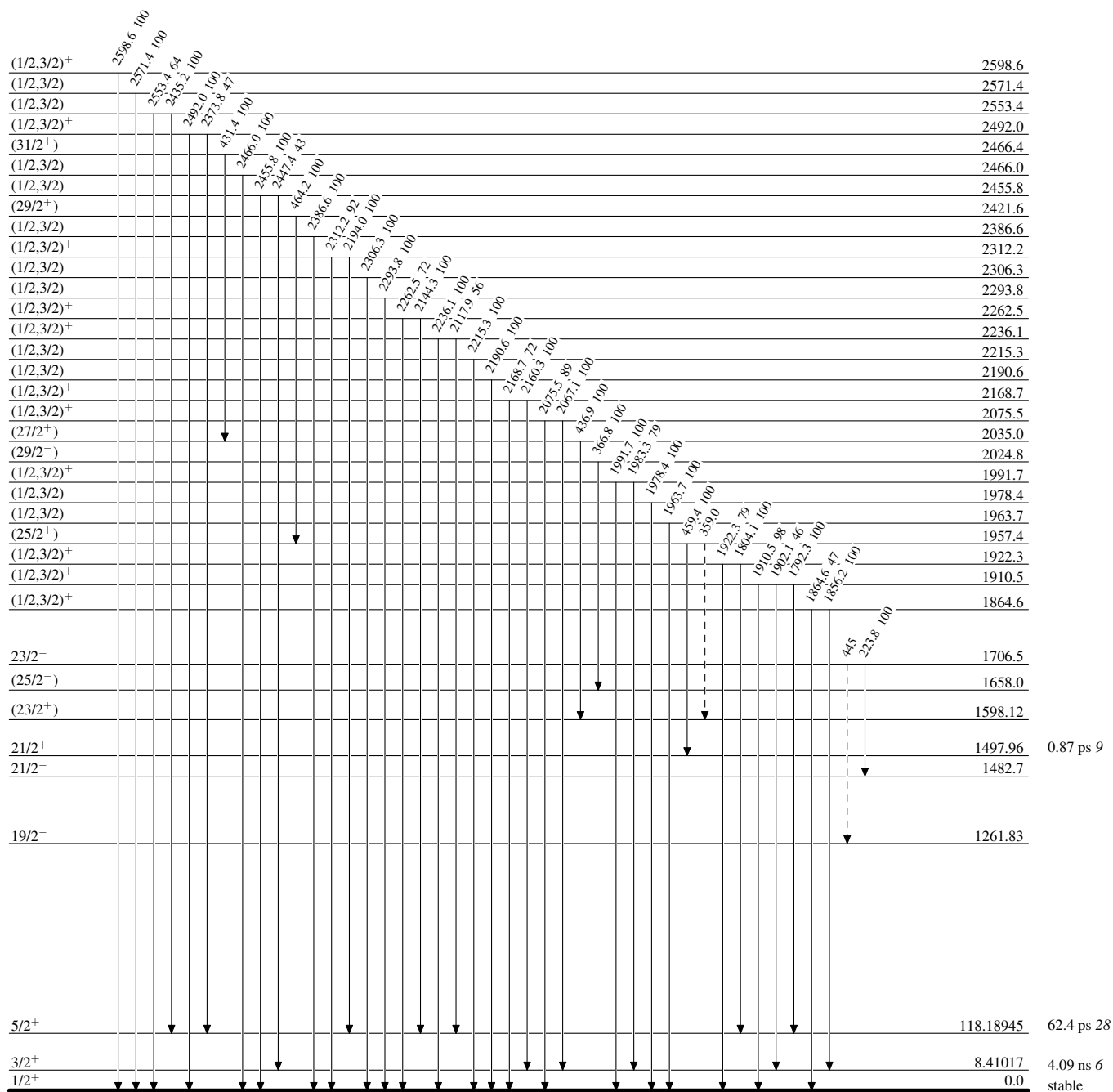


Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

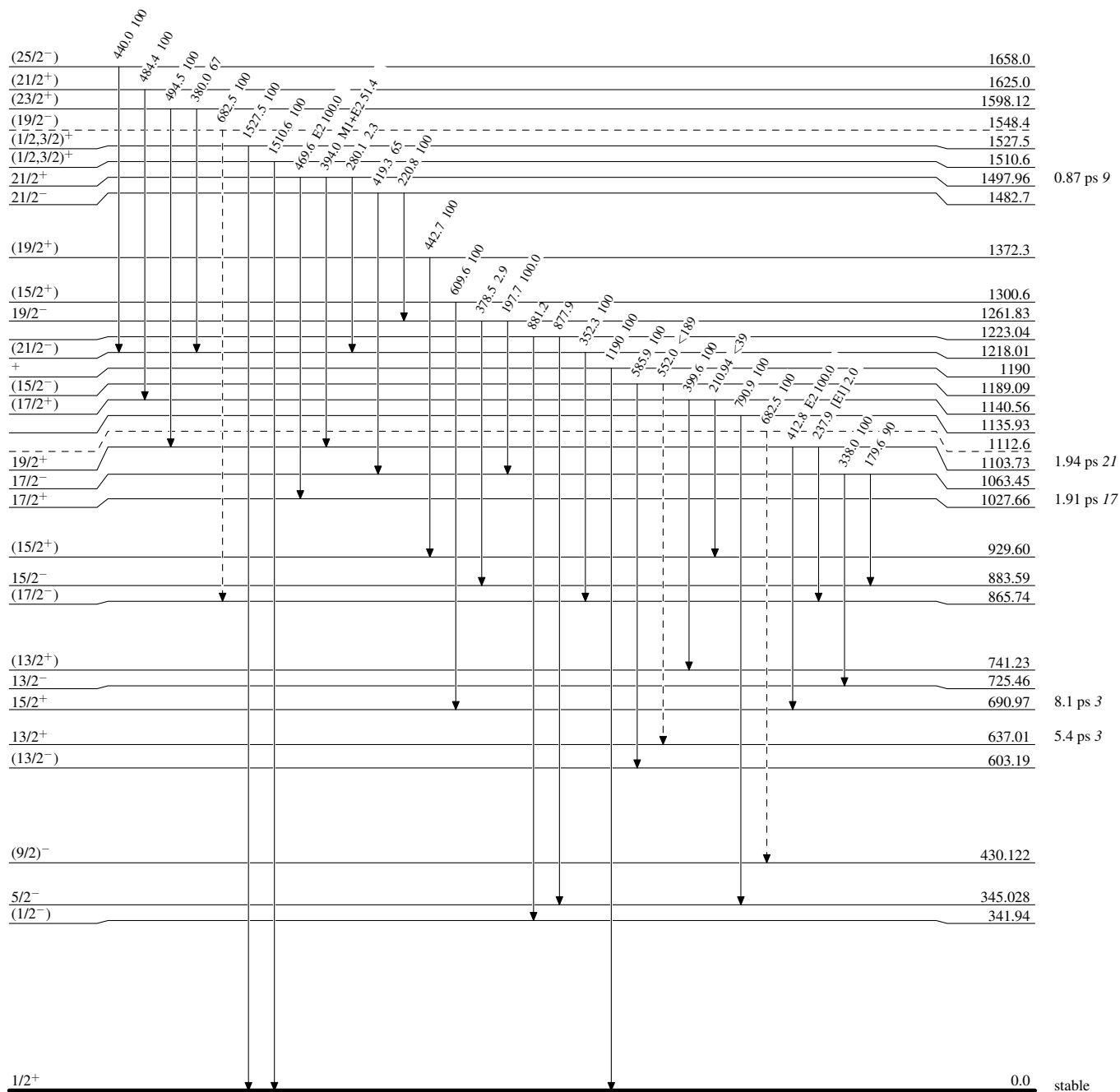
 - - - - - $\rightarrow$ γ Decay (Uncertain)

 $^{169}_{69}\text{Tm}_{100}$

Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

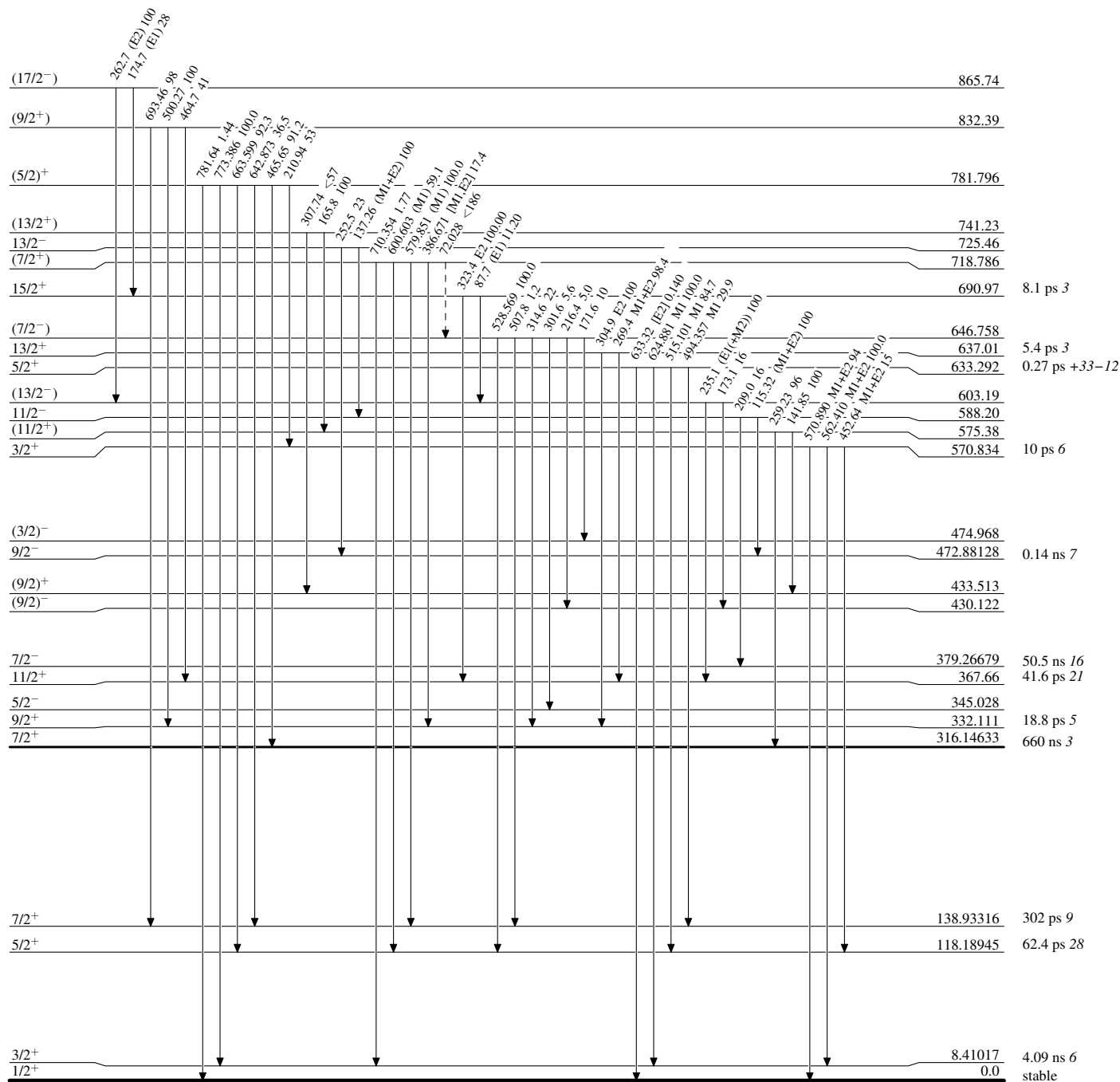
-----► γ Decay (Uncertain) $^{169}_{69}\text{Tm}_{100}$

Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

-----► γ Decay (Uncertain)

 $^{169}\text{Tm}_{100}$

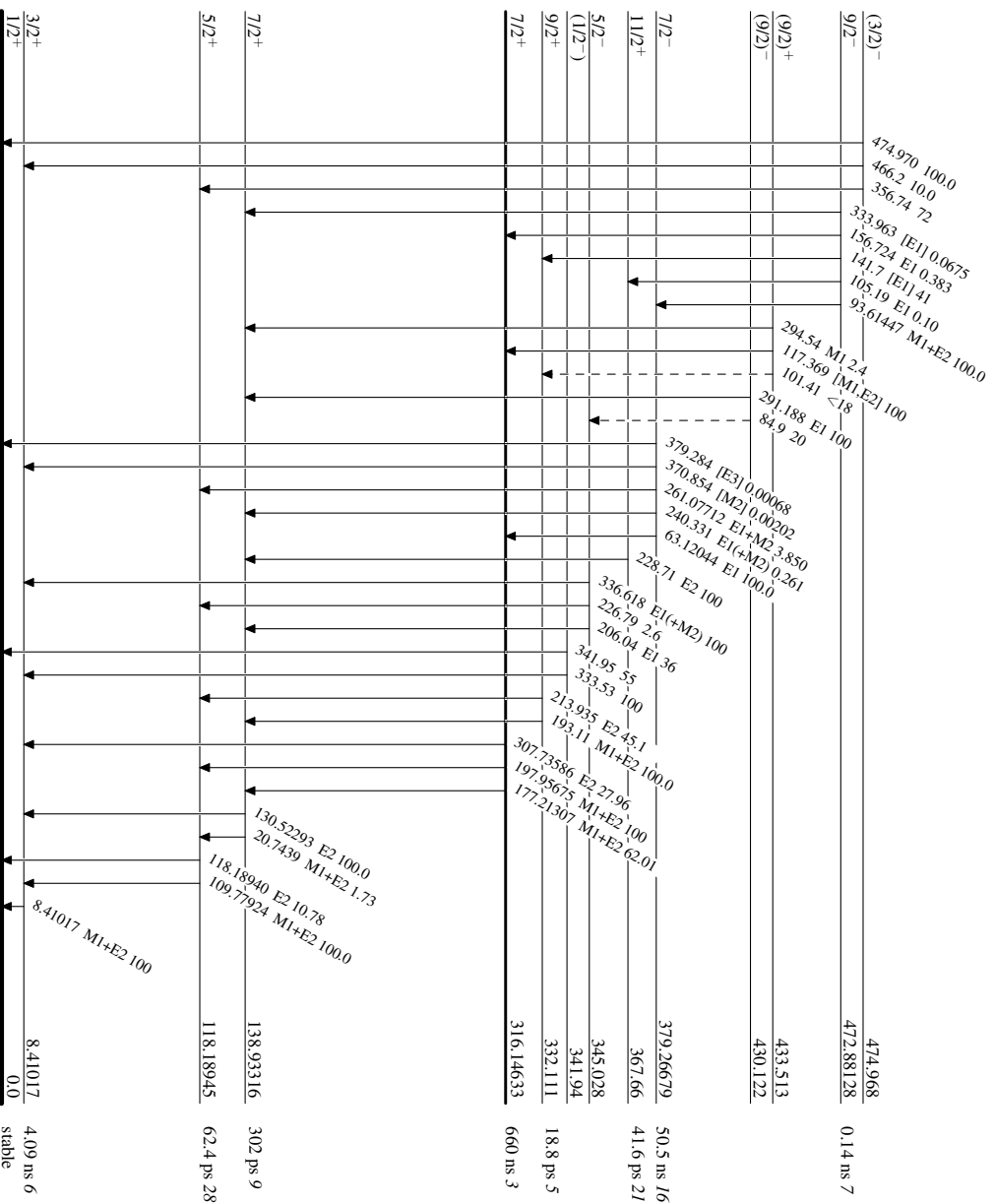
Adopted Levels, Gammas

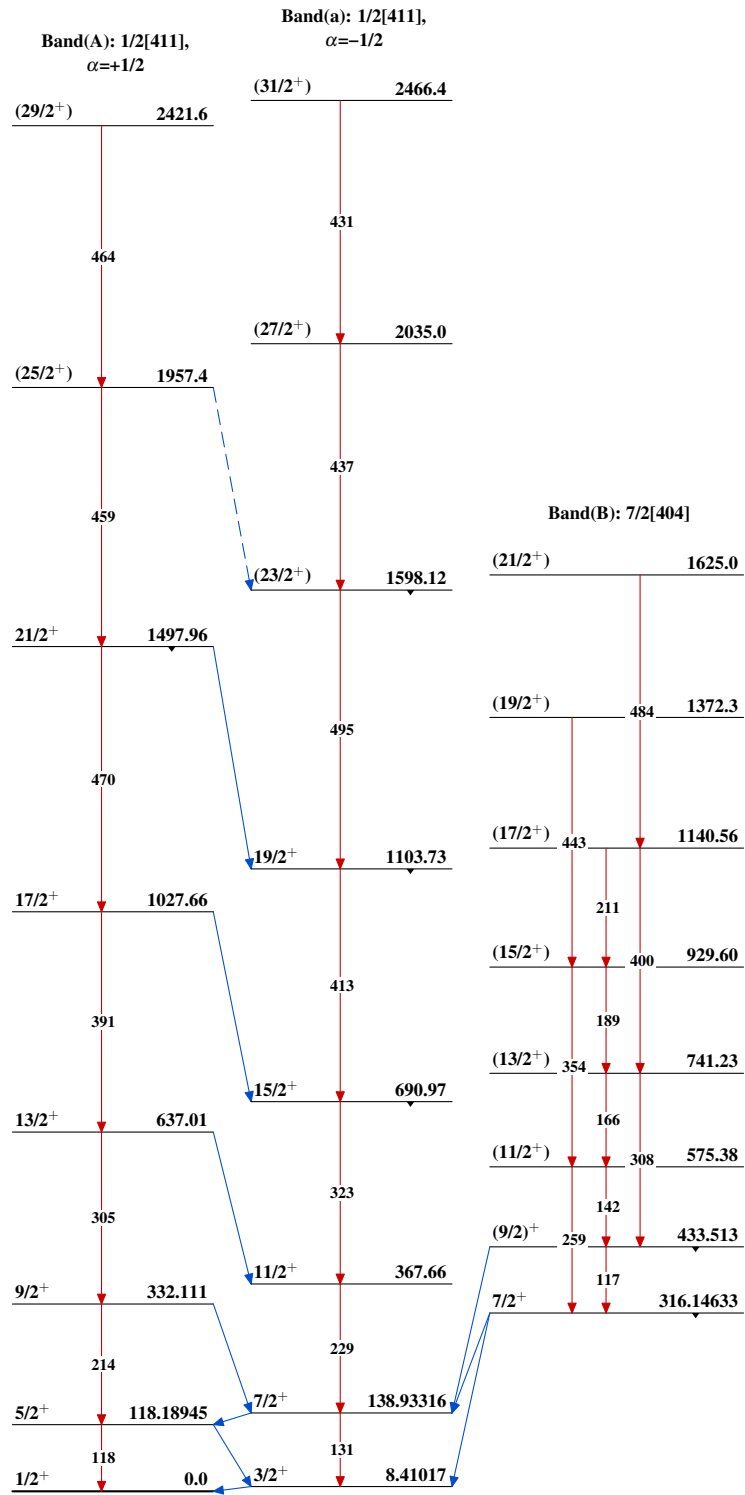
Legend

Level Scheme (continued)

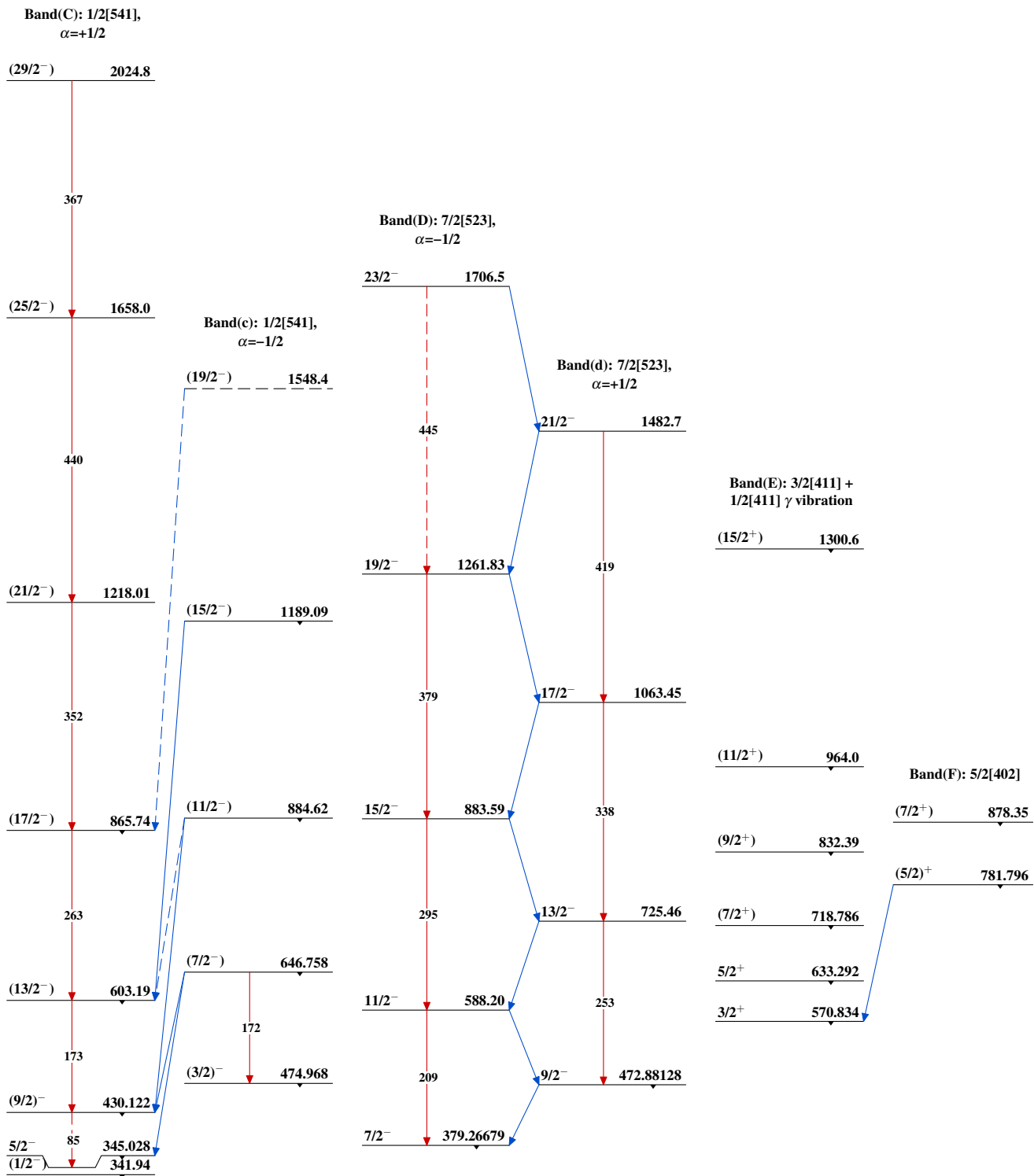
Intensities: Relative photon branching from each level

-----▶ γ Decay (Uncertain)



Adopted Levels, Gammas $^{169}_{69}\text{Tm}_{100}$

Adopted Levels, Gammas (continued)



Adopted Levels, Gammas (continued)

Band(G): 9/2[514]

(11/2⁻) 1152

¹⁶⁹Tm₁₀₀

¹⁶⁹Er β⁻ decay (9.39 d) 1968Ca06,1970Sh09,2021Ta24

Parent: ¹⁶⁹Er: E=0.0; J^π=1/2⁻; T_{1/2}=9.39 d 2; Q(β⁻)=353.5 8; %β⁻ decay=100.0

¹⁶⁹Er-J^π, T_{1/2}: from ¹⁶⁹Er Adopted Levels.

¹⁶⁹Er-Q(β⁻): from 2021Wa16.

1968Ca06: ¹⁶⁹Er was produced by neutron irradiation of 95% enriched ¹⁶⁸Er in the Swedish reactor. Purified placing in the isotope separator. Measured electron spectrum with the iron-core 50 cm radius double-focusing spectrometer.

1970Sh09: ¹⁶⁹Er produced by neutron irradiation of 95% enriched ¹⁶⁸Er at the DR3 reactor at Riso; measured E_γ, I_γ; deduced I_β.

2021Ta24: ¹⁶⁹Er was produced by neutron irradiation of enriched ¹⁶⁸Er₂O₃ target material and was chemically separated from the dissolved target; activity of reference sample was determined by triple-to-double coincidence ratio using liquid scintillation counting; I_γ measurements were carried out at Institute of Radiation Physics (IRA), Lausanne, Switzerland using one n-type high-purity germanium (HPGe) cylindrical detector, and at Paul Scherrer Institute (Ψ), Villigen-Ψ, Switzerland using one planar HPGe detector.

Others: 1948Ke11, 1951Ke44, 1956Bi30, 1956Ha72, 1959Ch31, 1963Mc13, 1965Du02, 1967Ma42, 1971MaXG.

Except for the ce and I_β data reported here, transition data were obtained with ¹⁶⁹Yb sources (see ¹⁶⁹Yb ε decay (32.016 d) for details and additional data), except where otherwise noted.

For K-shell auto-ionization probability data, see 1968Er02, 1971Ca44, and 1974Ja31.

For internal bremsstrahlung data, see 1976Pr06.

Measured X-ray intensities (2021Ta24)

Energy	Intensity (per 100 decay)	
49.7	2.91×10 ⁻³	6
50.7	5.39×10 ⁻³	10
57.3	1.74×10 ⁻³	3
59.0	4.85×10 ⁻⁴	9

¹⁶⁹Tm Levels

E(level) [†]	J ^π [‡]	T _{1/2} [‡]	Comments
0.0	1/2 ⁺	stable	
8.41017 15	3/2 ⁺	4.09 ns 6	T _{1/2} : other: 4.36 ns 17 (1963Mc13 – β ⁻ decay).
118.18945 11	5/2 ⁺	62.4 ps 28	

[†] From recoil-corrected E_γ.

[‡] From Adopted Levels.

β⁻ radiations

β⁻ feedings are from intensity imbalance at each level; g.s. feeding is from 100% less total I_β to 8.4+118.2 levels.

1965Du02 report E_β=344 keV 3 for β group to the g.s. and 8.4 levels combined.

E(decay)	E(level)	I _β ^{-†}	Log ft	Comments
(235.3 13)	118.18945	0.00498 8	9.59 ^{1u} 1	I _β ⁻ : other: 0.0048 10 (1970Sh09).
(345.1 13)	8.41017	45 5	6.57 5	
(353.5 16)	0.0	55 5	6.52 4	

[†] Absolute intensity per 100 decays.

¹⁶⁹Er β⁻ decay (9.39 d) [1968Ca06](#),[1970Sh09](#),[2021Ta24](#) (continued)

γ(¹⁶⁹Tm)

I_γ normalization: from I(γ+ce)/ΣIβ measurements.

<u>E_γ[†]</u>	<u>I_γ[@]</u>	<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.[‡]</u>	<u>δ[‡]</u>	<u>α^{&}</u>	<u>I_(γ+ce)[@]</u>	<u>Comments</u>
8.41017 15	0.172 20	8.41017	3/2 ⁺	0.0	1/2 ⁺	M1+E2	0.0323 10	260 7	45 [#] 5	%I _γ =0.172 20 I _γ : Deduced from I(γ+ce) and α. Mult.,δ: from M1:M2:M3 in 1968Ca06 . δ from subshell ratio data of 1968Ca06 and using the BrIccMixing code (v2.3b). M1:M2:M3:M4:M5:N1:N2:N3:(N4+N5):O1:(O2+O3)= 100:36.8 14:38.0 14:0.9 2:1.0 2:22.1 6:6.4 3:7.6 2:0.20 2: 3.7 1:2.08 6 (1968Ca06); M1:M2:M3:(M4+M5)=100:31 3:34 3: ≈1.2, N1:N2:N3=100:25 3:41 5, M/N=4.2 5, N/O=6.4 10 (1971MaXG). Other: (α(M)exp + α(N)exp)=106 6 (from βce coin (1959Ch31)); value is inconsistent with adopted multipolarity.
109.77924 4	0.00136 2	118.18945	5/2 ⁺	8.41017	3/2 ⁺	M1+E2	-0.153 11	2.369 33		%I _γ =0.00136 2 I _γ : rounded value of 0.001362 18 (2021Ta24).
118.18940 14	0.000151 2	118.18945	5/2 ⁺	0.0	1/2 ⁺	E2		1.642 23		%I _γ =0.000151 2 I _γ : rounded value of 0.0001511 24 (2021Ta24).

[†] From Adopted Gammas.

[‡] From Adopted Gammas, except as noted.

[#] From Ice(8.4γ)/ΣIβ=45 5 (Ice≈I(γ+ce)) ([1965Du02](#)). Other value for this ratio: 42 1% ([1959Ch31](#)).

[@] Absolute intensity per 100 decays.

[&] Total theoretical internal conversion coefficients, calculated using the BrIcc code ([2008Ki07](#)) with “Frozen Orbitals” approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

¹⁶⁹Yb ε decay (32.016 d) [1986Ad07](#),[1990Wa28](#),[2000Mo02](#)

Parent: ¹⁶⁹Yb: E=0.0; J π =7/2⁺; T_{1/2}=32.016 d 8; Q(ε)=899.1 8; % ε decay=100.0

¹⁶⁹Yb-J π , T_{1/2}: from ¹⁶⁹Yb Adopted Levels.

¹⁶⁹Yb-Q(ε): from [2021Wa16](#).

Others: [1950Co16](#), [1951Ma25](#), [1955Jo23](#), [1956Bi30](#), [1956Co13](#), [1956Ha68](#), [1956Ko21](#), [1956Mi05](#), [1957Ba59](#), [1958Ca11](#), [1958Gr05](#), [1958Ha31](#), [1958Na06](#), [1958Se71](#), [1958Sh64](#), [1959Ha09](#), [1959Ke25](#), [1959Ko56](#), [1962El08](#), [1962Gr09](#), [1963Al12](#), [1963Va32](#), [1964Su06](#), [1964Su06](#), [1965Bo08](#), [1965Dz07](#), [1966Dz10](#), [1966Er03](#), [1966Ko01](#), [1967Br31](#), [1968Gi02](#), [1968Ka14](#), [1969Ar23](#), [1969Gu01](#), [1969Mi17](#), [1970Al02](#), [1970An37](#), [1970Be83](#), [1970Mi15](#), [1970Ne11](#), [1971Bo49](#), [1972Ag03](#), [1972Bb13](#), [1972Ca35](#), [1972De67](#), [1972Kr18](#), [1972Se08](#), [1972Se14](#), [1973El15](#), [1973Ge14](#), [1973La15](#), [1974Be26](#), [1974Bo30](#), [1974En09](#), [1974Fu01](#), [1974ScYU](#), [1975Bo07](#), [1975Bu10](#), [1976Ge21](#), [1977Ge12](#), [1982RuZV](#), [1984Ak05](#), [1984Br13](#), [1985AkZW](#), [1987AbZY](#), [1987BaZB](#), [1990AdZZ](#), [1993BaZQ](#), [1994Co02](#), [1994De01](#), [1997De02](#), [1999Sc05](#), [2000AlZY](#), [2000Iw06](#), [2000MeZW](#), [2000Mo02](#), [2000Sa07](#), [2001De06](#), [2001KoZQ](#), [2015In02](#), [2021Fr11](#).

[1986Ad07](#): sources from neutron bombardments of 25% enriched ¹⁶⁸Yb or from spallation of tantalum by 680-MeV protons, mass separation; measured E γ , I γ (anti-Compt spect), $\gamma\gamma$ coin.

[1990Wa28](#): extension of work in [1986Ad07](#); measured E γ , I γ , E(ce), Ice. See also [1990WaZZ](#) and [1990AdZZ](#).

[2000Mo02](#): summary of measurements made in eleven laboratories as part of the EUROMET-410 project. Measured I γ (relative and absolute). See [1999MoZV](#) for a more detailed report.

[2015In02](#): ¹⁶⁹Yb source was produced by the spallation reaction of metallic tantalum bombarded by 660 MeV protons from the synchrocyclotron at JINR, Dubna, Russia. Internal conversion electrons were detected with an electrostatic electron spectrometer. Measured E(ce), I(ce). Deduced levels, precise γ transition energies, conversion coefficients, mixing ratios.

The decay scheme is based on that of [1986Ad07](#) (this scheme is considerably more complex than earlier ones). Additional weak transitions and decay-scheme modifications have been added, based primarily on the work in [1990Wa28](#).

¹⁶⁹Yb is a radionuclide that is important in nuclear medicine (brachytherapy) and as a standard source for γ -ray energy and intensity calibrations. Consequently, many precise measurements of I γ and E γ have been undertaken. These have been collectively analyzed here, and the resulting energy and intensity values are given below. See, e.g., [2002Be05](#), [1996Ch27](#) for prior evaluations of ¹⁶⁹Yb ε decay data.

¹⁶⁹Tm Levels

E(level) [†]	J π [‡]	T _{1/2} [‡]	Comments
0.0 [#]	1/2 ⁺	stable	
8.41017 [#] 15	3/2 ⁺	4.09 ns 6	E(level): from the recoil-corrected energy difference between E γ =118.18940 14 and E γ =109.77924 3 (2000He14). E(level): from Adopted Levels. T _{1/2} : other data from ε decay: 4.22 ns 11 (1987AbZY) from ce- γ (t); 4.13 ns 12 (1966Mc08); 4.10 ns 21 (1974Fu01).
118.18945 [#] 4	5/2 ⁺	62.4 ps 28	T _{1/2} : other: 62 ps 10 (1959B115).
138.93316 [#] 5	7/2 ⁺	302 ps 9	T _{1/2} : from Adopted Levels. ε decay data: 1959B115 (290 ps 70), 1960Be28 , 1964Su06 (321 ps 14), 1966Mc08 (289 ps 24).
316.14633 [@] 5	7/2 ⁺	660 ns 3	T _{1/2} : weighted average of 658 ns 3 (1950Fu63), 665 ns 5 (1974En09), 660 ns 5 (1994De01) from $\gamma\gamma$ (t). Others: 0.67 μ s (1951Ma25), 0.64 μ s 4 (1956Mi05), 670 ns 20 (1959Be62), 0.65 μ s (1972Ni03), 650 ns 26 (1974Bo30). g: 0.044 2 from DPAC (1972Ni03).
332.117 [#] 11	9/2 ⁺	18.8 ps 5	
345.028 ^{&} 3	5/2 ⁻		
367.65 [#] 5	11/2 ⁺	41.6 ps 21	Level (and 229 γ which deexcites it) introduced to accommodate two possible weak transitions from higher states. A 367.7 level is well established in Coulomb excitation and ¹⁷⁰ Er(p,2n γ), (d,3n γ).
379.26678 ^a 6	7/2 ⁻	50.5 ns 16	T _{1/2} : unweighted average of 49.8 ns 15 (1974Bo30), 54.1 ns 5 (1974En09), 51.6 ns 3 (1974Vi05), and 46.4 ns 15 (1997De02), all from $\gamma\gamma$ (t). Others: 45 ns (1956Mi05), 36 ns 1 (1959Be62).
430.121 ^{&} 11	(9/2) ⁻		
433.521 [@] 19	(9/2) ⁺		

Continued on next page (footnotes at end of table)

^{169}Yb ε decay (32.016 d) [1986Ad07](#), [1990Wa28](#), [2000Mo02](#) (continued) ^{169}Tm Levels (continued)

E(level) [†]	J π [‡]	T _{1/2} [‡]	Comments
472.88128 ^a 10	9/2 ⁻	0.14 ns 7	
474.969 ^{&} 9	(3/2) ⁻		A possible but unobserved 129.94 γ with I γ <1.5 was listed in the previous evaluation (2008Ba31). Authors of 2021Fr11 did not find any evidence of this γ ray. In this dataset the 129.94 γ is removed.
570.832 ^b 11	3/2 ⁺	10 ps 6	
633.292 ^b 3	5/2 ⁺	0.27 ps +33-12	
646.759 ^{&} 10	(7/2) ⁻		
718.786 ^b 4	(7/2) ⁺		
781.796 ^c 6	(5/2) ⁺		
832.42 ^b 7	(9/2) ⁺		
878.35 ^c 9	(7/2) ⁺		

[†] From Least-squares fit to E γ ; E(8.4 level) was held fixed at 8.41017 15. $\Delta E=1$ keV was assumed for E γ with missing uncertainty, weaker gamma transitions.

[‡] Adopted values, except as noted.

Band(A): 1/2[411] band.

@ Band(B): 7/2[404] band.

& Band(C): 1/2[541] band.

^a Band(D): 7/2[523] band.

^b Band(E): 3/2[411] band + K=2 γ vibration built on 1/2[411].

^c Band(F): 5/2[402] band.

 ε radiations

[1987Sa53](#) used γ -K x ray sum coin in single intrinsic Ge solid-state detector to determine relative K-capture probabilities: 0.812 29 (472.9 level), 0.823 34 (379.3 level), 0.825 43 (316.1 level).

E(decay)	E(level)	I ε [†]	Log f_t	Comments
(20.8 13)	878.35	0.26 13	5.66 22	
(66.7 13)	832.42	0.27 14	6.98 23	
(117.3 13)	781.796	0.9 6	7.35 29	
(180.3 13)	718.786	<0.45	>8.2	I($\varepsilon+\beta^+$): feeding overlaps zero value. Upper limit from GTOL code: Method 1.
(252.3 13)	646.759	0.0021 17	10.91 35	
(265.8 13)	633.292	0.027 8	9.86 13	
(328.3 13)	570.832	2.53 $\times 10^{-4}$ 9	11.609 16	
(426.2 13)	472.88128	12.39 17	7.677 7	
(465.6 13)	433.521	0.106 13	9.83 5	
(469.0 13)	430.121	<0.4	>9.3	I($\varepsilon+\beta^+$): feeding overlaps zero value. Upper limit from GTOL code: Method 1.
(519.8 13)	379.26678	80.8 9	7.056 5	
(554.1 13)	345.028	0.010 2	11.02 9	
(567.0 13)	332.117	0.010 3	11.05 13	
(583.0 13)	316.14633	6.1 9	8.29 6	

[†] Absolute intensity per 100 decays.

¹⁶⁹Yb ε decay (32.016 d) **1986Ad07,1990Wa28,2000Mo02 (continued)**

γ(¹⁶⁹Tm)

I_γ normalization: weighted average of %I_γ(198) data: 36.26 18, 35.7 6, 36.3 11, 35.9 7, 35.49 39, 36.06 14, 35.95 54, all from the Euromet-410 project (2000Mo02, 2000Ra04), 35.14 28 (1999Mi01), 35.5 4 (1994Co02), 36.0 5 (1983Fu12). Other %I_γ(198): 37.3 5 (datum '3-E' in 2000Mo02, a statistical outlier). Were the latter datum included the normalization would change from 0.3593 12 to 0.3598 14. Other: 0.360 5 can be obtained from total I(γ+ce) (to g.s. plus 8.4 level) minus

I(γ+ce)(8.4γ)=100% (negligible ε feeding to g.s. expected because ΔJ=3).

1983Fu12, 1986Me07, 1990Wa28, 1996Bh08, 2000Mo02 give x-ray intensity data, as summarized below.

For Auger electron data see, e.g., 1976Ar06, 1982Ar22, 1983IsZX, 1985AkZY, 1985Bu23, 1986Ba60, 2000AlZY.

1986Ad07 confirm that 285.0γ, 295.0γ, 304.0γ, 316.2γ, 320.0γ, 328.0γ, 354.7γ, 425.0γ, 492.4γ and 614.3γ, reported in earlier work, should not be assigned to ¹⁶⁹Yb decay.

1990WaZZ give intensity upper limits for the following γ's previously assigned to ¹⁶⁹Yb ε decay: 140.0γ (<0.0021), 160γ(<0.003), 207.0γ(<0.0015), 218.0γ(<0.0015), 229.0γ(<0.0011), 252γ(<0.0017), 285.0γ(<0.0007), 288γ(<0.0009), 304.0γ(<0.027), 316.2γ(<0.00028), 317γ(<0.00021), 320.0γ(<0.00017), 328.0γ(<0.00006), 354.7γ(<0.00004), 363γ(<0.00004), 394γ(<0.0003), 411γ(<0.000014), 417γ(<0.000014), 425.0γ(<0.000013), 492.4γ(<0.000023) and 614.8γ(<0.00012); I_γ for all are given relative to I_γ=100 for 198.0γ.

1985Be01 used ce linewidths for 20.8γ in an attempt to measure finite mass for the electron anti-neutrino.

K(α2)/K(α1)=0.590 15 and 0.589 4 (2021Fr11).

Summary of x-ray and γ relative intensity data for strongest γ's:

All intensities are given relative to I(198γ)=100.0. Calculated values assume %I_γ(198)=35.93 12. The weighted averages include all data, except those identified as statistical outliers based on the Chauvenet criterion; outliers are indicated by the symbol 'x'. Calculated values are from the program RADLST.

Reference	L(1)	L(αη)	L(β1)	8.4γ+L(β2)	L(γ1)	L(γ2)
3)						
1983Fu12	2.58 22	55.8 22	44.2 25	12.5 8	6.1 4	x 2.03 14 x
1986Me07	3.85 18	70.4 29	-	-	-	
1990Wa28	-	-	-	-	-	
1996Bh08	-	-	-	-	-	
2000Mo02(1-E)	3.7 13	66 5	49.7 37	13.8 15	7.4 13	2.7 9
2000Mo02(7-E)	3.23 16	62.8 31	46.5 23	12.1 8	6.98 34	2.56 14
2000Mo02(10-E1)	3.18 5	63.9 18	48.6 12	14.4 6	7.61 18	2.45 13
2000Mo02(10-E2)	3.54 11	61.7 12	48.8 6	12.65 15	7.41 19	2.74 5
Recommended	3.30 10	62.3 15	48.5 5	12.74 17	7.46 13	2.69 4
Calculated	3.14 5					

Reference	L(γ4)	L(tot)+8.4 20.8γ	K(α2)	K(α1)	K(α)
1983Fu12	-	-	0.53 6	148.6 31	262.5 58 -
1986Me07	-	-	0.578 24	156.2 22	272.7 40 -
1990Wa28	-	-	-	157 4	271 9 -
1996Bh08	-	-	-	153.0 5	271.0 10 -
2000Mo02(1-E)	-	-	0.586 33	149.2 25	263.7 47 412.6 54
2000Mo02(7-E)	-	134.7 40	0.535 29	140 6	249 9 388 11

2000Mo02(8-E)	-	-	0.45 4	x		419 8	
2000Mo02(9-E)	-	-	0.514 27		143.7 24	253.9 38	397.6 48
2000Mo02(10-E1)	0.488 75	140.6 17	0.547 8		146.4 22	260.1 39	406.3 45
2000Mo02(10-E2)	0.480 33	137.3 14	0.544 8		146.7 19	(260 3)	406.5 41
2000Mo02(11-E)	-	-	0.55 5		150.5 30	264.3 53	414.5 62
Recommended	0.48 3	138.4 12	0.547 5		150.9 21	267 4	407.0 24
Calculated		135+1γ 3		148 4	261 7		

Reference	K(β135)	K(β240)	K(β)	63.1γ	93.6γ	109.8γ	
1977Ge12	-	-		116 6	7.1 4	48.5 15	
1978Ve07	-	-		125 3	7.61 18	49.7 9	
1983Fu12	85.8 20	21.9 5		124.2 17	7.22 11	48.6 6	
1986Me07	83.5 12	22.8 4		124.9 17	7.28 10	48.9 5	
1990Wa28	78.7 22	20.0 5	x	120 3	7.31 13	49.0 7	
1996Bh08	89.0 20	23.0 10		120.0 5	6.6 5	47.1 10	
1999Mi01	-	-		7.01 9	48.8 6		
2000Mo02(1-E)	85.9 40	22.8 10	108.7 41	122.6 12	7.12 9	47.96 34	
2000Mo02(3-E)	-	-	115.9 23	6.86 12	46.05 64		
2000Mo02(4-E)	-	-	123.5 22	7.28 17	48.8 6		
2000Mo02(7-E)	81.4 27	21.4 7	102.8 28	123.3 39	7.05 23	47.2 15	
2000Mo02(8-E)	-	-	103.1 32	121.4 27	6.87 17	46.0 12	
2000Mo02(9-E)	80.6 12	21.67 46	102.2 13	121.4 6	7.44 13	48.9 10	
2000Mo02(10-E1)	81.4 8	22.63 43	104.0 9	123.3 6	7.19 3	48.45 24	
2000Mo02(10-E2)	84.2 11	22.66 32	106.8 12	123.4 15	7.23 9	48.75 59	
2000Mo02(11-E)	85.8 21	23.0 7	108.8 23	121.2 28	6.72 15	48.3 7	
Recommended	83.0 16	22.49 18	104.9 8	121.4 5	7.18 4	48.39 18	
Calculated			107 3				

Reference	117.4γ	118.2γ	117γ+118γ	130.5γ	156.7γ	177.2γ	
1977Ge12	-	5.31 16	-	32.0 10	-	62.2 19	
1978Ve07	0.055 20	5.38 9	-	31.8 12	-	61.4 10	
1983Fu12	-	5.17 6	-	31.33 28	-	62.3 6	
1986Me07	0.081 10	5.24 5	-	31.68 25	0.027 1	62.4 5	
1990Wa28	0.116 6	5.26 8	-	31.7 5	0.0278 9	61.7 11	
1996Bh08	-	5.13 10	-	31.6 10	-	62.2 10	
1999Mi01	-	5.18 7	-	31.60 36	-	61.9 7	
2000Mo02(1-E)	-	-	5.18 5	31.55 19	0.029 6	61.91 37	
2000Mo02(3-E)	-	5.17 10	-	31.18 44	-	61.9 9	
2000Mo02(4-E)	-	-	5.45 11	32.38 36	-	62.7 11	
2000Mo02(7-E)	0.121 22	5.33 18	5.45 18	31.4 10	0.026 6	62.6 19	
2000Mo02(8-E)	-	5.15 14	-	31.2 7	-	62.2 12	
2000Mo02(9-E)	-	5.13 7	-	30.7 5	-	63.1 3	x
2000Mo02(10-E1)	0.130 11	5.21 3	5.333 27	31.81 10	0.0297 45	61.95 25	
2000Mo02(10-E2)	0.116 6	5.24 6	5.35 6	-	-	-	
2000Mo02(11-E)	-	-	5.21 10	32.38 45	-	62.4 9	
Recommended	0.111 7	5.216 20	5.30 3	31.68 11	0.0275 7	62.01 21	

Reference	198.0γ	240.3γ	261.1 γ	307.7γ	336.6γ	
1972Bb13	-	-	-	(27.96 9)	0.0280 8	
1977Ge12	-	-	4.69 14	27.5 8	0.0321 17	x

1978Ve07	100.0	30	0.367	20	5.43	7	x	30.9	4	0.026	8
1983Fu12	100.0	14	0.301	3	4.67	8		28.1	6	-	
1986Me07	100.0	8	0.334	4	4.75	3		27.94	20	0.0284	16
1990Wa28	100.0		0.332	17	4.66	7		27.5	4	0.0248	4
1996Bh08	100.0		0.314	5	4.66	10		27.1	10	-	
1999Mi01	100.0	8	-		4.69	5		28.09	32	-	
1999Sc05	100.0		-	-	-			0.025	3		
2000Mo02(1-E)	100.0	5	0.282	15	4.641	32		27.94	11	-	
2000Mo02(3-E)	100.0	14	0.334	9	4.65	7		27.40	38	-	
2000Mo02(4-E)	100.0	17	0.359	23	4.84	8	x	28.45	37	-	
2000Mo02(7-E)	100.0	31	0.261	14	4.61	14		28.2	9	-	
2000Mo02(8-E)	100.0	19	0.396	29	4.70	14		28.3	5	-	
2000Mo02(9-E)	100.0	11	0.332	8	5.00	7	x	29.67	33	x	-
2000Mo02(10-E1)	100.0	4	0.288	12	4.653	42		28.01	8	-	
2000Mo02(10-E2)	100.0	28	-	-	-	-		-	-	-	
2000Mo02(11-E)	100.0	15	0.283	28	4.73	11		28.23	40	-	
Recommended	100.00		0.317	17	4.684	20		27.96	9	0.0263	8

$E_\gamma^\dagger$	$I_\gamma^{#f}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^b	δ^b	α^g	$I_{(\gamma+ce)}^f$	Comments
8.41017 15	1.000 24	8.41017	3/2 ⁺	0.0	1/2 ⁺	M1+E2	0.0323 10	263 5	264 4	%I _γ =0.359 9 E _γ : from level energy differences. Other: 8.4101 4 (2015In02) from weighted average of measured energies of the M1, M2, N1, N3 and O1 conversion electron lines. I _(γ+ce) : from intensity balance at 8.4 level; ε feeding not expected (ΔJ=2, Δπ=no). Σ(Ice)=253 7 (1976Ar06). I _γ : deduced from I(γ+ce) and α. Mult.: M1:M2:M3:N:O=43 5:13 3:15 3:16 3:3.3 5 (1976Ar06); M1:M2:M3:M4:M5=100:34.5 20:39.0 20:7.1 9:5.8 8 (2000AlZY); O1:O2:O3:P1=18.6 7:5.5 3:4.4 3:1.0 1 (2001KoZQ); M2:M1=100:34 4 and N3:N1=100:40 6 (2015In02). See ¹⁶⁹ Er β ⁻ decay and ¹⁶⁹ Tm(γ,γ) Mossbauer datasets for additional ce data.
20.7439 3	0.547 5	138.93316	7/2 ⁺	118.18945	5/2 ⁺	M1+E2	0.0280 15	54.7 8	30.8 22	%I _γ =0.197 2 E _γ : From 2015In02: from weighted average of measured energies of the L1, L2, L3, M1, M2, N1,

¹⁶⁹Yb ε decay (32.016 d) 1986Ad07,1990Wa28,2000Mo02 (continued) $\gamma(^{169}\text{Tm})$ (continued)

E_γ [†]	I_γ ^{#f}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^b	α ^g	Comments
								and O1 conversion electron lines. Other: 20.752 9 (1990Wa28). I_γ : deduced from $I(\gamma+\text{ce})$ and α . $I_\gamma(\text{exp})=0.578$ 24 (1986Me07), 0.53 6 (1983Fu12), 0.486 33, 0.535 29, 0.45 4, 0.514 27, 0.547 8, 0.55 5 (all from 2000Mo02); the average of these is 0.545 9. $I_{(\gamma+\text{ce})}$: from intensity balance at 118.2 and 138.9 levels. Identical positive and negative corrections to $I(\gamma+\text{ce})(\text{exp}) (=34.4$ 16) are consistent with zero ε feeding to each. Mult.: $\alpha(\text{L})\text{exp}=38$ 4, $\alpha(\text{M})\text{exp}=8.7$ 7 (Ice from 1976Ar06); L1:L2:L3:M1:M2:M3=6.3 6:0.82 7:0.36 4:1.42 13:0.19 2:0.08 1 (1976Ar06); L1:L2:L3=100:13.3 7:5.4 8, M1:M2:M3:(N+O)=100:13.7 3:5.26 25:30 4, M/(N+O)=0.25 3 (apparently misprinted) (1969Gu01); L1:L2:L3=100:14 1:5.0 6 (2000AlZY). Also the L2/L1, L3/L1, M2/M1, M3/M1, N2/N1,N3/N1 data of 2015In02 – listed in δ . δ : from L2/L3=0.135 5 (weighted average of data from 1969Gu01, 169TM3cG, 1976Ar06, 2000AlZY), L3/L1=0.0526 22 (weighted average of data from 1969Gu01, 1976Ar06, 2000AlZY); L2/L1=0.108 3, L3/L1=0.057 3, M2/M1=0.112 11, M3/M1=0.050 14, N2/N1=0.128 4, N3/N1=0.046 4 (2015In02). Other: 0.00 5 ($\gamma\gamma(\theta)$, 1967BeZX). δ was deduced using the BriceMixing code (v2.3b).
^x 39.58 [‡]								
42.76 ^{ah}	<0.7 ^a	472.88128	9/2 ⁻	430.121	(9/2) ⁻			% I_γ <0.3
45.93 ^{ah}	<0.03 ^a	878.35	(7/2 ⁺)	832.42	(9/2 ⁺)			% I_γ <0.01
50.63 ^{ah}	<1.5 ^a	832.42	(9/2 ⁺)	781.796	(5/2 ⁺)			% I_γ <0.5
50.86 ^{ah}	<1.5 ^a	430.121	(9/2) ⁻	379.26678	7/2 ⁻			% I_γ <0.5
51.51 ^{ah}	<0.05 ^a	367.65?	11/2 ⁺	316.14633	7/2 ⁺			% I_γ <0.02
^x 62.45 [‡]								
63.01 ^{ah}	<6.0 ^a	781.796	(5/2 ⁺)	718.786	(7/2 ⁺)			% I_γ <2.2
63.12044 4	121.4 5	379.26678	7/2 ⁻	316.14633	7/2 ⁺	E1	1.098 15	% I_γ =43.6 2 E_γ : other: 63.1216 12 (2015In02 – from measurement of K-conversion electron line). δ for possible M2 admixture: -0.01 6 (nuclear orientation, 1987Da11, 1987Kr12); 0.0 from weighted average L2/L1=0.352 5 (1969Gu01, 1976Ar06, 1985AkZW, 1987BaZB, 2000AlZY); 0.013 +4-6 from weighted average L3/L1=0.475 8 (1969Gu01, 1976Ar06, 1985AkZW, 1987BaZB, 2000AlZY) (or<0.010 from unweighted average). Mult.: $\alpha(\text{K})\text{exp}=0.83$ 16 (Ice from 1976Ar06), 1.02 15 (K x ray/ γ measurement, 1974Vi05); $\alpha(\text{L1})\text{exp}=0.0911$ 25 (Ice from 1976Ar06); L1:L2:L3=100:37.2 20:46.5 20 (1969Gu01); K:L1:L2:L3:M:N=36 7:3.96 11:1.40 4:1.80 6:1.7 2:0.40 5 (1976Ar06);

¹⁶⁹Yb ε decay (32.016 d) [1986Ad07,1990Wa28,2000Mo02](#) (continued)

E_γ ^{$\dagger$}	I_γ ^{$\#f$}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	$\gamma(^{169}\text{Tm})$ (continued)			Comments
						Mult. ^{b}	δ ^{b}	α ^{g}	
									L1:L2:L3:M1:M2:M3:(M4+M5):N1:N2:N3:(N4+N5): (O+P)= 100.0 13:34.8 6:48.3 7:19.3 6:7.9 4:9.4 4:1.5 2:4.8 2:1.5 2: 2.4 4:0.3 1:0.17 2 (1985AkZW); L1:L2:L3=100:34.5 12:45.5 24 (1987BaZB); L1:L2:L3=100:35 3:42 3 (2000AlZY), L1:L2:L3=100:36.0 6:44.8 8 (from L1/L2=2.78 5 and L1/L3=2.23 4 in 1966Ha04).
65.87 ^{ah}	<0.029 ^{a}	433.521	(9/2) ⁺	367.65?	11/2 ⁺				%I γ <0.010
72.027 ^{ah}	<0.01 ^{a}	718.786	(7/2) ⁺	646.759	(7/2) ⁻				%I γ <0.004
85.09 ^{ah}	<0.008 ^{a}	430.121	(9/2) ⁻	345.028	5/2 ⁻				%I γ <0.003
^x 85.30 ^{$\ddagger$}									
93.61447 8	7.18 4	472.88128	9/2 ⁻	379.26678	7/2 ⁻	M1+E2	+0.183 3	3.75 5	%I γ =2.58 2 δ : weighted average of 0.187 7 and 0.183 4 (based on L2/L1=0.168 6 and L3/L1=0.087 3, respectively, from weighted average of data from 1969Gu01 , 1976Ar06 , 1985AkZW , 1987BaZB , 2000MeZW), and +0.167 17 (nuclear orientation, 1987Da11 , 1987Kr12). However, from time differential $\gamma\gamma(\theta)$, 1997De02 conclude that 94 γ is pure M1 and discrepancy with δ from ce data is due to penetration effects; see comment on $\delta(198\gamma)$ also. Mult.: $\alpha(K)\text{exp}=2.9$ 3 (Ice from 1976Ar06), $\alpha(L)\text{exp}=0.490$ 15 and $\alpha(M)\text{exp}=0.158$ 6 (2020Vi11); L1:L2:L3=100:16.9 10:9.26 35 (1969Gu01); K:L1:L2:L3:M:N=7.5 7:1.18 4:0.19 3:0.10 2:0.4 1:0.16 4 (1976Ar06); K:L1:L2:L3:M1:M2:M3:N= 199.0 27:31.9 5:4.9 3:2.5 2:7.2 4:1.6 2:0.8 1:0.25 3 (1985AkZW); L1:L2:L3=1.0:0.179 6:0.085 5 (2000MeZW).
95.70 ^{ah}	<0.006 ^{a}	474.969	(3/2) ⁻	379.26678	7/2 ⁻				%I γ <0.002
95.86 ^{ah}	<0.006 ^{a}	570.832	3/2 ⁺	474.969	(3/2) ⁻				%I γ <0.002
98.01 ^{ah}	<0.005 ^{a}	430.121	(9/2) ⁻	332.117	9/2 ⁺				%I γ <0.002
101.404 ^{ah}	<0.02 ^{a}	433.521	(9/2) ⁺	332.117	9/2 ⁺				%I γ <0.01
^x 102.8 ^{$\ddagger$}									
105.19 10	0.0072 [@] 21	472.88128	9/2 ⁻	367.65?	11/2 ⁺	E1		0.292 4	%I γ =0.0026 8 Mult.: from unenumerated ce data of 1993BaZQ . Seen in only one spectrum; existence questionable (1990Wa28).
109.77924 4	48.39 18	118.18945	5/2 ⁺	8.41017	3/2 ⁺	M1+E2	-0.153 11	2.369 33	%I γ =17.39 9 δ : from Adopted Gammas. δ from ε decay: -0.145 14

¹⁶⁹Yb ε decay (32.016 d) ^{1986Ad07,1990Wa28,2000Mo02} (continued)

$\gamma(^{169}\text{Tm})$ (continued)								Comments
E_γ [†]	I_γ ^{#f}	E_i (level)	J_i^π	E_f	J_f^π	Mult. ^b	α^g	
								(^{1969Gu01} , $\gamma\gamma(\theta)$), 0.143 5 (from L2/L1=0.1224 23, weighted average of data from ^{1969Gu01} , ^{1975Me08} , ^{1976Ar06} , ^{1985AkZW} , ^{1987BaZB}), 0.149 3 (from L3/L1=0.0478 16, weighted average of data from ^{1969Gu01} , ^{1975Me08} , ^{1976Ar06} , ^{1985AkZW} , ^{1987BaZB}), -0.160 16 ($\gamma\gamma(\theta)$, ^{1978Ve07}), and -0.21 6 (nuclear orientation, ^{1987Da11} , ^{1987Kr12}); the weighted average of these is 0.1478 25 (unweighted average, 0.161 13). Mult.: $\alpha(K)\text{exp}=2.02$ 7 (Ice from ^{1976Ar06}), 2.04 2 (^{1995Zh20}), 2.05 10 (^{2020Vi11}); 0.325 3 (Ice from ^{1990Wa28}), 0.33 2 (^{2020Vi11}); L1:L2:L3=100:12.3 6:4.79 16 (^{1969Gu01}); K:L1:L2:L3=34.9 11:4.87 9:0.56 6:0.24 2 (^{1976Ar06}); L1:L2:L3=100:12.58 25:5.0 2 (^{1975Me08}); L1:L2:L3:M1:M2:M3:N:(O+P)= 129.0 16:14.9 4:5.6 2:20.4 7:3.8 3:1.6 2:6.1 10:1.7 3 (^{1985AkZW}); L1:L2:L3=100:12.7 5:5.32 25 (^{1987BaZB}). %I γ <0.01 %I γ <0.009
113.64 ^{ah}	<0.03 ^a	832.42	(9/2 ⁺)	718.786	(7/2 ⁺)			
113.98 ^{ah}	<0.024 ^a	430.121	(9/2) ⁻	316.14633	7/2 ⁺			
^x 114.1 [‡]								
^x 115.29 [‡]								
117.376 19	0.111 7	433.521	(9/2) ⁺	316.14633	7/2 ⁺	[M1,E2]	1.82 14	%I γ =0.040 3
118.18940 14	5.216 20	118.18945	5/2 ⁺	0.0	1/2 ⁺	E2	1.642 23	%I γ =1.875 10 Mult.: $\alpha(K)\text{exp}=0.69$ 3 (Ice from ^{1976Ar06}), 0.710 3 (^{2020Vi11}); $\alpha(L)\text{exp}=0.70$ 4 (^{2020Vi11}); K:M=1.28 6:0.30 5 (^{1976Ar06}); K:L1:L2:L3=31.9 5:3.4 2:16.0 4:14.5 6 (^{1985AkZW}). %I γ =11.39 6 Mult.: $\alpha(K)\text{exp}=0.545$ 5 (^{1995Zh20} , K x ray- γ coin), 0.549 17 (^{2020Vi11}); $\alpha(L)\text{exp}=0.484$ 18 (Ice from ^{1990Wa28}), 0.46 3 (^{2020Vi11}); $\alpha(M)\text{exp}=0.134$ 5 (^{2020Vi11}); L1:L2:L3=29.2 5:114 2:100 (^{1966Er03}); L1:L2:L3=28.5 9:113 2:100 (^{1975Me08}); K:L1:L2:L3:M:N=6.2 3:0.72 9:2.5 1:2.2 1:1.6 3:0.33 5 (^{1976Ar06}); L1:L2:L3=28.8 6:110 10:100, L3/M3=4.17 15, M1:M2:M3=28 3:115 8:100 (^{1968Gi06}); K:L:M:N=44.9 14:39.7 15:9.78 15:2.30 8 (^{1990Wa28}), L1:L2:L3=30 3:107 10:100 (^{1972Ag03}).
130.52293 6	31.68 11	138.93316	7/2 ⁺	8.41017	3/2 ⁺	E2	1.143 16	
^x 141.8 [‡]								
^x 147.5 [‡]								
^x 148.5 [‡]								
156.724 11	0.0275 7	472.88128	9/2 ⁻	316.14633	7/2 ⁺	E1	0.1016 14	%I γ =0.0099 3 Mult.: from unenumerated ce data of ^{1993BaZQ} . %I γ <0.003
173.88 ^{ah}	<0.008 ^a	646.759	(7/2 ⁻)	472.88128	9/2 ⁻			

¹⁶⁹Yb ε decay (32.016 d) [1986Ad07](#),[1990Wa28](#),[2000Mo02](#) (continued)

$\gamma(^{169}\text{Tm})$ (continued)

E_γ [†]	I_γ ^{#f}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^b	δ ^b	α ^g	Comments
177.21307 6	62.01 21	316.14633	7/2 ⁺	138.93316	7/2 ⁺	M1+E2	-0.30 13	0.594 18	%I γ =22.29 11 δ : unweighted average of 0.41 3 (α (L3)exp, 1972Ag03), 0.425 9 and 0.434 7 (from L2/L1=0.211 5 and L3/L1=0.118 3, respectively, the weighted averages of data from 1969Gu01 , 1975Me08 , 1976Ar06 , 1987BaZB), -0.20 +8-11 and -0.19 5 (1978Ve07 , $\gamma\gamma(\theta)$), -0.44 1 (nuclear orientation, 1987Da11 , 1987Kr12), 0.32 10 (α (K)exp, 1990Wa28), -0.20 +4-3 (1994De01 , $\gamma\gamma(\theta)$), 0.19 +4-5 (α (K)exp, 1995Zh20); uncertainty (0.04) expanded to 0.13 to include most precise datum. Mult.: α (K)exp=0.515 5 (1995Zh20 , K x ray- γ coin), 0.498 14 (Ice from 1990Wa28), 0.48 3 (Ice from 1976Ar06), 0.52 3 (1973El15), 0.488 25 (Ice from 1976Ar06), 0.453 15 (2020Vi11); α (L)exp=0.085 5 (2020Vi11); α (L3)exp=0.0071 7 (1972Ag03); α (M)exp=0.024 3 (2020Vi11); L1:L2:L3=100:21.2 10:12.0 4 (1969Gu01); K:L1:L2:L3=729 15:100:21.2 8:11.5 5 (1975Me08); K:L1:L2:L3:M:N=10.7 7:1.59 5:0.31 3:0.17 2:0.43 3:0.12 1 (1976Ar06); L1:L2:L3=100:21.3 9:11.9 6 (1987BaZB); K:L:M:N=80.2 23:14.91 18:3.31 7:0.84 3 (1990Wa28).
193.15 5	0.021 @ 3	332.117	9/2 ⁺	138.93316	7/2 ⁺	M1+E2 ^e	-0.126 ^e 21	0.479 7	%I γ =0.008 1
197.95675 7	100	316.14633	7/2 ⁺	118.18945	5/2 ⁺	M1+E2	-0.326 6	0.433 6	%I γ =35.94 12 δ : weighted average of -0.306 17 (1969Gu01 , $\gamma\gamma(\theta)$), 0.329 7 (from L2/L1=0.1430 23, weighted average of data in 1969Gu01 , 1975Me08 , 1976Ar06 , 1987BaZB), 0.320 8 (from L3/L1=0.0571 22, weighted average of data of 1969Gu01 , 1975Me08 , 1976Ar06 , 1987BaZB), -0.352 18 (nuclear orientation, 1987Da11 , 1987Kr12). Other values: -0.29 +5-10 (1978Ve07 , $\gamma\gamma(\theta)$), -6.1 +4-6 (1994De01 , $\gamma\gamma(\theta)$). 1994De01 advocate the larger of the $\gamma\gamma(\theta)$ solutions and attribute the discrepancy between their δ and that from ce data to penetration effects; the evaluator rejects this δ because, as also noted by 1999Sc05 , it would have a deleterious

¹⁶⁹Yb ε decay (32.016 d) [1986Ad07](#),[1990Wa28](#),[2000Mo02](#) (continued)

$\gamma(^{169}\text{Tm})$ (continued)									
E_γ [†]	I_γ ^{#f}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^b	δ ^b	α ^g	Comments
									effect on decay scheme intensity balance. Mult.: $\alpha(\text{K})_{\text{exp}}=0.388$ 4 (1995Zh20), 0.375 14 (Ice from 1976Ar06), 0.386 7 (Ice from 1990Wa28), 0.39 2 (1973El15), 0.38 2 (1975Me08), 0.376 6 (2020Vi11); $\alpha(\text{L})_{\text{exp}}=0.060$ 4 (2020Vi11); $\alpha(\text{M})_{\text{exp}}=0.015$ 2 (2020Vi11); L1:L2:L3=100:15.6 9:6.1 3 (1969Gu01); K:L1:L2:L3=732 15:100:14.2 3:5.71 23 (1975Me08); K:L1:L2:L3:M:N=13.4 5:1.81 4:0.25 2:0.10 1:0.5 1:0.14 3 (1976Ar06); L1:L2:L2=100:14.3 4:4.8 5 (1987BaZB); K:L:M=100.0 18:16.85 23:3.82 6 (1990Wa28); M/L=0.235 7, N+/M=0.281 17 (1970Mi15). Other: 1972Ag03 .
199.77 ^{ah}	<0.09 ^a	633.292	5/2 ⁺	433.521	(9/2) ⁺				%I γ <0.03
205.99 6	0.0094 23	345.028	5/2 ⁻	138.93316	7/2 ⁺	E1		0.0497 7	%I γ =0.0034 8 I γ : weighted average of 0.0071 4 (1990AdZZ , 1990Wa28) and 0.0116 1 (1986Me07). Mult.: from unenumerated ce data of 1993BaZQ .
213.935 17	0.0081 [@] 6	332.117	9/2 ⁺	118.18945	5/2 ⁺	E2 ^e		0.2080 29	%I γ =0.0029 2
226.3 7	0.0007 [@] 5	345.028	5/2 ⁻	118.18945	5/2 ⁺				%I γ =2.5 $\times 10^{-4}$ 18
228.71 ^h 5	<0.0011	367.65?	11/2 ⁺	138.93316	7/2 ⁺	E2 ^e		0.1673 23	%I γ <4.0 $\times 10^{-4}$ See comment with 367.7 level. E γ : from Adopted Gammas. I γ : upper limit estimated from spectrum (1990WaZZ). %I γ =0.114 6
240.331 3	0.317 17	379.26678	7/2 ⁻	138.93316	7/2 ⁺	E1(+M2)	<+0.12	0.042 9	δ : <0.12 (from K/L1, 1972Ag03) and +0.5 4 (nuclear orientation, 1987Da11 , 1987Kr12). Other: 0.095 16 reported by 1976Ar06 , but basis for this is unclear. Mult.: $\alpha(\text{K})_{\text{exp}}=0.041$ 3 (Ice from 1972Ag03), 0.040 2 (2020Vi11); $\alpha(\text{M})_{\text{exp}}=0.005$ 1 (2020Vi11); K:L1:L2:L3=857 107:100:15 6:16 7 (1972Ag03); K:L=45 5:10 5 (1976Ar06).
261.07712 9	4.674 20	379.26678	7/2 ⁻	118.18945	5/2 ⁺	E1+M2	-0.07 3	0.032 5	%I γ =1.680 9 δ : ≤ 0.025 (from K/L1, 1972Ag03), 0.032 8 (1976Ar06), -0.123 +22-20 ($\gamma\gamma(\theta)$, 1978Ve07), -0.060 19 (nuclear orientation, 1987Da11 , 1987Kr12), -0.03 4 (1988MeZW , $\gamma\gamma(\theta)$, evaluator's analysis). Mult.: $\alpha(\text{K})_{\text{exp}}=0.030$ 1 (Ice from 1972Ag03), 0.024 2

¹⁶⁹Yb ε decay (32.016 d) [1986Ad07](#),[1990Wa28](#),[2000Mo02](#) (continued)

$\gamma(^{169}\text{Tm})$ (continued)									
E_γ [†]	I_γ ^{#f}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^b	δ ^b	α ^g	Comments
									(Ice from 1976Ar06), 0.027 <i>I</i> (2020Vi11); K:L1:L2:L3=867 67:100:13.8 <i>I2</i> :14.2 <i>I0</i> (1972Ag03).
291.188 <i>II</i>	0.0120 [@] <i>4</i>	430.121	(9/2) ⁻	138.93316	7/2 ⁺	E1		0.02068 <i>29</i>	%I γ =0.0043 <i>2</i> Mult.: from unenumerated ce data of 1993BaZQ .
294.54 <i>II</i>	0.0027 <i>7</i>	433.521	(9/2) ⁺	138.93316	7/2 ⁺	M1		0.1522 <i>2I</i>	%I γ =9.7 $\times 10^{-4}$ <i>25</i> I γ : from 1990Wa28 . Other I γ : 0.020 <i>2</i> (1978Ve07). Mult.: from unenumerated ce data of 1993BaZQ . Seen in only one spectrum; existence questionable (1990Wa28).
301.73 ^{ah}	<0.013 ^a	646.759	(7/2) ⁻	345.028	5/2 ⁻				%I γ <0.005
306.83 ^{ah}	<0.5 ^a	781.796	(5/2) ⁺	474.969	(3/2) ⁻				%I γ <0.2
307.52 ^{ah}	<1.4 ^a	878.35	(7/2) ⁺	570.832	3/2 ⁺				%I γ <0.5
307.73586 <i>IO</i>	27.96 <i>9</i>	316.14633	7/2 ⁺	8.41017	3/2 ⁺	E2		0.0662 <i>9</i>	%I γ =10.05 <i>5</i> Mult.: $\alpha(\text{K})_{\text{exp}}$ =0.053 <i>5</i> (Ice from 1962Gr16), 0.050 <i>2</i> (Ice from 1976Ar06), 0.0514 <i>IO</i> (Ice from 1990Wa28), 0.045 <i>3</i> (2020Vi11); $\alpha(\text{L})_{\text{exp}}$ =0.015 <i>2</i> (2020Vi11); K/L=3.49 <i>II</i> , K/L3=15.5 <i>8</i> (1971Bo49); K:L1:L2:L3=1641 87:195 7:172 5:100, M1:M2:M3=161 <i>I6</i> :152 <i>I5</i> :100, L/M=4.17 <i>I7</i> (1968Gi06); K:L=50 <i>2</i> :15 <i>2</i> (1976Ar06); K:L:M:N=3.73 7:1.15 <i>3</i> :0.266 <i>I3</i> :0.068 <i>IO</i> (1990Wa28).
333.963 <i>I3</i>	0.00485 <i>I7</i>	472.88128	9/2 ⁻	138.93316	7/2 ⁺				%I γ =0.00174 <i>6</i> I γ : from I γ =0.0077 <i>43</i> and 0.0044 <i>3</i> (2000Mo02), 0.00493 <i>I5</i> (1990Wa28), 0.0070 <i>9</i> (1986Me07), 0.0045 <i>8</i> (1976Ge21), 0.0045 <i>6</i> (1972Bb13).
336.618 <i>3</i>	0.0263 <i>8</i>	345.028	5/2 ⁻	8.41017	3/2 ⁺	E1(+M2)	≤ 0.66	0.07 <i>6</i>	%I γ =0.0095 <i>3</i> Mult., δ : E1,M2 from unenumerated ce data of 1993BaZQ ; $\alpha(\text{K})_{\text{exp}}$ ≤ 0.11 (Ice from 1970Al02).
356.74 <i>5</i>	3.92 $\times 10^{-4}$ [@] <i>I7</i>	474.969	(3/2) ⁻	118.18945	5/2 ⁺				%I γ =1.41 $\times 10^{-4}$ <i>6</i>
370.854 <i>8</i>	0.00245 <i>26</i>	379.26678	7/2 ⁻	8.41017	3/2 ⁺	[M2] ^d		0.300 <i>4</i>	%I γ =8.8 $\times 10^{-4}$ <i>IO</i> I γ : from 0.00181 <i>II</i> and <0.0055 (2000Mo02), 0.00267 <i>IO</i> (1990Wa28), 0.0034 <i>9</i> (1976Ge21), 0.00292 <i>II</i> (1972Bb13). 0.010 <i>5</i> (2000Mo02 , data set E-1) is a statistical outlier. Other I γ : 0.0228 <i>I6</i> (1986Me07), 0.019 <i>I</i> (1978Ve07). Mult.: $\alpha(\text{K})_{\text{exp}}$ =0.17 <i>9</i> (Ice from 1990Wa28).
379.284 <i>I8</i>	0.00113 <i>23</i>	379.26678	7/2 ⁻	0.0	1/2 ⁺	[E3] ^d		0.1270 <i>I8</i>	%I γ =4.1 $\times 10^{-4}$ <i>8</i>

¹⁶⁹Yb ε decay (32.016 d) ^{1986Ad07,1990Wa28,2000Mo02} (continued)

$\gamma(^{169}\text{Tm})$ (continued)									
E_γ [†]	I_γ ^{#f}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^b	δ^b	α^g	Comments
									I_γ : from $I_\gamma=0.00172$ 31 (2000Mo02), 0.00049 3 (1990Wa28), 0.00084 28 (1976Ge21), 0.00103 20 (1972Bb13). Ice and I_γ from 1990Wa28 imply $\alpha(\text{K})_{\text{exp}}=0.35$ 5 (cf. $\alpha(\text{K})=0.074$ for probable multipolarity). This suggests a major error in I_γ or Ice(K) in 1990Wa28, probably the latter. $I_\gamma=0.00113$ 23 if the datum from 1990Wa28 is omitted from the weighted average. $I_\gamma=0.0034$ 5 (1986Me07) is a statistical outlier.
386.671 13 452.62 8	9.32×10^{-4} 21 4.9×10^{-5} 15	718.786 570.832	(7/2 ⁺) 3/2 ⁺	332.117 118.18945	9/2 ⁺ 5/2 ⁺	[M1,E2] M1+E2 ^e		0.054 20 0.030 4	% $I_\gamma=3.35\times10^{-4}$ 8 % $I_\gamma=1.8\times10^{-5}$ 6
464.7&	1.0×10^{-5} & 6	832.42	(9/2 ⁺)	367.65?	11/2 ⁺				I_γ : weighted average of 0.000046 10 (1990Wa28) and 0.00014 6 (1972Bb13). % $I_\gamma=3.6\times10^{-6}$ 22 E_γ : from level energy difference. Other: 464.72 9 (1990WaZZ).
465.65&	5.30×10^{-4} & 6	781.796	(5/2 ⁺)	316.14633	7/2 ⁺				% $I_\gamma=1.905\times10^{-4}$ 23 E_γ : from level energy difference. Other: 465.657 6 (1990WaZZ).
466.56&	5.4×10^{-5} & 6	474.969	(3/2 ⁻)	8.41017	3/2 ⁺				% $I_\gamma=1.94\times10^{-5}$ 22 E_γ : from level energy difference. Other: 466.562 8 (1990WaZZ).
474.970 9	5.41×10^{-4} 12	474.969	(3/2 ⁻)	0.0	1/2 ⁺				% $I_\gamma=1.94\times10^{-4}$ 5
494.357 8	0.00410 7	633.292	5/2 ⁺	138.93316	7/2 ⁺	M1 ^c		0.0389 5	I_γ : weighted average of 0.000540 12 (1990Wa28), 0.00064 22 (1976Ge21), 0.00056 6 (1972Bb13). % $I_\gamma=0.00147$ 3 I_γ : weighted average of 0.00408 7 (1990Wa28), 0.0048 8 (1986Me07), 0.0048 8 (1976Ge21), 0.00414 20 (1972Bb13). Mult.: $\alpha(\text{K})_{\text{exp}}=0.035$ 5 (Ice from 1970Al02); K/L=3.7 21 (1970Al02).
500.35 10 507.8 3 515.101 6	2.46×10^{-5} @ 21 4.1×10^{-6} @ 22 0.01161 17	832.42 646.759 633.292	(9/2 ⁺) (7/2 ⁻) 5/2 ⁺	332.117 138.93316 118.18945	9/2 ⁺ 7/2 ⁺ 5/2 ⁺	M1 ^c		0.0350 5	% $I_\gamma=8.8\times10^{-6}$ 8 % $I_\gamma=1.5\times10^{-6}$ 8 % $I_\gamma=0.00417$ 6
528.569 10	3.33×10^{-4} 8	646.759	(7/2 ⁻)	118.18945	5/2 ⁺				I_γ : weighted average of 0.01154 18 (1990Wa28), 0.0111 8 (1986Me07), 0.013 1 (1978Ve07), 0.0132 11 (1976Ge21), 0.0117 5 (1972Bb13). Mult.: $\alpha(\text{K})_{\text{exp}}=0.028$ 4 (Ice from 1970Al02); $\alpha(\text{K})_{\text{exp}}=0.0340$ 24 (Ice from 1990Wa28); K/L=6 3 (1970Al02). % $I_\gamma=1.20\times10^{-4}$ 3

¹⁶⁹Yb ε decay (32.016 d) ^{1986Ad07,1990Wa28,2000Mo02} (continued)

$\gamma(^{169}\text{Tm})$ (continued)									Comments
$E_\gamma^\dagger$	$I_\gamma^{#f}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^b	δ^b	α^g	
									I_γ : weighted average of 0.000333 8 (^{1990Wa28}), 0.00034 25 (^{1976Ge21}), 0.000341 36 (^{1972Bb13}) other I_γ : 0.0057 8 (^{1986Me07}). $\%I_\gamma=1.5\times 10^{-6}$ 4 $\%I_\gamma=1.19\times 10^{-4}$ 3 I_γ : weighted average of 0.000329 7 (^{1990Wa28}), 0.00042 25 (^{1976Ge21}), 0.00038 4 (^{1972Bb13}). Other I_γ : 0.0015 3 (^{1986Me07}). Mult.: $\alpha(\text{K})\text{exp}\leq 0.053$ (Ice from ^{1970Al02}). $\%I_\gamma=1.11\times 10^{-4}$ 7 I_γ : weighted average of 0.000297 20 (^{1990Wa28}), 0.00039 28 (^{1976Ge21}), 0.00036 3 (^{1972Bb13}). Other I_γ : 0.0009 2 (^{1986Me07}). Mult.: $\alpha(\text{K})\text{exp}\leq 0.065$ (Ice from ^{1970Al02}). $\%I_\gamma=0.00193$ 3 I_γ : weighted average of 0.00535 9 (^{1990Wa28}), 0.0063 10 (^{1986Me07}), 0.005 2 (^{1978Ve07}), 0.062 8 (^{1976Ge21}), 0.00528 22 (^{1972Bb13}). Mult.: $\alpha(\text{K})\text{exp}=0.025$ 3 (Ice from ^{1970Al02}); $\alpha(\text{K})\text{exp}=0.017$ 4 (Ice from ^{1990Wa28}). $\%I_\gamma=0.00114$ 2 I_γ : weighted average of 0.00317 6 (^{1990Wa28}), 0.0026 5 (^{1986Me07}), 0.005 3 (^{1978Ve07}), 0.0035 8 (^{1976Ge21}), 0.00322 14 (^{1972Bb13}). Mult.: $\alpha(\text{K})\text{exp}=0.021$ 7 (Ice from ^{1970Al02}). $\%I_\gamma=0.0049$ 2 I_γ : weighted average of 0.01390 25 (^{1990Wa28}), 0.0116 8 (^{1986Me07}), 0.020 5 (^{1978Ve07}), 0.0154 14 (^{1976Ge21}), 0.0137 6 (^{1972Bb13}). Mult.: $\alpha(\text{K})\text{exp}=0.0178$ 21 (Ice from ^{1970Al02}); $\alpha(\text{K})\text{exp}=0.0155$ 26 (Ice from ^{1990Wa28}); K/L=6.0 19 (^{1970Al02}). $\%I_\gamma=6.9\times 10^{-6}$ 5 $\%I_\gamma=7.66\times 10^{-5}$ 18 I_γ : weighted average of 0.000212 5 (^{1990Wa28}), 0.00025 22 (^{1976Ge21}), 0.000224 17 (^{1972Bb13}). $\%I_\gamma=1.93\times 10^{-4}$ 6 I_γ : weighted average of 0.000528 17 (^{1990Wa28}), 0.00062 25 (^{1976Ge21}), 0.000565 28 (^{1972Bb13}).
546.16 22	4.1×10^{-6} @ 11	878.35	(7/2 ⁺)	332.117	9/2 ⁺				
562.410 12	3.31×10^{-4} 7	570.832	3/2 ⁺	8.41017	3/2 ⁺	M1+E2 ^e	0.8 ^e +5-4	0.022 4	
570.890 27	3.10×10^{-4} 18	570.832	3/2 ⁺	0.0	1/2 ⁺	M1+E2 ^e	0.8 ^e +5-4	0.021 4	
579.851 5	0.00536 8	718.786	(7/2 ⁺)	138.93316	7/2 ⁺	(M1) ^c		0.0259 4	
600.603 8	0.00317 5	718.786	(7/2 ⁺)	118.18945	5/2 ⁺	(M1) ^c		0.02366 33	
624.881 4	0.0137 4	633.292	5/2 ⁺	8.41017	3/2 ⁺	M1 ^c		0.02140 30	
633.32 10	1.92×10^{-5} @ 13	633.292	5/2 ⁺	0.0	1/2 ⁺	[E2]		0.00959 13	
642.873 9	2.13×10^{-4} 5	781.796	(5/2 ⁺)	138.93316	7/2 ⁺				
663.599 7	5.38×10^{-4} 15	781.796	(5/2 ⁺)	118.18945	5/2 ⁺				

¹⁶⁹Yb ε decay (32.016 d) **1986Ad07,1990Wa28,2000Mo02 (continued)**

$\gamma(^{169}\text{Tm})$ (continued)						Comments
E_γ †	I_γ #f	$E_i(\text{level})$	J_i^π	E_f	J_f^π	
693.46 8	2.42×10 ⁻⁵ @ 12	832.42	(9/2 ⁺)	138.93316	7/2 ⁺	%I γ =8.7×10 ⁻⁶ 4 %I γ =3.4×10 ⁻⁵ 3 I γ : weighted average of 0.000087 6 (1990Wa28), 0.00008 8 (1976Ge21), 0.000109 8 (1972Bb13). Mult.: $\alpha(K)\text{exp}\leq 0.057$ (Ice from 1970Al02).
710.354 15	9.5×10 ⁻⁵ 7	718.786	(7/2 ⁺)	8.41017	3/2 ⁺	
739.42 11	5.1×10 ⁻⁶ @ 6	878.35	(7/2 ⁺)	138.93316	7/2 ⁺	
760.24 24	2.3×10 ⁻⁶ @ 6	878.35	(7/2 ⁺)	118.18945	5/2 ⁺	
773.386 14	5.81×10 ⁻⁴ 9	781.796	(5/2 ⁺)	8.41017	3/2 ⁺	%I γ =2.09×10 ⁻⁴ 3 I γ : weighted average of 0.000578 10 (1990Wa28), 0.00062 28 (1976Ge21), 0.000607 28 (1972Bb13).
781.64 8	8.4×10 ⁻⁶ @ 7	781.796	(5/2 ⁺)	0.0	1/2 ⁺	
						%I γ =3.0×10 ⁻⁶ 3

† E_γ quoted to 0.01 eV are from the evaluation by 2000He14, except where otherwise noted, (with energy scale based on $E_\gamma=411.80205$ keV 17 for the “Gold standard” (2⁺ to g.s. transition in ¹⁹⁸Hg)) and ΔE is quoted here without the 0.3 ppm uncertainty arising from the energy-wavelength conversion. All other E_γ are based on data from 1990Wa28, 1990WaZZ, except where noted (the calibration energies assumed by 1990Wa28 are $5.8\times 10^{-4}\%$ higher than those given in 2000He14, so all E_γ data from 1990Wa28 have been reduced accordingly). The additional 0.3 ppm uncertainty applicable to E_γ from 2000He14 was taken into account when deducing $E(\text{level})$ values from E_γ .

‡ From 1993BaZQ only; uncertainty unstated by authors.

I_γ relative to $I(198\gamma)=100.0$; weighted averages (using limitation of relative statistical weights method for discrepant data sets) of data from 1972Bb13, 1976Ge21, 1977Ge12, 1978Ve07, 1983Fu12, 1986Me07 (same 1986Me10), 1990Wa28, 1996Bh08, 1999Mi01 and the nine sets of measurements reported in 2000Mo02, except as noted. Note that 2000Mo02 report the results from the various groups participating in the EUROMET-410 project; however, some data from that exercise were also published independently by 1999Sc05, 2000ZaZY (2 measurements, see also 2000Sa07) and 2000Iw06 (see also 2001De06). Occasionally, a datum from one of the latter sources differs from that reported in 2000Mo02. 2000Iw06 give 1.9% uncertainty for $I(198\gamma)$ and the evaluator adopts this; the value of 1.1% in $\%I(198\gamma)$ given in 2000Mo02 is possibly a misprint of 2.1%. I_γ data for the 21 γ , 334 γ and 371 γ are 0.539 29, 0.0051 5 and 0.0019 6, respectively, in 1999Sc05, but 0.586 33, 0.008 4 and 0.010 5 in 2000Mo02; the evaluator has used the data from the later of the two publications. 2000Sa07 present I_γ values which are close to, but differ from, those of study ‘3-E’ in 2000Mo02; the latter were used in the present evaluator’s averages upon the advice of one of the authors. Data identified as statistical outliers (based on the Chauvenet criterion) were excluded from averages (13 cases). Uncertainties arising from source activity measurements (1999MoZV, 1983Fu12), when significant, were subtracted in quadrature from reported absolute intensities before scaling data to give $I(198\gamma)=100$. Uncertainties in the 198 γ reference line were added in quadrature to uncertainties in the other lines prior to averaging. Data from 1970Al02, 1972Bb13, 1976Ge21, 1986Ad07 were reported relative to $I(308\gamma)$ so were renormalized so $I(308\gamma)=27.96$, the value adopted here, to enable intercomparison of all authors’ data. Data from 2000Mo02, data set 10-E2, do not include the 198 γ , but it is clear from tables 16 and 18 of 1999MoZV that those authors assumed the same source activity when converting from relative to absolute I_γ , so the evaluator has done likewise. I_γ values in 1976Ar06 are not used here because they are derived from measured ce intensities and assumed multipolarities. Data from 1986Ad07 are presumed to have been superseded by 1990Wa28.

@ From 1990Wa28.

& $E_\gamma=465.748$ 10, $I_\gamma=0.000578$ 13 for complex peak (1990Wa28); consistent with $I_\gamma=0.00067$ 6 in 1972Bb13 and 0.00081 22 in 1976Ge21. This peak could be resolved experimentally into two peaks ($E_\gamma=465.662$ 22 and 466.66 28, $I_\gamma=0.000523$ 11 and 0.000062 7, respectively) (1990Wa28); however, since the authors

γ(¹⁶⁹Tm) (continued)

expected three transitions near this energy, they assumed E_γ from the decay scheme and deduced I_γ from a three-peak decomposition of the multiplet. It is that I_γ which is given here, along with E_γ from the decay scheme.

^a E_γ (from level energy differences) and I_γ (upper limit estimated from γ-ray spectrum) for possible (but unobserved) E1, M1, E2, or M1+E2 transition. See [1990WaZZ](#) for additional, but weaker, possible γ's (I_γ<0.004, relative to I_γ=100 for 198.0γ). Placement is shown as tentative here, and γ is not included in Adopted Gammas, unless there exists some independent evidence for its existence.

^b From ce data summarized by [1976Ar06](#), except where noted; the photon and ce intensity scales were normalized through α(K)=0.547 (E2 theory) for 130.5γ (for [1976Ar06](#), [1990Wa28](#)) or through α(K)=0.0484 (E2 theory) for 308γ (for [1970Al02](#), [1972Ag03](#)).

^c From α(K)_{exp} calculated using Ice from [1970Al02](#) (normalized so α(K)_{exp}(308γ)=0.0484 (E2 theory)) and I_γ adopted here.

^d Comparison to RUL shows calculated strength within recommended limit.

^e From Adopted Gammas.

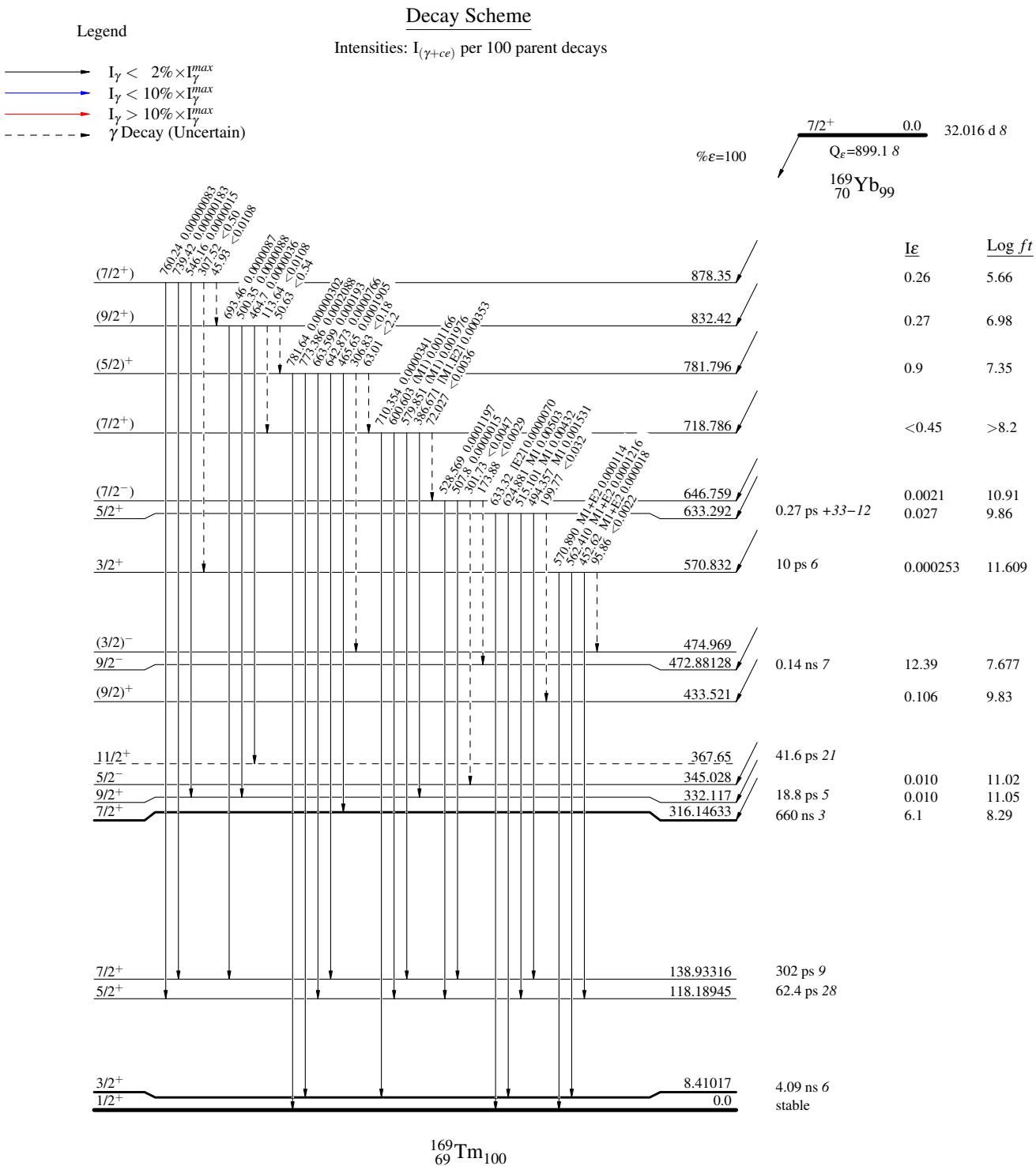
^f For absolute intensity per 100 decays, multiply by 0.3594 *I*₂.

^g Total theoretical internal conversion coefficients, calculated using the BrIcc code ([2008Ki07](#)) with "Frozen Orbitals" approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

^h Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

^{169}Yb ϵ decay (32.016 d) 1986Ad07,1990Wa28,2000Mo02



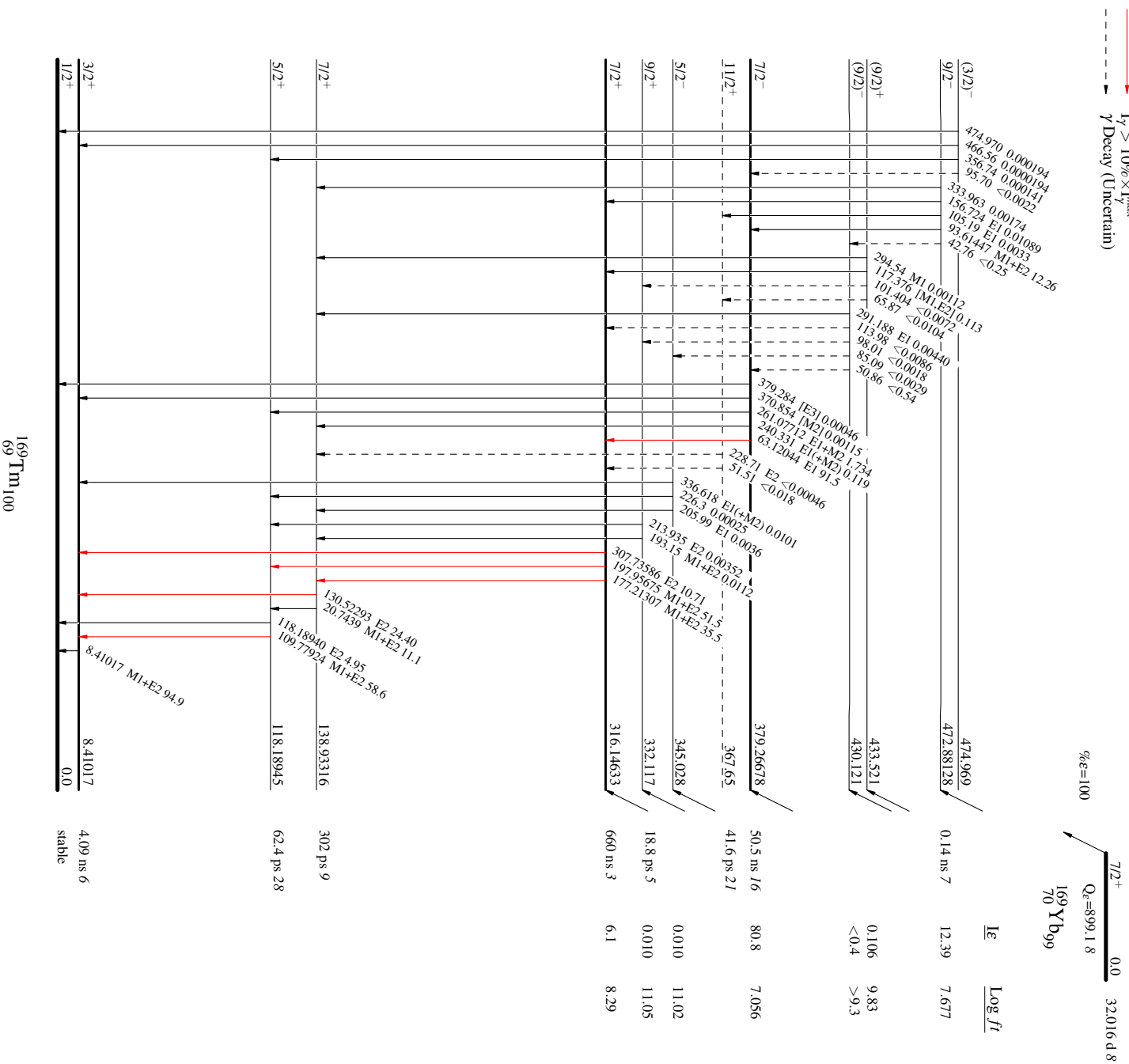
¹⁶⁹Yb ϵ decay (32.016 d) 1986Ad07,1990Wa28,2000M602

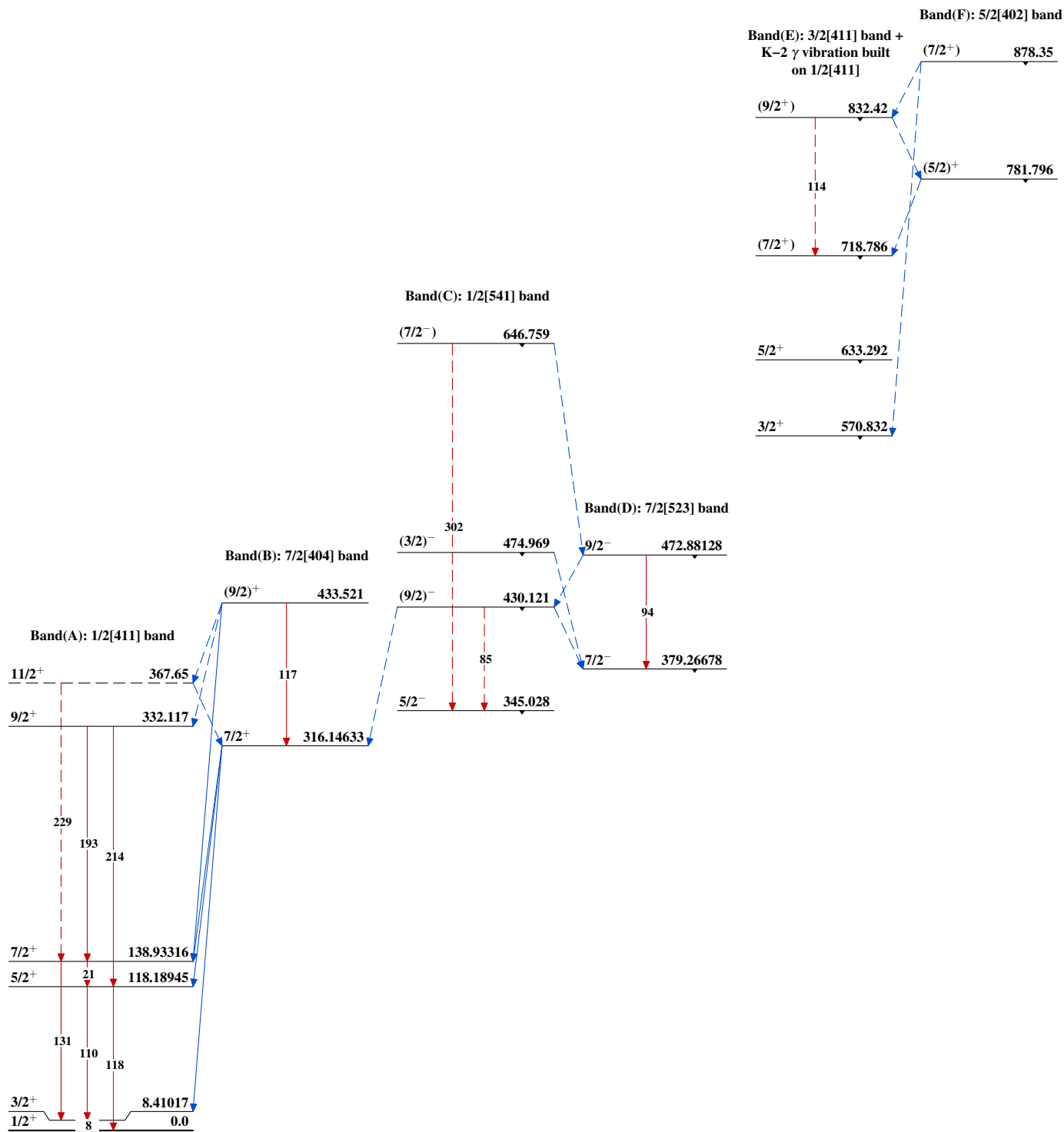
Decay Scheme (continued)

Legend

- $I_\gamma < 2\% \times I_{\max}$
- $I_\gamma < 10\% \times I_{\max}$
- $I_\gamma > 10\% \times I_{\max}$
- γ Decay (Uncertain)

Intensities: $I_{(\gamma+\epsilon)}$ per 100 parent decays



^{169}Yb ε decay (32.016 d) 1986Ad07,1990Wa28,2000Mo02

 $^{168}\text{Er}(\text{p,p})$ IAR [1971McYS](#)

E(p)=10-12 MeV; measured excitation functions at eight angles (Si(Li), FWHM=10 keV at 10 MeV).

 ^{169}Tm Levels

<u>E(level)</u>	<u>Comments</u>
16104	E(level): deduced from E(res)=10530 and S(p)=5574.4 8 (2021Wa16). Uncertainty unstated by authors but probably ≈ 20 keV, based on stated uncertainty in deduced Coulomb energy ($= -16.53 \pm 2$ MeV). Analog of $^{169}\text{Er}(\text{g.s.})$.

¹⁶⁸Er(³He,d),(α,t) **1974Ch44**

E(³He)=24 MeV (nine angles used), E(α)=27 MeV (θ=45°, 60°); Er metal targets enriched to 99.989% in ¹⁶⁸Er; measured E(level) (mag spect, FWHM=16-18 keV), (³He,d) angular distributions, (³He,d) and (α,t) differential cross sections and cross-section ratios; interpreted level structure, comparing spectroscopic factors (DWBA analysis) with Nilsson-model predictions (pairing correlations and Coriolis coupling considered).

¹⁶⁹Tm Levels

All levels were observed in both (³He,d) and (α,t).

E(level) [†]	J ^π [‡]	L [#]	S [@]	Comments
0.0 ^{&}	1/2 ⁺			
8 ^{&} 2	3/2 ⁺			S=0.64 (³ He,d) and 0.91 (α,t), if the cross section for 0.0+8 levels is assumed to be for this level.
118 ^{&} 2	5/2 ⁺		0.32	S: 1974Ch44 note that this value is about 2 to 3 times larger than that predicted for the 5/2 ⁺ 1/2[411] state. Other: 0.39 (α,t).
140 ^{&} 2	7/2 ⁺		0.28	E(level): other: 139 2 (α,t). S: other: 0.19 (α,t).
316 ^a 2	7/2 ⁺		1.19	S: other: 1.67 (α,t).
345 ^b 2	1/2 ⁻ , 5/2 ⁻			Complex peak composed of 341.9 ((1/2 ⁻)) and 345.0 (5/2 ⁻) states (adopted E(level) and J ^π). S=0.71 (³ He,d) and 0.44 (α,t), if entire cross section is assumed to be for the 5/2 ⁻ 1/2[541] state.
432 ^b 2	9/2 ⁻		1.03	Adopted J ^π =(9/2) ⁻ . S: other: 1.51 (α,t).
476 ^b 2	3/2 ⁻	1	0.13	Adopted J ^π =(3/2) ⁻ . S: other: 0.11 (α,t).
570 ^d 2	3/2 ⁺		0.04	S: other: 0.04 (α,t).
588 ^c 2	11/2 ⁻		0.57	S: other: 0.57 (α,t).
634 ^d 2	5/2 ⁺		0.39	S: other: 0.44 (α,t).
648 ^b 2	7/2 ⁻		0.09	E(level): other: 647 2 (α,t). Adopted J ^π =(7/2) ⁻ . S: other: 0.15 (α,t).
785 ^e 2	5/2 ⁺	2	0.87	Adopted J ^π =(5/2) ⁺ . S: other: 1.34 (α,t).
885 2				
938 2				E(level): other: 937 2 (α,t).
1152 ^f 2	11/2 ⁻		1.13	Adopted J ^π =(11/2) ⁻ . S: other: 1.15 (α,t).
1243 2				E(level): other: 1242 2 (α,t).
1372 2	1/2 ⁺	0		E(level): other: 1373 2 (α,t).
1400 2				
1515 2				E(level): other: 1514 2 (α,t).

[†] From (³He,d). Values from (α,t) are same, except a few within 1 keV – those are listed in the comments. Authors note that the uncertainty for the excitation energies are less than 2 keV. The evaluator assigns 2 keV for all.

[‡] Authors' values from (³He,d) angular distributions and (³He,d)/(α,t) cross-section ratios. Values that are not identical to those in Adopted Levels are noted.

[#] From DWBA analysis of angular distributions in (³He,d).

[@] Nuclear structure factor from (³He,d) (=dσ/dΩ(exp)/(2N dσ/dΩ(DWBA)), where N=4.42); for nuclear structure factors from (α,t) N=50. Measured dσ/dΩ at 25° and 60° for (³He,d) and at 45° and 60° for (α,t). Nuclear structure factors from (³He,d) are listed in the column and those from (α,t) are in the comments.

[&] Band(A): 1/2[411].

 $^{168}\text{Er}(^3\text{He,d}),(\alpha,\text{t})$ **1974Ch44 (continued)**

 ^{169}Tm Levels (continued)

^a Band(B): 7/2[404].

^b Band(C): 1/2[541]. Strongly perturbed level order due to large (≈ 4) decoupling parameter.

^c Band(D): 7/2[523].

^d Band(E): 3/2[411] + K=2 (1/2[411] γ vibration built on 1/2[411]).

^e Band(F): 5/2[402].

^f Band(G): 9/2[514].

¹⁶⁸Er(³He,d),(α,t) 1974Ch44

Band(F): 5/2[402]

5/2⁺ 785

Band(C): 1/2[541]

7/2⁻ 648

Band(E): 3/2[411] + K=2
(1/2[411] γ vibration
built on 1/2[411])

5/2⁺ 634

Band(D): 7/2[523]

11/2⁻ 588

3/2⁺ 570

3/2⁻ 476

9/2⁻ 432

1/2⁻,5/2⁻ 345

Band(B): 7/2[404]

7/2⁺ 316

Band(A): 1/2[411]

7/2⁺ 140

5/2⁺ 118

3/2⁺ 8
1/2⁺ 0.0

$^{168}\text{Er}(^3\text{He,d}),(\alpha,\text{t})$ **1974Ch44 (continued)**

Band(G): 9/2[514]

11/2⁻ 1152

$^{169}_{69}\text{Tm}_{100}$

$^{169}\text{Tm}(\gamma,\gamma)$:Mossbauer effect

See, for example, [1976Wi18](#), [1984Gu02](#), [1984Gu16](#), [1985St12](#), and [1988Bo41](#) for other physical and chemical properties determined in ^{169}Tm Mossbauer experiments.

^{169}Tm Levels

$E(\text{level})^\dagger$	$J^\pi^\dagger$	$T_{1/2}^\dagger$
0.0	$1/2^+$	stable
8.410	$3/2^+$	4.09 ns 6

† From Adopted Levels.

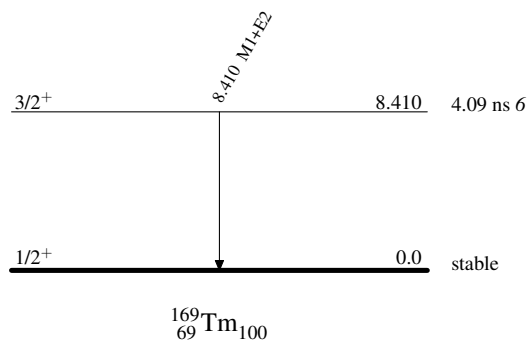
$\gamma(^{169}\text{Tm})$

$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	δ	Comments
8.410	8.410	$3/2^+$	0.0	$1/2^+$	M1+E2	0.037 +7-8	Mult., δ : from $\alpha(\text{exp})=290\ 49$, weighted average of $\alpha(\text{exp})=325\ 35$ (1964Ka02) and $\alpha(\text{exp})=220\ 50$ (1968Wa05). δ was deduced using the BriccMixing code (v2.3b).

† Adopted value (rounded).

$^{169}\text{Tm}(\gamma,\gamma)$:Mossbauer effect

Level Scheme



¹⁶⁹Tm(γ, γ') **1999Hu01**

No significant changes compared to that in the previous evaluation ([2008Ba31](#)) by C.M. Baglin.

1999Hu01: bremsstrahlung endpoint energies of 4.5 and 7.0 MeV; 96.8% ¹⁶⁹Tm oxide target with ²⁷Al and B added for calibration purposes; Ge cluster detector (130°) + single Ge detector (90°); measured E γ , I γ , integrated cross section for nuclear resonance fluorescence; deduced (2J+1) $\Gamma_{\gamma 0}/E_{\gamma}^3$ (where J is the spin of the excited level) and, from this, B(M1) or B(E1) assuming D excitation. Also [1997VoZZ](#) (data not listed).

¹⁶⁹Tm Levels

E(level) [†]	J π [‡]	(J+1/2) $\Gamma_{\gamma 0}/E_{\gamma}^3$ [#]	I s (eV b) [@]	Comments
0.0	1/2 ⁺			J π : from Adopted Levels.
8.4 ^{&}				
118.2 ^{&}				
1510.6 4	(1/2,3/2)	1.6 4	9.3 22	B(M1)=0.14 3 if $\pi=+$; B(E1)=0.0015 4 if $\pi=-$ (1999Hu01).
1527.5 6	(1/2,3/2)	1.0 4	6.0 21	B(M1)=0.09 3 if $\pi=+$; B(E1)=0.0010 3 if $\pi=-$ (1999Hu01).
1864.6 2	(1/2,3/2)	4.0 6	9.0 11	B(M1)=0.35 5 if $\pi=+$; B(E1)=0.0038 6 if $\pi=-$ (1999Hu01).
1910.5 1	(1/2,3/2)	12.7 7	37.5 20	B(M1)=1.09 6 if $\pi=+$; B(E1)=0.0121 7 if $\pi=-$ (1999Hu01).
1922.3 2	(1/2,3/2)	0.76 23	2.5 7	B(M1)=0.066 20 if $\pi=+$; B(E1)=0.00073 22 if $\pi=-$ (1999Hu01).
1963.7 3	(1/2,3/2)	0.39 12	3.0 9	B(M1)=0.034 10 if $\pi=+$; B(E1)=0.00038 11 if $\pi=-$ (1999Hu01).
1978.4 3	(1/2,3/2)	0.42 12	3.2 9	B(M1)=0.036 10 if $\pi=+$; B(E1)=0.00040 11 if $\pi=-$ (1999Hu01).
1991.7 2	(1/2,3/2)	1.26 28	5.4 9	B(M1)=0.109 24 if $\pi=+$; B(E1)=0.00121 27 if $\pi=-$ (1999Hu01).
2075.5 7	(1/2,3/2)	0.8 4	3.0 10	B(M1)=0.07 3 if $\pi=+$; B(E1)=0.0008 3 if $\pi=-$ (1999Hu01).
2168.7 4	(1/2,3/2)	0.73 23	2.6 8	B(M1)=0.063 20 if $\pi=+$; B(E1)=0.00070 22 if $\pi=-$ (1999Hu01).
2190.6 3	(1/2,3/2)	0.45 9	3.8 8	B(M1)=0.039 8 if $\pi=+$; B(E1)=0.00043 9 if $\pi=-$ (1999Hu01).
2215.3 3	(1/2,3/2)	0.38 24	3.3 21	B(M1)=0.033 21 if $\pi=+$; B(E1)=0.00036 23 if $\pi=-$ (1999Hu01).
2236.1 2	(1/2,3/2)	1.03 12	5.6 7	B(M1)=0.089 11 if $\pi=+$; B(E1)=0.00098 12 if $\pi=-$ (1999Hu01).
2262.5 4	(1/2,3/2)	0.89 22	3.2 8	B(M1)=0.077 19 if $\pi=+$; B(E1)=0.00085 21 if $\pi=-$ (1999Hu01).
2293.8 4	(1/2,3/2)	0.38 9	3.4 8	B(M1)=0.033 8 if $\pi=+$; B(E1)=0.00036 9 if $\pi=-$ (1999Hu01).
2306.3 5	(1/2,3/2)	0.28 8	2.4 8	B(M1)=0.024 7 if $\pi=+$; B(E1)=0.00027 8 if $\pi=-$ (1999Hu01).
2312.2 4	(1/2,3/2)	0.66 19	2.9 18	B(M1)=0.057 16 if $\pi=+$; B(E1)=0.00063 18 if $\pi=-$ (1999Hu01).
2386.6 4	(1/2,3/2)	0.42 17	3.8 16	B(M1)=0.036 15 if $\pi=+$; B(E1)=0.00040 17 if $\pi=-$ (1999Hu01).
2455.8 4	(1/2,3/2)	0.45 14	3.0 8	B(M1)=0.039 12 if $\pi=+$; B(E1)=0.00043 13 if $\pi=-$ (1999Hu01).
2466.0 2	(1/2,3/2)	0.20 6	2.0 5	B(M1)=0.018 5 if $\pi=+$; B(E1)=0.00020 6 if $\pi=-$ (1999Hu01).
2492.0 2	(1/2,3/2)	1.05 10	6.9 7	B(M1)=0.091 9 if $\pi=+$; B(E1)=0.00101 10 if $\pi=-$ (1999Hu01).
2553.4 12	(1/2,3/2)	0.51 17	2.0 7	B(M1)=0.044 15 if $\pi=+$; B(E1)=0.00049 17 if $\pi=-$ (1999Hu01).
2571.4 6	(1/2,3/2)	0.20 6	2.0 6	B(M1)=0.018 5 if $\pi=+$; B(E1)=0.00020 6 if $\pi=-$ (1999Hu01).
2598.6 8	(1/2,3/2)	0.73 21	7.3 2	B(M1)=0.063 18 if $\pi=+$; B(E1)=0.00070 20 if $\pi=-$ (1999Hu01).
2602.8 11	(1/2,3/2)	0.36 7	3.6 7	B(M1)=0.031 6 if $\pi=+$; B(E1)=0.00034 7 if $\pi=-$ (1999Hu01).
2687.0 4	(1/2,3/2)	0.23 6	2.4 6	B(M1)=0.020 5 if $\pi=+$; B(E1)=0.00022 6 if $\pi=-$ (1999Hu01).
2749.4 5	(1/2,3/2)	0.63 15	3.4 7	B(M1)=0.055 13 if $\pi=+$; B(E1)=0.00061 14 if $\pi=-$ (1999Hu01).
2756.4 7	(1/2,3/2)	0.29 7	3.1 7	B(M1)=0.025 6 if $\pi=+$; B(E1)=0.00028 7 if $\pi=-$ (1999Hu01).
2769.1 4	(1/2,3/2)	0.89 12	6.7 8	B(M1)=0.077 10 if $\pi=+$; B(E1)=0.00085 11 if $\pi=-$ (1999Hu01).
2786.5 4	(1/2,3/2)	0.42 8	4.6 9	B(M1)=0.037 7 if $\pi=+$; B(E1)=0.00041 8 if $\pi=-$ (1999Hu01).
2814.2 6	(1/2,3/2)	0.7 4	3.8 22	B(M1)=0.06 4 if $\pi=+$; B(E1)=0.0006 4 if $\pi=-$ (1999Hu01).
2818.6 4	(1/2,3/2)	0.30 13	3.3 14	B(M1)=0.026 11 if $\pi=+$; B(E1)=0.00029 12 if $\pi=-$ (1999Hu01).
2843.1 5	(1/2,3/2)	0.22 6	2.4 6	B(M1)=0.019 5 if $\pi=+$; B(E1)=0.00021 6 if $\pi=-$ (1999Hu01).
2861.1 7	(1/2,3/2)	0.68 24	7.5 27	B(M1)=0.059 21 if $\pi=+$; B(E1)=0.00065 23 if $\pi=-$ (1999Hu01).
2943.3 4	(1/2,3/2)	0.9 3	3.0 7	B(M1)=0.08 3 if $\pi=+$; B(E1)=0.0009 3 if $\pi=-$ (1999Hu01).
2996.2 4	(1/2,3/2)	0.68 13	3.7 7	B(M1)=0.059 11 if $\pi=+$; B(E1)=0.00065 12 if $\pi=-$ (1999Hu01).
3127.6 6	(1/2,3/2)	0.41 7	4.8 9	B(M1)=0.035 6 if $\pi=+$; B(E1)=0.00039 7 if $\pi=-$ (1999Hu01).
3175.6 7	(1/2,3/2)	0.21 6	2.6 7	B(M1)=0.018 5 if $\pi=+$; B(E1)=0.00020 6 if $\pi=-$ (1999Hu01).
3185.0 12	(1/2,3/2)	0.63 25	7.7 31	B(M1)=0.054 22 if $\pi=+$; B(E1)=0.00060 24 if $\pi=-$ (1999Hu01).
3187.5 7	(1/2,3/2)	0.19 10	2.3 18	B(M1)=0.016 9 if $\pi=+$; B(E1)=0.00018 10 if $\pi=-$ (1999Hu01).
3191.3 5	(1/2,3/2)	0.61 14	4.2 8	B(M1)=0.053 12 if $\pi=+$; B(E1)=0.00059 13 if $\pi=-$ (1999Hu01).
3199.7 7	(1/2,3/2)	0.68 20	8.3 24	B(M1)=0.059 17 if $\pi=+$; B(E1)=0.00065 19 if $\pi=-$ (1999Hu01).
3204.8 7	(1/2,3/2)	0.95 25	7.5 20	B(M1)=0.082 22 if $\pi=+$; B(E1)=0.00091 24 if $\pi=-$ (1999Hu01).
3254.6 4	(1/2,3/2)	0.52 15	2.6 6	B(M1)=0.045 13 if $\pi=+$; B(E1)=0.00050 14 if $\pi=-$ (1999Hu01).
3274.5 8	(1/2,3/2)	0.60 14	7.6 18	B(M1)=0.052 12 if $\pi=+$; B(E1)=0.00057 13 if $\pi=-$ (1999Hu01).
3286.5 3	(1/2,3/2)	0.58 8	7.3 10	B(M1)=0.050 7 if $\pi=+$; B(E1)=0.00055 8 if $\pi=-$ (1999Hu01).

Continued on next page (footnotes at end of table)

¹⁶⁹Tm(γ, γ') **1999Hu01** (continued)

¹⁶⁹Tm Levels (continued)

E(level) [†]	J π [‡]	(J+1/2) $\Gamma_{\gamma 0}/E_{\gamma}^3$ [#]	I _s (eV b) [@]	Comments
3299.6 6	(1/2,3/2)	0.8 3	4.8 15	B(M1)=0.067 27 if $\pi=+$; B(E1)=0.0007 3 if $\pi=-$ (1999Hu01).
3308.4 9	(1/2,3/2)	0.25 9	3.2 12	B(M1)=0.022 8 if $\pi=+$; B(E1)=0.00024 9 if $\pi=-$ (1999Hu01).
3341.2 7	(1/2,3/2)	0.76 19	6.7 14	B(M1)=0.066 16 if $\pi=+$; B(E1)=0.00073 18 if $\pi=-$ (1999Hu01).
3376.4 4	(1/2,3/2)	0.63 13	4.0 6	B(M1)=0.054 11 if $\pi=+$; B(E1)=0.00060 12 if $\pi=-$ (1999Hu01).
3383.9 6	(1/2,3/2)	0.41 7	5.2 9	B(M1)=0.035 6 if $\pi=+$; B(E1)=0.00039 7 if $\pi=-$ (1999Hu01).
3419.2 5	(1/2,3/2)	0.42 9	5.4 12	B(M1)=0.036 8 if $\pi=+$; B(E1)=0.00040 9 if $\pi=-$ (1999Hu01).
3436.3 8	(1/2,3/2)	0.56 24	4.4 19	B(M1)=0.048 21 if $\pi=+$; B(E1)=0.00053 23 if $\pi=-$ (1999Hu01).
3442.0 10	(1/2,3/2)	0.24 14	3.2 18	B(M1)=0.021 12 if $\pi=+$; B(E1)=0.00023 13 if $\pi=-$ (1999Hu01).
3458.6 7	(1/2,3/2)	0.28 15	3.7 19	B(M1)=0.024 13 if $\pi=+$; B(E1)=0.00027 14 if $\pi=-$ (1999Hu01).
3475.7 3	(1/2,3/2)	1.13 27	4.8 9	B(M1)=0.098 23 if $\pi=+$; B(E1)=0.00108 25 if $\pi=-$ (1999Hu01).
3480.3 3	(1/2,3/2)	0.42 6	5.5 8	B(M1)=0.036 5 if $\pi=+$; B(E1)=0.00040 6 if $\pi=-$ (1999Hu01).
3497.0 4	(1/2,3/2)	0.17 7	2.4 10	B(M1)=0.015 6 if $\pi=+$; B(E1)=0.000017 7 if $\pi=-$ (1999Hu01).
3527.0 7	(1/2,3/2)	0.35 14	2.0 6	B(M1)=0.030 12 if $\pi=+$; B(E1)=0.00033 13 if $\pi=-$ (1999Hu01).
3538.7 6	(1/2,3/2)	0.22 6	2.9 9	B(M1)=0.019 5 if $\pi=+$; B(E1)=0.00021 6 if $\pi=-$ (1999Hu01).
3541.9 6	(1/2,3/2)	0.53 15	3.6 10	B(M1)=0.046 13 if $\pi=+$; B(E1)=0.00051 14 if $\pi=-$ (1999Hu01).
3573.3 4	(1/2,3/2)	0.30 18	4.5 10	B(M1)=0.026 16 if $\pi=+$; B(E1)=0.00029 18 if $\pi=-$ (1999Hu01).
3613.0 3	(1/2,3/2)	0.28 8	3.9 11	B(M1)=0.024 7 if $\pi=+$; B(E1)=0.00027 8 if $\pi=-$ (1999Hu01).
3624.8 3	(1/2,3/2)	1.18 18	5.8 8	B(M1)=0.102 16 if $\pi=+$; B(E1)=0.00113 18 if $\pi=-$ (1999Hu01).
3724.7 5	(1/2,3/2)	0.69 13	4.9 9	B(M1)=0.060 11 if $\pi=+$; B(E1)=0.00066 12 if $\pi=-$ (1999Hu01).
3736.2 7	(1/2,3/2)	0.21 8	3.0 12	B(M1)=0.018 7 if $\pi=+$; B(E1)=0.00020 8 if $\pi=-$ (1999Hu01).
3741.7 4	(1/2,3/2)	0.29 8	4.2 12	B(M1)=0.025 7 if $\pi=+$; B(E1)=0.00028 8 if $\pi=-$ (1999Hu01).
3766.3 7	(1/2,3/2)	0.25 7	3.5 10	B(M1)=0.021 6 if $\pi=+$; B(E1)=0.00023 7 if $\pi=-$ (1999Hu01).
3795.7 11	(1/2,3/2)	0.29 23	1.6 11	B(M1)=0.025 20 if $\pi=+$; B(E1)=0.00028 22 if $\pi=-$ (1999Hu01).
3806.7 6	(1/2,3/2)	0.16 6	2.4 8	B(M1)=0.014 5 if $\pi=+$; B(E1)=0.00015 6 if $\pi=-$ (1999Hu01).
3862.5 6	(1/2,3/2)	0.24 8	3.6 11	B(M1)=0.021 7 if $\pi=+$; B(E1)=0.00023 8 if $\pi=-$ (1999Hu01).
3875.3 7	(1/2,3/2)	0.33 9	5.0 14	B(M1)=0.029 8 if $\pi=+$; B(E1)=0.00032 9 if $\pi=-$ (1999Hu01).
3916.8 6	(1/2,3/2)	0.29 8	4.4 13	B(M1)=0.025 7 if $\pi=+$; B(E1)=0.00028 8 if $\pi=-$ (1999Hu01).
3950.2 7	(1/2,3/2)	0.31 6	4.7 8	B(M1)=0.027 5 if $\pi=+$; B(E1)=0.00030 6 if $\pi=-$ (1999Hu01).
4103.6 5	(1/2,3/2)	0.12 5	1.7 8	B(M1)=0.010 4 if $\pi=+$; B(E1)=0.00011 4 if $\pi=-$ (1999Hu01).
4190.2 10	(1/2,3/2)	0.43 27	2.5 12	B(M1)=0.037 23 if $\pi=+$; B(E1)=0.00041 25 if $\pi=-$ (1999Hu01).
4279.7 4	(1/2,3/2)	0.17 6	2.8 9	B(M1)=0.015 5 if $\pi=+$; B(E1)=0.00017 6 if $\pi=-$ (1999Hu01).
4764.5 14	(1/2,3/2)	0.12 7	2.1 12	B(M1)=0.010 6 if $\pi=+$; B(E1)=0.00011 7 if $\pi=-$ (1999Hu01).
4789.8 11	(1/2,3/2)	0.17 8	3.2 15	B(M1)=0.015 7 if $\pi=+$; B(E1)=0.00017 8 if $\pi=-$ (1999Hu01).
4853.0 11	(1/2,3/2)	0.14 8	2.6 16	B(M1)=0.012 7 if $\pi=+$; B(E1)=0.00013 8 if $\pi=-$ (1999Hu01).
4865.5 8	(1/2,3/2)	0.30 20	2.3 21	B(M1)=0.026 17 if $\pi=+$; B(E1)=0.00029 19 if $\pi=-$ (1999Hu01).
4954.0 5	(1/2,3/2)	0.49 12	9.2 21	B(M1)=0.042 10 if $\pi=+$; B(E1)=0.00046 11 if $\pi=-$ (1999Hu01).
5211.5 6	(1/2,3/2)	0.61 12	12.4 23	B(M1)=0.053 10 if $\pi=+$; B(E1)=0.00059 11 if $\pi=-$ (1999Hu01).
5507 3	(1/2,3/2)	0.5 5	10 11	B(M1)=0.04 5 if $\pi=+$; B(E1)=0.0005 5 if $\pi=-$ (1999Hu01).
5529.9 6	(1/2,3/2)	1.2 4	26 9	B(M1)=0.11 4 if $\pi=+$; B(E1)=0.0012 4 if $\pi=-$ (1999Hu01).
5593.3 11	(1/2,3/2)	1.1 8	14 9	B(M1)=0.09 7 if $\pi=+$; B(E1)=0.0010 8 if $\pi=-$ (1999Hu01).
5598.3 4	(1/2,3/2)	0.7 4	14 8	B(M1)=0.06 3 if $\pi=+$; B(E1)=0.0006 3 if $\pi=-$ (1999Hu01).

[†] Authors' values, except as noted. From spectrum obtained at 4.5 MeV bremsstrahlung endpoint energy if E(level)<4300, from 7.0 MeV bremsstrahlung endpoint energy spectrum otherwise.

[‡] D excitation from 1/2⁺ g.s. expected.

[#] (J+1/2) $\Gamma_{\gamma 0}/E_{\gamma}^3$ (meV/MeV³); deduced by 1999Hu01 from measured scattering cross section and branching.

[@] Integrated scattering cross section (eV b).

[&] From Adopted Levels (rounded off to nearest 0.1 keV).

$^{169}\text{Tm}(\gamma, \gamma')$ **1999Hu01 (continued)** $\gamma(^{169}\text{Tm})$

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π
1510.6	(1/2,3/2)	1510.6	100	0.0	1/2 ⁺	3127.6	(1/2,3/2)	3127.6	100	0.0	1/2 ⁺
1527.5	(1/2,3/2)	1527.5	100	0.0	1/2 ⁺	3175.6	(1/2,3/2)	3175.6	100	0.0	1/2 ⁺
1864.6	(1/2,3/2)	1856.2	68 18	8.4		3185.0	(1/2,3/2)	3185.0	100	0.0	1/2 ⁺
		1864.6	32	0.0	1/2 ⁺	3187.5	(1/2,3/2)	3187.5	100	0.0	1/2 ⁺
1910.5	(1/2,3/2)	1792.3	41 4	118.2		3191.3	(1/2,3/2)	3182.9	45 18	8.4	
		1902.1	19 2	8.4				3191.3	55	0.0	1/2 ⁺
		1910.5	40	0.0	1/2 ⁺	3199.7	(1/2,3/2)	3199.7	100	0.0	1/2 ⁺
1922.3	(1/2,3/2)	1804.1	56 26	118.2		3204.8	(1/2,3/2)	3086.6	36 12	118.2	
		1922.3	44	0.0	1/2 ⁺			3204.8	64	0.0	1/2 ⁺
1963.7	(1/2,3/2)	1963.7	100	0.0	1/2 ⁺	3254.6	(1/2,3/2)	3246.2	59 31	8.4	
1978.4	(1/2,3/2)	1978.4	100	0.0	1/2 ⁺			3254.6	41	0.0	1/2 ⁺
1991.7	(1/2,3/2)	1983.3	44 20	8.4		3274.5	(1/2,3/2)	3274.5	100	0.0	1/2 ⁺
		1991.7	56	0.0	1/2 ⁺	3286.5	(1/2,3/2)	3286.5	100	0.0	1/2 ⁺
2075.5	(1/2,3/2)	2067.1	53 39	8.4		3299.6	(1/2,3/2)	3291.2	51 38	8.4	
		2075.5	47	0.0	1/2 ⁺			3299.6	49	0.0	1/2 ⁺
2168.7	(1/2,3/2)	2160.3	58 22	8.4		3308.4	(1/2,3/2)	3308.4	100	0.0	1/2 ⁺
		2168.7	42	0.0	1/2 ⁺	3341.2	(1/2,3/2)	3332.8	32 12	8.4	
2190.6	(1/2,3/2)	2190.6	100	0.0	1/2 ⁺			3341.2	68	0.0	1/2 ⁺
2215.3	(1/2,3/2)	2215.3	100	0.0	1/2 ⁺	3376.4	(1/2,3/2)	3368.0	51 17	8.4	
2236.1	(1/2,3/2)	2117.9	36 10	118.2				3376.4	49	0.0	1/2 ⁺
		2236.1	64	0.0	1/2 ⁺	3383.9	(1/2,3/2)	3383.9	100	0.0	1/2 ⁺
2262.5	(1/2,3/2)	2144.3	58 18	118.2		3419.2	(1/2,3/2)	3419.2	100	0.0	1/2 ⁺
		2262.5	42	0.0	1/2 ⁺	3436.3	(1/2,3/2)	3318.1	40 26	118.2	
2293.8	(1/2,3/2)	2293.8	100	0.0	1/2 ⁺			3436.3	60	0.0	1/2 ⁺
2306.3	(1/2,3/2)	2306.3	100	0.0	1/2 ⁺	3442.0	(1/2,3/2)	3442.0	100	0.0	1/2 ⁺
2312.2	(1/2,3/2)	2194.0	52 19	118.2		3458.6	(1/2,3/2)	3458.6	100	0.0	1/2 ⁺
		2312.2	48	0.0	1/2 ⁺	3475.7	(1/2,3/2)	3467.3	68 28	8.4	
2386.6	(1/2,3/2)	2386.6	100	0.0	1/2 ⁺			3475.7	32	0.0	1/2 ⁺
2455.8	(1/2,3/2)	2447.4	30 19	8.4		3480.3	(1/2,3/2)	3480.3	100	0.0	1/2 ⁺
		2455.8	70	0.0	1/2 ⁺	3497.0	(1/2,3/2)	3497.0	100	0.0	1/2 ⁺
2466.0	(1/2,3/2)	2466.0	100	0.0	1/2 ⁺	3527.0	(1/2,3/2)	3518.6	58 42	8.4	
2492.0	(1/2,3/2)	2373.8	32 9	118.2				3527.0	42	0.0	1/2 ⁺
		2492.0	68	0.0	1/2 ⁺	3538.7	(1/2,3/2)	3538.7	100	0.0	1/2 ⁺
2553.4	(1/2,3/2)	2435.2	61 26	118.2		3541.9	(1/2,3/2)	3423.7	50 21	118.2	
		2553.4	39	0.0	1/2 ⁺			3541.9	50	0.0	1/2 ⁺
2571.4	(1/2,3/2)	2571.4	100	0.0	1/2 ⁺	3573.3	(1/2,3/2)	3573.3	100	0.0	1/2 ⁺
2598.6	(1/2,3/2)	2598.6	100	0.0	1/2 ⁺	3613.0	(1/2,3/2)	3613.0	100	0.0	1/2 ⁺
2602.8	(1/2,3/2)	2602.8	100	0.0	1/2 ⁺	3624.8	(1/2,3/2)	3506.6	35 9	118.2	
2687.0	(1/2,3/2)	2687.0	100	0.0	1/2 ⁺			3616.4	30 8	8.4	
2749.4	(1/2,3/2)	2741.0	49 21	8.4				3624.8	35	0.0	1/2 ⁺
		2749.4	51	0.0	1/2 ⁺	3724.7	(1/2,3/2)	3606.5	50 13	118.2	
2756.4	(1/2,3/2)	2756.4	100	0.0	1/2 ⁺			3724.7	50	0.0	1/2 ⁺
2769.1	(1/2,3/2)	2760.7	29 8	8.4		3736.2	(1/2,3/2)	3736.2	100	0.0	1/2 ⁺
		2769.1	71	0.0	1/2 ⁺	3741.7	(1/2,3/2)	3741.7	100	0.0	1/2 ⁺
2786.5	(1/2,3/2)	2786.5	100	0.0	1/2 ⁺	3766.3	(1/2,3/2)	3766.3	100	0.0	1/2 ⁺
2814.2	(1/2,3/2)	2805.8	47 42	8.4		3795.7	(1/2,3/2)	3787.3	62 79	8.4	
		2814.2	53	0.0	1/2 ⁺			3795.7	38	0.0	1/2 ⁺
2818.6	(1/2,3/2)	2818.6	100	0.0	1/2 ⁺	3806.7	(1/2,3/2)	3806.7	100	0.0	1/2 ⁺
2843.1	(1/2,3/2)	2843.1	100	0.0	1/2 ⁺	3862.5	(1/2,3/2)	3862.5	100	0.0	1/2 ⁺
2861.1	(1/2,3/2)	2861.1	100	0.0	1/2 ⁺	3875.3	(1/2,3/2)	3875.3	100	0.0	1/2 ⁺
2943.3	(1/2,3/2)	2825.1	27 24	118.2		3916.8	(1/2,3/2)	3916.8	100	0.0	1/2 ⁺
		2934.9	43 30	8.4		3950.2	(1/2,3/2)	3950.2	100	0.0	1/2 ⁺
		2943.3	30	0.0	1/2 ⁺	4103.6	(1/2,3/2)	4103.5	100	0.0	1/2 ⁺
2996.2	(1/2,3/2)	2878.0	53 14	118.2		4190.2	(1/2,3/2)	4181.7	64 67	8.4	
		2996.2	47	0.0	1/2 ⁺			4190.1	36	0.0	1/2 ⁺

Continued on next page (footnotes at end of table)

$^{169}\text{Tm}(\gamma, \gamma')$ **1999Hu01 (continued)** $\gamma(^{169}\text{Tm})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π
4279.7	(1/2,3/2)	4279.6	100	0.0	1/2 ⁺	5211.5	(1/2,3/2)	5211.4	100	0.0	1/2 ⁺
4764.5	(1/2,3/2)	4764.4	100	0.0	1/2 ⁺	5507	(1/2,3/2)	5507	100	0.0	1/2 ⁺
4789.8	(1/2,3/2)	4789.7	100	0.0	1/2 ⁺	5529.9	(1/2,3/2)	5529.8	100	0.0	1/2 ⁺
4853.0	(1/2,3/2)	4852.9	100	0.0	1/2 ⁺	5593.3	(1/2,3/2)	5584.8	41 48	8.4	
4865.5	(1/2,3/2)	4857.0	59 65	8.4				5593.2	59	0.0	1/2 ⁺
		4865.4	41	0.0	1/2 ⁺	5598.3	(1/2,3/2)	5598.2	100	0.0	1/2 ⁺
4954.0	(1/2,3/2)	4953.9	100	0.0	1/2 ⁺						

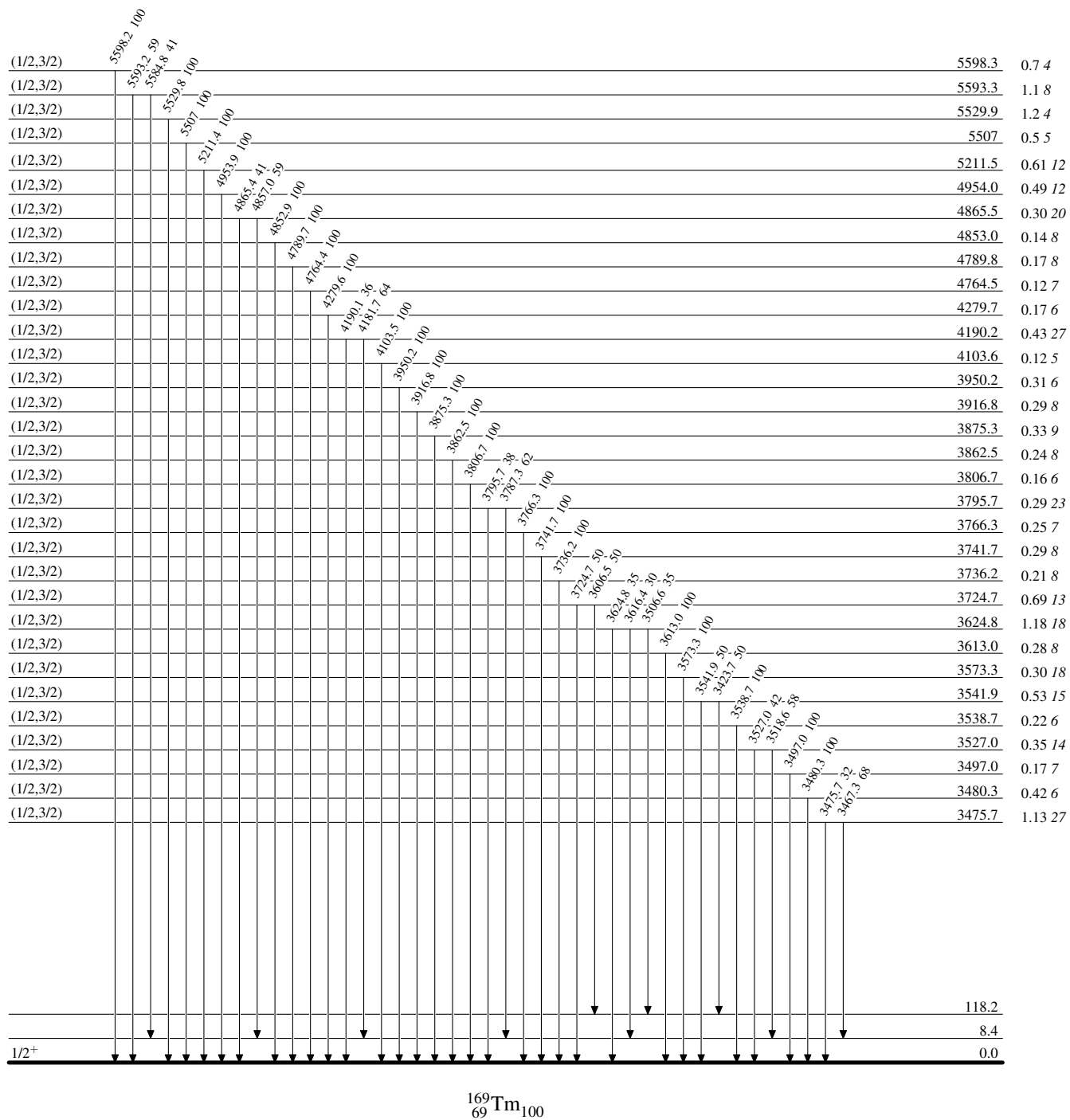
[†] Not given by authors; deduced from authors' level energies (corrected for recoil).

[‡] Percent photon branching from level (from authors' Γ_i/Γ for transitions to 8.4 and 118.2 levels, when present).

$^{169}\text{Tm}(\gamma, \gamma')$ 1999Hu01

Level Scheme

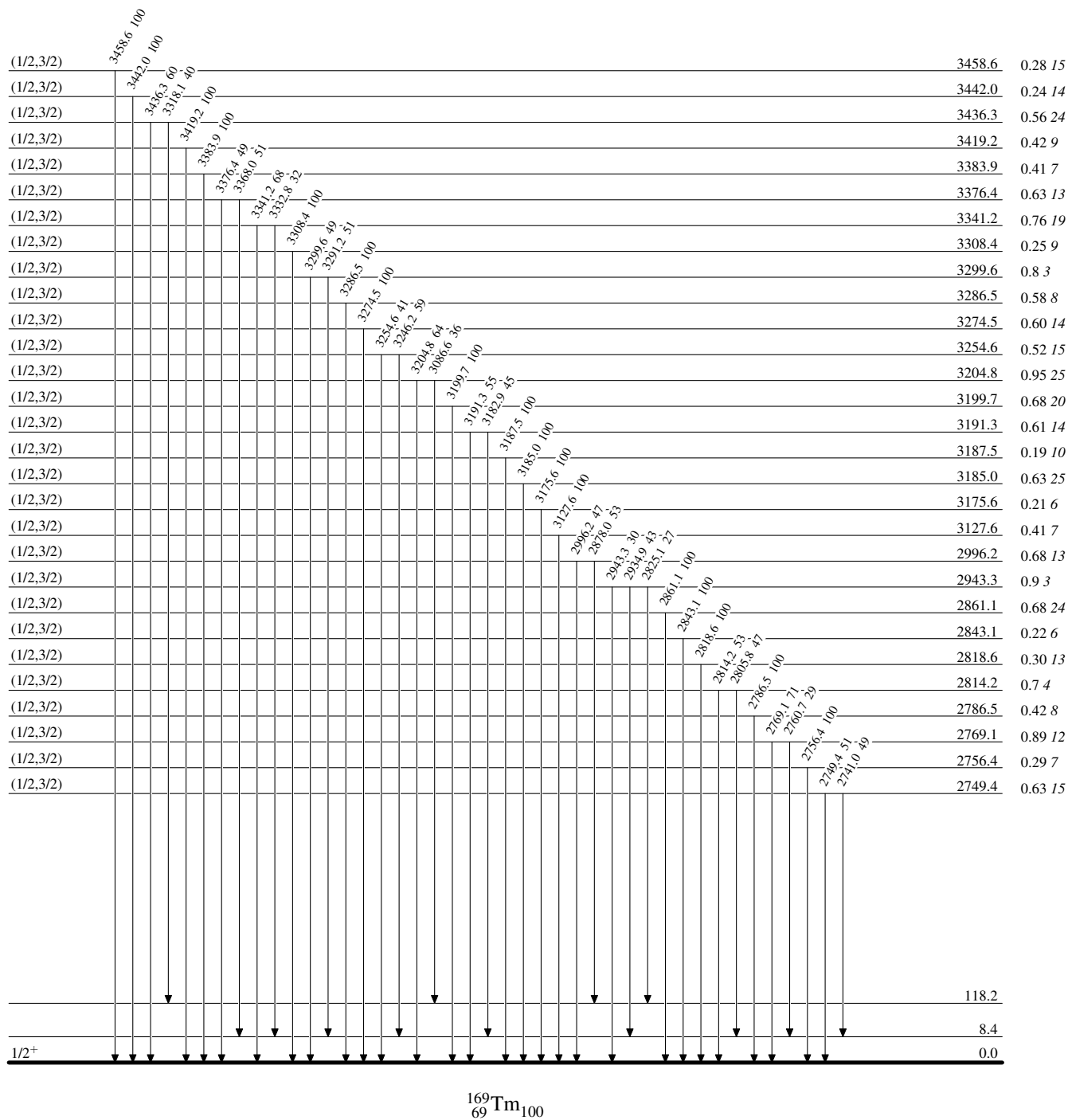
Intensities: % photon branching from each level



$^{169}\text{Tm}(\gamma, \gamma')$ 1999Hu01

Level Scheme (continued)

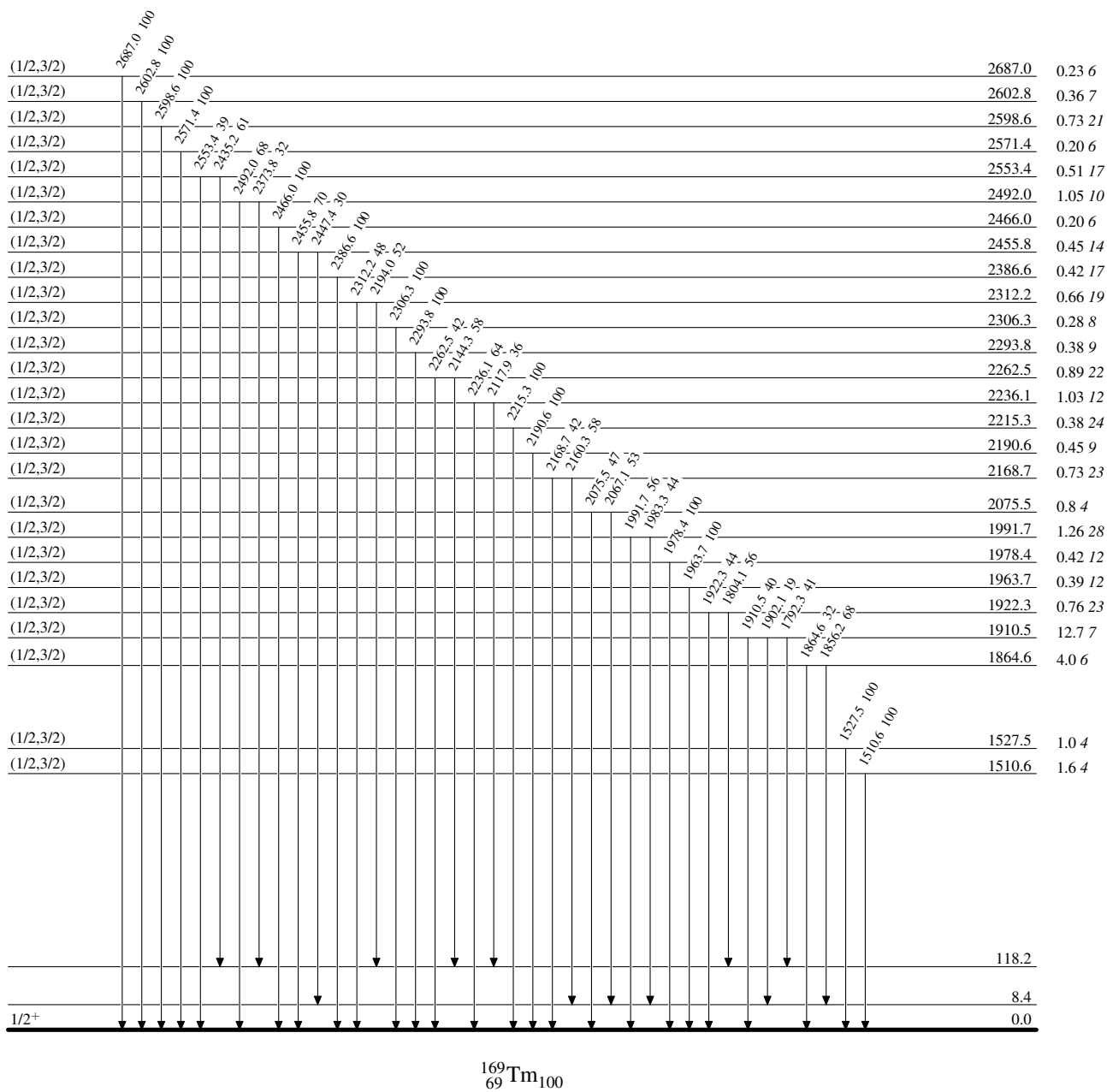
Intensities: % photon branching from each level



$^{169}\text{Tm}(\gamma, \gamma')$ 1999Hu01

Level Scheme (continued)

Intensities: % photon branching from each level



 $^{169}\text{Tm}(\text{e},\text{e}'\text{p})$ IAR [1976Su02](#)

No significant changes compared to that in the previous evaluation ([2008Ba31](#)) by C.M. Baglin.

Analyzed protons ($E(\text{p}) > 4.7$ MeV) with broad-range magnetic spectrometer, set at $\theta = 125.3^\circ$ relative to the electron beam (100 solid-state detectors); 99%-purity Tm target; investigated excitation energies from 15 MeV to 18 MeV.

 ^{169}Tm Levels

E(level) [†]	J^π [‡]	Comments
1.576×10^4 13	$1/2^-$	$\Gamma_{\gamma 0} = 10.0$ 11. Analog of $1/2^-$ $^{169}\text{Er}(\text{g.s.})$.
1.634×10^4 14	$(1/2)^-$	$\Gamma_{\gamma 0} = 13.9$ 12. Analog of $(1/2)^-$ $^{169}\text{Er}(562.0 \text{ level})$.

[†] From [1976Su02](#).

[‡] From J^π of analog state in ^{169}Er .

$^{169}\text{Tm}(n,n'\gamma),(\text{pol } n,n)$ **2000Ko61**

2000Ko61: $(n,n'\gamma)$, $E(n)=0.2\text{--}1.0$ MeV from pulsed p bombardment of Li; tof; Compton-suppressed Ge detector, plastic scin (n monitor); measured E_γ , I_γ , $\gamma(\theta)$ ($E(n)=750$ keV), $\theta(\text{lab})=25^\circ$ to 135° (10° steps), excit (125° , 50 keV steps), $d\sigma/d\Omega$.

Others: **1953Fo13** $((n,n')$, $E(n)=0.1 \approx 30$ eV; reported resonances at 3.92, 14.8, and 17.6 eV); **1969Ro13**; **1989Sc07** $((n,n')$,

$E(n)=7.75$ MeV, measured $\sigma(\theta)$, $A_\gamma(\theta)$ analyzing power, unresolved levels below 600 keV), **1965Ce01** (determined spin 1 for 3.92 eV resonance), **1967Al01** (studied 3.9 eV resonance).

 ^{169}Tm Levels

$E(\text{level})^\dagger$	$E(\text{level})^\dagger$	$E(\text{level})^\dagger$	$E(\text{level})^\dagger$
0.0	332.2 6	474.6 5	781.7 5
8.5 5	341.8 5	570.7 5	832.0 7
118.3 5	344.9 6	633.2 6	878.4 7
139.0 5	367.4 8	646.5 6	
316.2 6	429.8 8	718.7 6	

† From least-squares fit to E_γ .

 $\gamma(^{169}\text{Tm})$

$E_i(\text{level})$	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	Comments
118.3	109.9 6	100	8.5	
139.0	130.4 6	100	8.5	
316.2	177.0 6	60	139.0	
	198.0 6	100	118.3	
	307.3 6	23.4	8.5	
332.2	193.2 6	100	139.0	
	213.7 6	39.2	118.3	
341.8	333.3 6	100	8.5	
	341.8 6	57.5	0.0	
344.9	205.7 6	29.8	139.0	
	336.3 6	100	8.5	
367.4	228.4 6		139.0	
429.8	290.8 6	100	139.0	
474.6	356.5 6	67.2	118.3	
	465.8 6	14.9	8.5	
	474.6 6	100.0	0.0	
570.7	452.2 6	14.4	118.3	
	562.3 6	83.3	8.5	
	570.7 6	100.0	0.0	
633.2	494.1 6	28.3	139.0	
	515.0 6	78.1	118.3	
	624.7 6	100.0	8.5	
646.5	301.4 6	8.5	344.9	
	314.3 6	20.7	332.2	
	528.5 6	100.0	118.3	
718.7	386.2 6	15.0	332.2	
	579.9 6	100.0	139.0	
	600.5 6	57.4	118.3	
781.7	210.8 6	47.4	570.7	
	465.0 6	86.0	316.2	E_γ, I_γ : Less definitely determined (2000Ko61).
	643.0 6	31.0	139.0	
	663.6 6	90.0	118.3	
	773.6 6	100.0	8.5	
832.0	499.9 6	100.0	332.2	
	692.9 6	92.9	139.0	

Continued on next page (footnotes at end of table)

 $^{169}\text{Tm}(\text{n},\text{n}'\gamma),(\text{pol n},\text{n})$ **2000Ko61** (continued)

 $\gamma(^{169}\text{Tm})$ (continued)

$E_i(\text{level})$	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f
878.4	739.5 6	100.0	139.0
	760.1 6	66.4	118.3

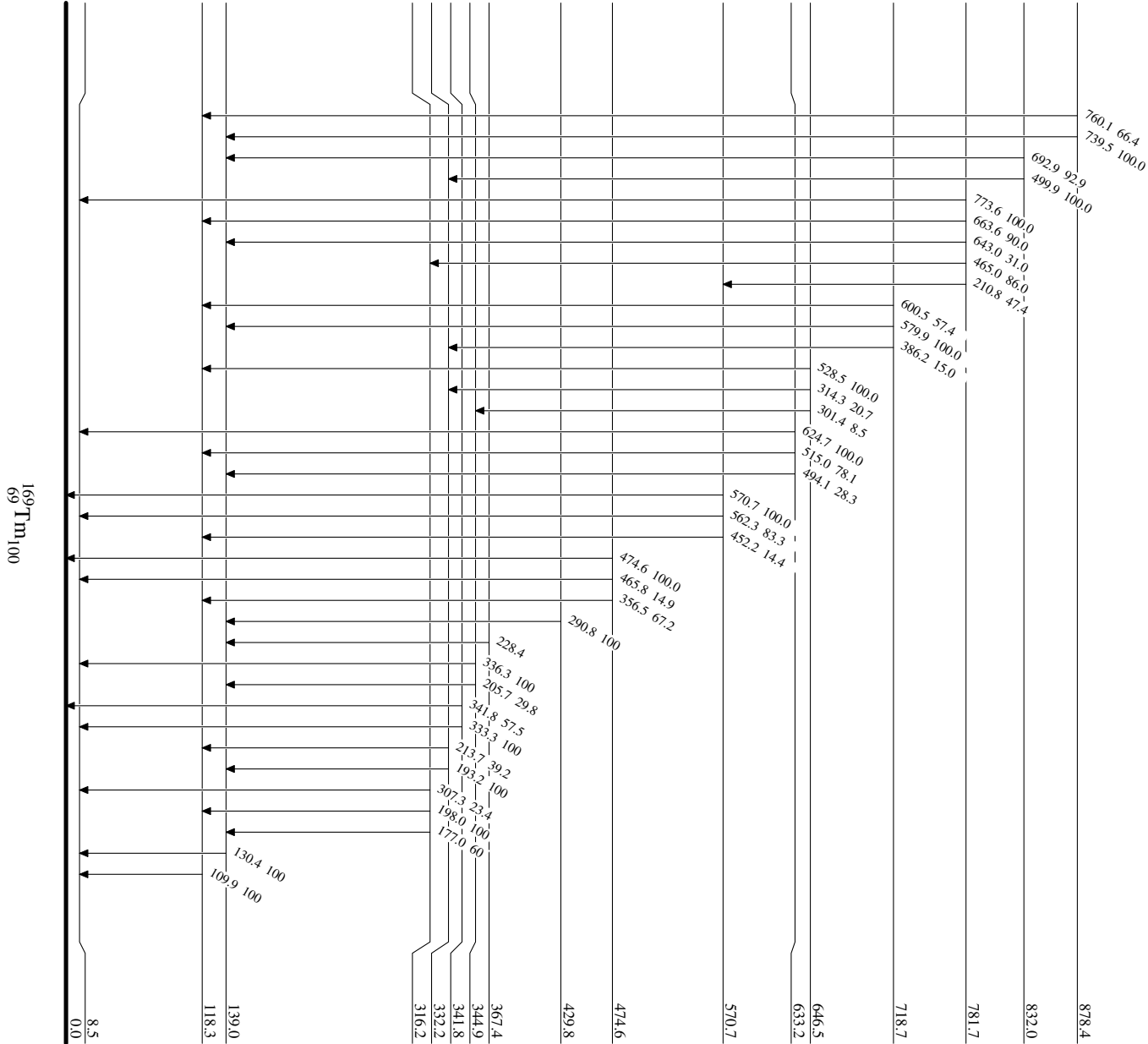
[†] Uncertainties range from 0.3 keV to 0.6 keV. The evaluator assigns 0.6 keV for all E_γ .

[‡] Relative photon branching from level. Authors noted uncertainties vary from 1% to 10% for strong lines but may be as high as 45% for weak transitions.

$^{169}\text{Tm}(n,n'\gamma),(\text{pol } n,n)$ 2000Ko61

Level Scheme

Intensities: Relative photon branching from each level



 $^{169}\text{Tm}(^3\text{He}, ^3\text{He}')$ [1975Ho05](#), [1980Bu16](#)

[1975Ho05](#): $E(^3\text{He})=80$ MeV from isochronous cyclotron at the Institut des Sciences Nucleaires in Grenoble; the scattered particles were detected with silicon detector telescopes at $\theta=25^\circ$; measured scattered $^3\text{He}'$, deduced giant resonance energy, full width, differential cross-section. Overall FWHM=250 keV.

[1980Bu16](#): $E(^3\text{He})=108.5$ MeV; performed at Institut des Sciences Nuclaires, Grenoble; spectrometer with position sensitive detector; $\theta=0^\circ$ to $\approx 8^\circ$; measured resonance E , Γ , strength for GMR.

 ^{169}Tm Levels

<u>E(level)</u>	<u>Comments</u>
1.20×10^4 5	E(level): from 1975Ho05 . $\Gamma=6.2 \times 10^3$ keV, $d\sigma/d\Omega(25^\circ)=2.5$ mb/sr 10 (1975Ho05).
1.47×10^4 3	E(level): from 1980Bu16 . GMR; %EWSR=51 12, $\Gamma=2.5 \times 10^3$ keV 3 (1980Bu16).

$^{169}\text{Tm}(^{32}\text{S}, ^{32}\text{S}'\gamma)$ **2019As06**

Edited/Adapted the XUNDL dataset compiled by B. Singh (McMaster), Oct 28, 2019.

2019As06: $E(^{32}\text{S})=164$ MeV beam from the 14-UD BARC-TIFR Pelletron, Mumbai. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin, $\gamma(\theta)$, $\gamma\gamma(\theta)(\text{DCO})$, and $\gamma\gamma(\text{lin pol})$ using INGA array of 19 Compton-suppressed clover HPGe detectors. Deduced high-spin levels, J^π , bands. Comparison with projected and cranked shell model calculations. Authors also published the same work in **2017As01**. In **2019As06**, more and precise data are presented compared to those in **2017As01**.

 ^{169}Tm Levels

E(level) [†]	J^π [‡]	Comments
0.0 [#]	1/2 ⁺	
8.41017 [@] 15	3/2 ⁺	E(level): from Adopted Levels.
117.93 [#] 7	5/2 ⁺	
138.96 [@] 10	7/2 ⁺	
315.54 12	7/2 ⁺	
331.87 [#] 12	9/2 ⁺	
367.68 [@] 12	11/2 ⁺	
379.27 ^a 18	7/2 ⁻	
430.02 ^{&} 13	9/2 ⁻	
473.25 ^b 16	9/2 ⁻	
588.34 ^a 19	11/2 ⁻	
602.88 ^{&} 13	13/2 ⁻	
636.89 [#] 13	13/2 ⁺	
690.70 [@] 14	15/2 ⁺	
725.29 ^b 20	13/2 ⁻	
865.62 ^{&} 15	17/2 ⁻	
883.30 ^a 23	15/2 ⁻	
1027.52 [#] 14	17/2 ⁺	
1063.11 ^b 25	17/2 ⁻	
1103.52 [@] 15	19/2 ⁺	
1217.73 ^{&} 19	21/2 ⁻	
1261.2 ^a 3	19/2 ⁻	
1482.3 ^b 3	21/2 ⁻	
1497.38 [#] 15	21/2 ⁺	
1597.87 [@] 21	23/2 ⁺	
1657.7 ^{&} 3	25/2 ⁻	
1706.1 ^a 4	(23/2 ⁻)	
1956.8 [#] 3	25/2 ⁺	
2024.5 ^{&} 4	(29/2 ⁻)	
2034.8 [@] 3	27/2 ⁺	
2421.0 [#] 4	29/2 ⁺	
2466.2 [@] 4	31/2 ⁺	

[†] Deduced by the evaluator from least-squares fit to $E\gamma$ data holding the 8.41017 level energy fixed and without considering the tentative or expected $E\gamma$ s. Reduced $\chi^2=3.2$ is larger than critical $\chi^2=1.8$. It is possible that some of the $E\gamma$ uncertainties are underestimated.

[‡] As given in **2019As06**, based on DCO ratios, linear polarization asymmetries, and band structures.

[#] Band(A): $\pi 1/2[411], \alpha=+1/2$.

$^{169}\text{Tm}(^{32}\text{S}, ^{32}\text{S}'\gamma)$ **2019As06 (continued)** ^{169}Tm Levels (continued)

@ Band(a): $\pi 1/2[411], \alpha = -1/2$.

& Band(B): $\pi 1/2[541], \alpha = +1/2$. Band crossing observed.

^a Band(C): $\pi 7/2[523], \alpha = -1/2$.

^b Band(c): $\pi 7/2[523], \alpha = +1/2$.

 $\gamma(^{169}\text{Tm})$

DCO values are from gates on $\Delta J=2$, stretched quadrupole transitions.

E_γ	$I_\gamma^{\ddagger}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [#]	Comments
(34)		636.89	13/2 ⁺	602.88	13/2 ⁻		
63.0		379.27	7/2 ⁻	315.54	7/2 ⁺		
87.7 <i>1</i>	1.89 <i>2</i>	690.70	15/2 ⁺	602.88	13/2 ⁻	D	DCO=0.66 <i>9</i> Mult.: other: E1 in 2019As06 .
93.8 <i>2</i>	0.29 <i>2</i>	473.25	9/2 ⁻	379.27	7/2 ⁻	[M1+E2]	
109.6 [†] <i>1</i>	100.00 [†] <i>9</i>	117.93	5/2 ⁺	8.41017	3/2 ⁺	D+Q	DCO=0.86 <i>1</i> Mult.: other: M1+E2 in 2019As02 .
115.0 <i>2</i>	0.98 <i>3</i>	588.34	11/2 ⁻	473.25	9/2 ⁻	[M1+E2]	
117.8 [†] <i>1</i>	10.13 [†] <i>3</i>	117.93	5/2 ⁺	0.0	1/2 ⁺	Q	DCO=0.94 <i>5</i> Mult.: other: E2 in 2019As02 .
130.6 [†] <i>1</i>	72.65 [†] <i>8</i>	138.96	7/2 ⁺	8.41017	3/2 ⁺	Q	DCO=0.95 <i>3</i> Mult.: other: E2 in 2019As02 .
136.8 <i>1</i>	1.02 <i>3</i>	725.29	13/2 ⁻	588.34	11/2 ⁻	[M1+E2]	
141.7 <i>2</i>	0.12 <i>4</i>	473.25	9/2 ⁻	331.87	9/2 ⁺	[E1]	
157.8 <i>2</i>	0.33 <i>2</i>	883.30	15/2 ⁻	725.29	13/2 ⁻	[M1+E2]	
162 ^{&}	0.03 <i>1</i>	1027.52	17/2 ⁺	865.62	17/2 ⁻		E_γ : observed (inset of Fig. 4(a)), listed in parentheses in Table 1. The evaluator interpret it as a tentative placement and not adopted.
173.1 <i>1</i>	1.75 <i>3</i>	602.88	13/2 ⁻	430.02	9/2 ⁻	[E2]	
174.6 <i>2</i>	0.20 <i>1</i>	865.62	17/2 ⁻	690.70	15/2 ⁺	D	DCO=0.58 <i>12</i> Mult.: other: E1 in 2019As02 .
179.6 <i>2</i>	0.20 <i>2</i>	1063.11	17/2 ⁻	883.30	15/2 ⁻	[M1+E2]	
192.9 [†] <i>1</i>	61.49 [†] <i>7</i>	331.87	9/2 ⁺	138.96	7/2 ⁺	M1+E2	DCO=0.88 <i>1</i> Pol=-0.026 <i>1</i> .
197.6 [@] <i>1</i>	1.72 [@] <i>2</i>	315.54	7/2 ⁺	117.93	5/2 ⁺	[M1+E2]	
197.6 [@] <i>2</i>	1.72 [@] <i>2</i>	1261.2	19/2 ⁻	1063.11	17/2 ⁻	[M1+E2]	
209.0 <i>2</i>	0.21 <i>2</i>	588.34	11/2 ⁻	379.27	7/2 ⁻	[E2]	
213.6 [†] <i>3</i>	25.55 [†] <i>5</i>	331.87	9/2 ⁺	117.93	5/2 ⁺	E2	DCO=0.96 <i>1</i> Pol=+0.046 <i>3</i> .
221.1 <i>2</i>	0.15 <i>2</i>	1482.3	21/2 ⁻	1261.2	19/2 ⁻	[M1+E2]	
223.8 <i>2</i>	0.08 <i>2</i>	1706.1	(23/2 ⁻)	1482.3	21/2 ⁻	[M1+E2]	
228.6 [†] <i>1</i>	54.36 [†] <i>7</i>	367.68	11/2 ⁺	138.96	7/2 ⁺	E2	DCO=0.99 <i>1</i> Pol=+0.038 <i>1</i> .
235.0 <i>1</i>	2.99 <i>3</i>	602.88	13/2 ⁻	367.68	11/2 ⁺	E1	DCO=0.59 <i>2</i> $\delta(M2/E1)=0.00$ <i>5</i> from DCO and Pol values. Pol=+0.09 <i>2</i> . DCO=0.55 <i>6</i>
237.9 <i>2</i>	0.10 <i>2</i>	1103.52	19/2 ⁺	865.62	17/2 ⁻	[E1]	
240.1 <i>2</i>	0.02 <i>1</i>	379.27	7/2 ⁻	138.96	7/2 ⁺	[E1]	
252.2 <i>2</i>	0.18 <i>1</i>	725.29	13/2 ⁻	473.25	9/2 ⁻	[E2]	
262.9 <i>1</i>	1.33 <i>4</i>	865.62	17/2 ⁻	602.88	13/2 ⁻	Q	DCO=0.94 <i>14</i> Mult.: other: E2 in 2019As02 .

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$^{169}\text{Tm}(^{32}\text{S}, ^{32}\text{S}'\gamma)$ **2019As06** (continued) $\gamma(^{169}\text{Tm})$ (continued)

E_γ	$I_\gamma^\ddagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [#]	δ	Comments
269.4 [†] 1	25.01 [†] 4	636.89	13/2 ⁺	367.68	11/2 ⁺	M1+E2		DCO=0.64 1 Pol=-0.034 1.
280.1 2	0.05 1	1497.38	21/2 ⁺	1217.73	21/2 ⁻	[E1]		
291.3 1	1.98 5	430.02	9/2 ⁻	138.96	7/2 ⁺	E1		DCO=0.60 5 Pol=+0.02 1.
295.4 2	0.22 1	883.30	15/2 ⁻	588.34	11/2 ⁻	[E2]		
304.9 [†] 1	20.88 [†] 4	636.89	13/2 ⁺	331.87	9/2 ⁺	E2		DCO=1.06 1 Pol=+0.089 2.
322.9 [†] 1	16.87 [†] 4	690.70	15/2 ⁺	367.68	11/2 ⁺	E2		DCO=1.01 1 A ₂ =+0.243 9; A ₄ =-0.042 13 Pol=+0.081 2.
334.2 2	0.05 1	473.25	9/2 ⁻	138.96	7/2 ⁺	[E1]		
336.8 [†] 1	4.55 [†] 2	1027.52	17/2 ⁺	690.70	15/2 ⁺	M1+E2	-0.13 4	DCO=0.45 2 A ₂ =-0.311 48; A ₄ =+0.002 75 δ : from $\gamma(\theta)$, with alignment parameter $\sigma/J \approx 0.42$ 3. $\delta(\text{E2/M1}) = -0.15$ 2 from DCO and POL data. Pol=-0.037 1.
337.6 2	0.10 1	1063.11	17/2 ⁻	725.29	13/2 ⁻	[E2]		
352.4 2	0.30 1	1217.73	21/2 ⁻	865.62	17/2 ⁻	[E2]		
359.0 ^{&}		1956.8	25/2 ⁺	1597.87	23/2 ⁺			E_γ : observed (Fig. 5(a)), listed without parentheses and intensity in Table 1. The evaluator interpret it as a tentative placement.
366.8 2	0.08 2	2024.5	(29/2 ⁻)	1657.7	25/2 ⁻	[E2]		
378.3 2	0.05 1	1261.2	19/2 ⁻	883.30	15/2 ⁻	[E2]		
380.0 2	0.08 2	1597.87	23/2 ⁺	1217.73	21/2 ⁻	[E1]		
390.7 [†] 1	9.49 [†] 3	1027.52	17/2 ⁺	636.89	13/2 ⁺	E2		DCO=1.02 2 Pol=+0.093 3.
393.7 [†] 1	1.12 [†] 1	1497.38	21/2 ⁺	1103.52	19/2 ⁺	M1+E2		DCO=0.47 3 Pol=-0.136 15.
412.7 [†] 1	4.89 [†] 2	1103.52	19/2 ⁺	690.70	15/2 ⁺	E2		DCO=1.02 5 Pol=+0.098 3.
419.2 2	0.08 1	1482.3	21/2 ⁻	1063.11	17/2 ⁻	[E2]		
431.4 [†] 2	0.018 [†] 2	2466.2	31/2 ⁺	2034.8	27/2 ⁺	[E2]		
436.9 [†] 2	0.053 [†] 1	2034.8	27/2 ⁺	1597.87	23/2 ⁺	[E2]		
440.0 2	0.14 2	1657.7	25/2 ⁻	1217.73	21/2 ⁻	[E2]		
445 ^{&}		1706.1	(23/2 ⁻)	1261.2	19/2 ⁻			E_γ : observed (Fig. 5(b)), listed in parentheses in Table 1. The evaluator interpret it as a tentative placement.
459.4 [†] 2	0.030 [†] 1	1956.8	25/2 ⁺	1497.38	21/2 ⁺	[E2]		
464.2 [†] 2	0.047 [†] 1	2421.0	29/2 ⁺	1956.8	25/2 ⁺	[E2]		
469.9 [†] 1	2.18 [†] 2	1497.38	21/2 ⁺	1027.52	17/2 ⁺	E2		DCO=1.01 5 Pol=+0.059 6.
494.5 [†] 2	0.12 [†] 2	1597.87	23/2 ⁺	1103.52	19/2 ⁺	[E2]		

[†] From 2017As01 and also listed in 2019As06.

[‡] In 2019As06, relative intensities are presented with respect to $I_\gamma(109.6\gamma)=1000$, in this dataset values are scaled down by a factor of 10. It appears that some of the uncertainties for relative I_γ values listed in Table 1 of 2019As06 are too small to be realistic, e.g. 0.1% for the 109.6, 130.6, 192.9, 228.6 gamma rays. The quoted uncertainties are probably only statistical.

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 $^{169}\text{Tm}(^{32}\text{S}, ^{32}\text{S}'\gamma)$ **2019As06 (continued)**

 $\gamma(^{169}\text{Tm})$ (continued)

Assignments given in parentheses in Table I of [2019As06](#) are from ΔJ^π values. The evaluator treated these as assumed and placed in square brackets. D or D+Q are assigned based on the DCO ratio, pure electric or mixed with magnetic are presented in [2019As02](#).

@ Multiply placed with undivided intensity.

& Placement of transition in the level scheme is uncertain.

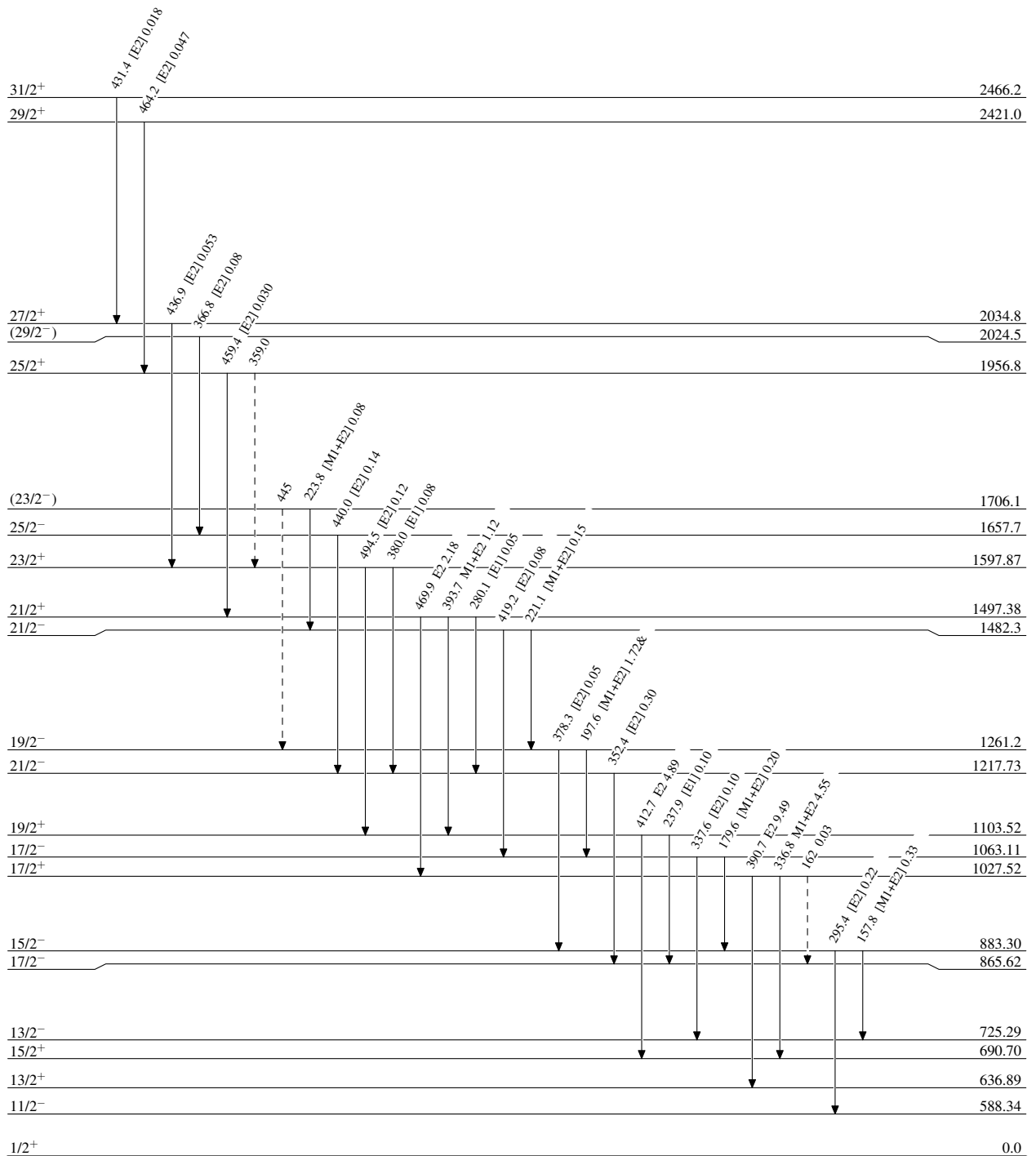
$^{169}\text{Tm}(^{32}\text{S}, ^{32}\text{S}'\gamma)$ 2019As06

Level Scheme

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

Legend

-  $I_\gamma < 2\% \times I_\gamma^{\max}$
 $I_\gamma < 10\% \times I_\gamma^{\max}$
 $I_\gamma > 10\% \times I_\gamma^{\max}$
 γ Decay (Uncertain)

 $^{169}\text{Tm}_{100}$

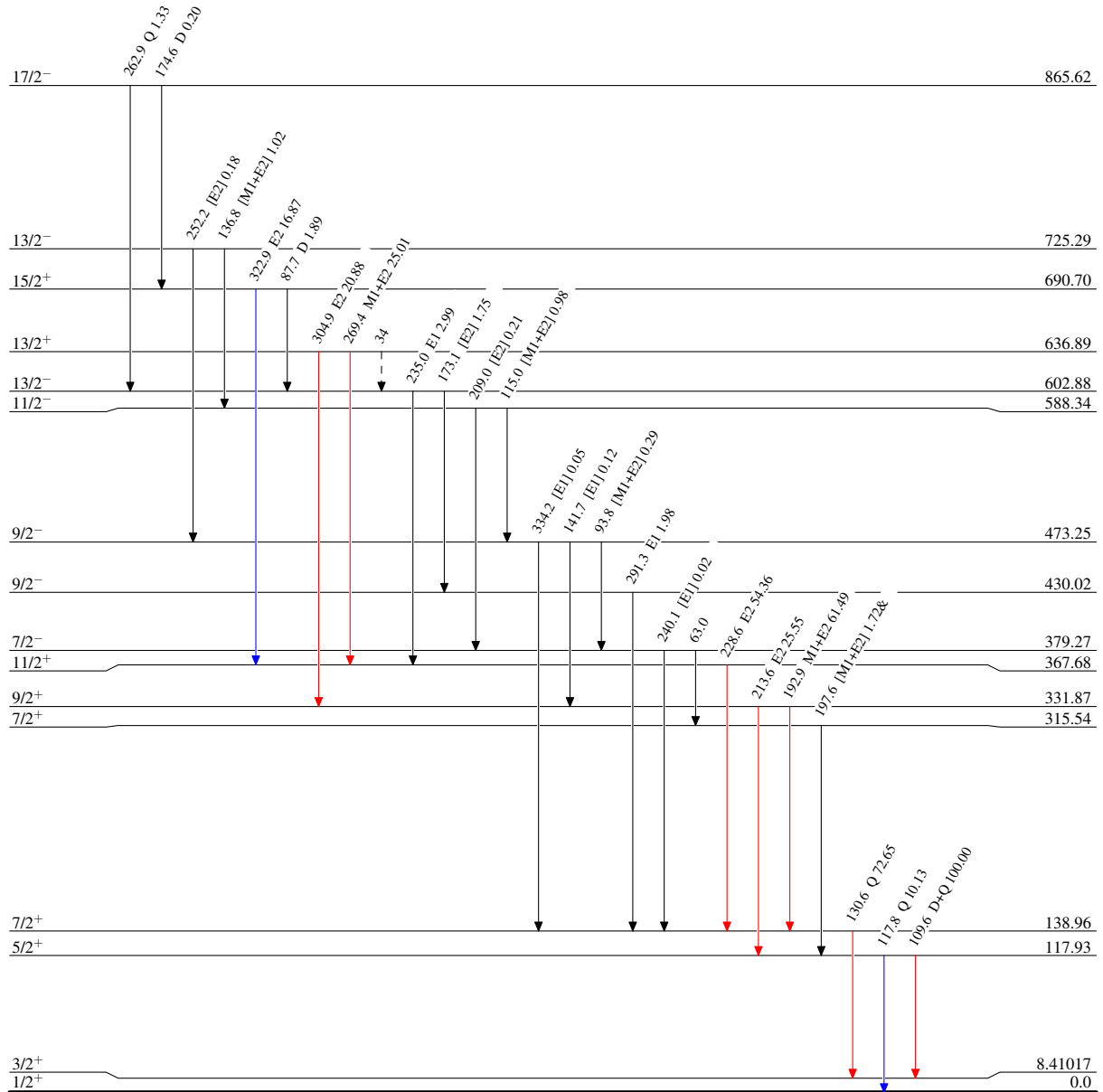
$^{169}\text{Tm}(^{32}\text{S}, ^{32}\text{S}'\gamma)$ 2019As06

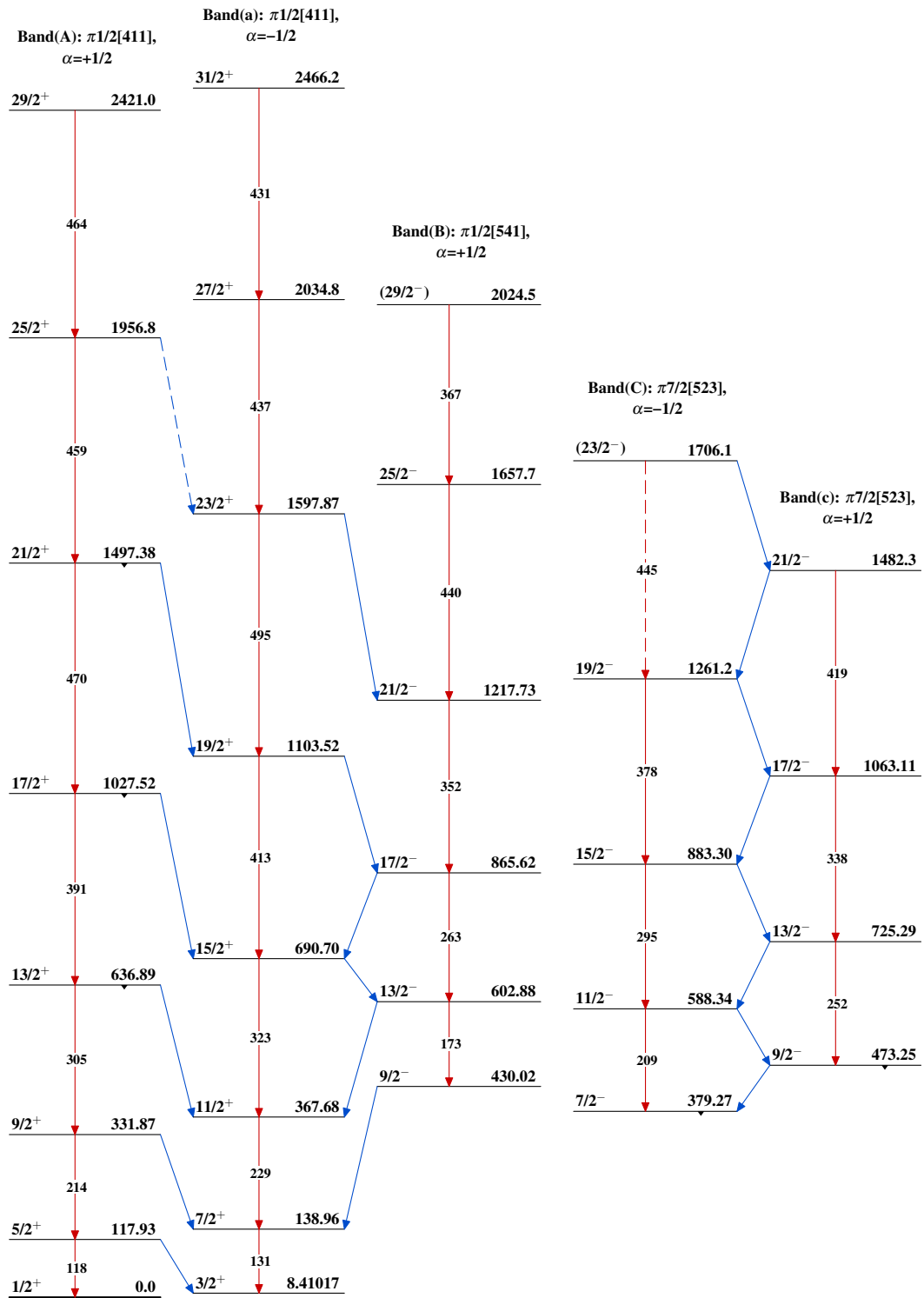
Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $-----\longrightarrow$ γ Decay (Uncertain)

 $^{169}\text{Tm}_{100}$

$^{169}\text{Tm}(^{32}\text{S}, ^{32}\text{S}'\gamma)$ 2019As06 $^{169}_{69}\text{Tm}_{100}$

Coulomb excitation 1977Ta10,1999Ro03

1977Ta10: $E(^{32}\text{S})=130\text{--}140$ MeV; thulium metal targets; measured $E\gamma$, $I\gamma$ (Ge(Li), resolution ≈ 2 keV at 1.3 MeV), ^{32}S - γ coin, γ -ray angular distributions (0° to 90° , 15° steps), level lifetimes.

1999Ro03: $E(^{58}\text{Ni})=170, 190, 220$ MeV; ^{169}Tm /annealed Gd foil/Cu targets; Ge detectors (at $\pm 60^\circ$ and $\pm 120^\circ$ for transient field measurements, at 0° to 65° for angular correlation study), Si surface barrier detector for charged particle detection; measured g-factors ($\gamma(\theta, H, t)$, $H=0.08$ T), $E\gamma$, $I\gamma$, ^{58}Ni - $\gamma(\theta)$, relative Coulomb excitation cross sections; g-factors determined relative to values of 0.304 18 and 0.383 14, respectively, for the $5/2^+$ and $7/2^+$ members of the g.s. band.

Others:

1958Ch36: $E(p)=3.7$ MeV; bent quartz crystal spectrograph, measured $E\gamma$.

1960B110: $E(p)=2.5$ MeV; microwave beam pulsing system and a beta-ray spectrometer. Measured mean-lifetime of 118 keV ($5/2^+$) state.

1963De25: $E(^{16}\text{O})=44$ MeV.

1963Di09: $E(^{16}\text{O})=60$ MeV; NaI, scintillation counter; measured $E\gamma$, conversion electron.

1965As03: $E(\alpha)=3.1$ MeV; Two NaI, measured $E\gamma$, $\gamma(\theta)$.

1967Se09: $E(^{16}\text{O})=50$ MeV, determined the branching ratios for the de-excitation of levels in the ground-state rotational bands by measuring the γ -ray intensities in singles spectra with a Ge(Li) detector.

1979BaYN: $E(^{16}\text{O})=60$ MeV.

1955He64: $E(\alpha)=6$ MeV; NaI; measured $E\gamma$, $I\gamma$.

1956Hu49, 1958Ma36, 1960Be16, 1960Na13, 1960OI02, 1961Po08, 1964Ho18, 1964Ho25, 1965De05, 1966Bo16, 1979Wa15.

The level scheme is from **1977Ta10**, except where noted.

 ^{169}Tm Levels

$E(\text{level})^\dagger$	J^π	$T_{1/2}$	Comments
0.0 [#]	$1/2^+$		
8.39 [#] 5	$3/2^+$	4.09 ns 6	$T_{1/2}$: from Adopted Levels.
118.16 [#] 4	$5/2^+$	62 ps 3	$T_{1/2}$: 62.4 ps 28 from microwave pulsed beam measurements (1960B110); see ^{169}Tm Adopted Levels for other $T_{1/2}$ data.
138.72 [#] 23	$7/2^+$	302 ps 2	$T_{1/2}$: recoil-shadow measurements (1979BaYN); uncertainty includes only statistical component (total uncertainty is most certainly larger). See ^{169}Tm Adopted Levels for other $T_{1/2}$ data.
331.80 [#] 24	$9/2^+$	18.8 ps 5	g-factor= $+0.347$ 20 (1999Ro03). $T_{1/2}$: from $\tau=27.1$ ps 7 – recoil-distance measurements (1977Ta10).
367.0 [#] 4	$11/2^+$	41.6 ps 21	g-factor= $+0.414$ 26 (1999Ro03). $T_{1/2}$: from $\tau=60.0$ ps 3 – recoil-distance measurement (1977Ta10).
571.00 [@] 23	$3/2^+$	10 ps 6	$B(E2)\uparrow=0.033$ 4 $B(E2)\uparrow$: from $BE2\downarrow$ (listed in 1967Se09 as $\varepsilon B(E2)\uparrow=0.0167$ 22 for 571γ . Other: 0.026 3 (1963Di09 from $BE2\downarrow$ (listed as $\varepsilon B(E2)\uparrow=12.8 \times 10^{-51}$ e ² .cm ⁴) for 571γ . Uncertainty from 11% in column 5 Table 6, 1963De25 . J^π : E2 excitation from ratio of thick target yields at two ^{16}O beam energies for ce(K) of 562 and 570 transitions (1963Di09). $T_{1/2}$: deduced from $B(E2)\uparrow$ and adopted $E\gamma$, transition branching.
633.1 [@] 5	$5/2^+$	0.27 ps +33–12	$B(E2)\uparrow=0.0039$ 27 $B(E2)\uparrow$: from $BE2\downarrow$ (1963Di09 from $BE2\downarrow$ (listed as $\varepsilon B(E2)\uparrow=1.3 \times 10^{-51}$ e ² .cm ⁴) for 633γ . 70% uncertainty from Table 6 column 5. $T_{1/2}$: from $B(E2)\uparrow=0.0039$ and adopted γ -ray properties ($E\gamma$, transition branching).
636.5 [#] 4	$13/2^+$	5.4 ps 3	g-factor= $+0.365$ 22 (1999Ro03). $T_{1/2}$: from $\tau=7.8$ ps 5 – recoil-distance and Doppler-broadened line shape measurements (1977Ta10).
690.3 [#] 9	$15/2^+$	8.1 ps 3	g-factor= $+0.42$ 4 (1999Ro03). $T_{1/2}$: from $\tau=11.7$ ps 5 – recoil-distance and Doppler-broadened line shape measurements (1977Ta10).
717.9 [@] 8	$(7/2^+)$		

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Coulomb excitation 1977Ta10,1999Ro03 (continued) ^{169}Tm Levels (continued)

<u>E(level)[†]</u>	<u>J^π[‡]</u>	<u>T_{1/2}</u>	<u>Comments</u>
≈900?			B(E2) [†] =0.008 4 B(E2) [†] : from 1963Di09 (listed as $\epsilon_\gamma B(E2)=(8\ 4) \times 10^{-51} \text{ e}^2.\text{cm}^4$) for ≈900γ.
1027.4 [#] 9	17/2 ⁺	1.91 ps 17	g-factor=+0.37 4 (1999Ro03). T _{1/2} : from τ=2.75 ps 25 – Doppler-broadened line shape measurements (1977Ta10).
1103.0 [#] 12	19/2 ⁺	1.94 ps 21	g-factor=+0.44 8 (1999Ro03). T _{1/2} : from τ=2.8 ps 3 – Doppler-broadened line shape measurements (1977Ta10).
1190 20	+		B(E2) [†] =0.040 9 B(E2) [†] : weighted average of 0.039 13 (1963De25) and 0.041 12 (1963Di09 – listed as $\epsilon_\gamma B(E2)=(41\ 12) \times 10^{-51} \text{ e}^2.\text{cm}^4$ for ≈1170γ).
1497.0 [#] 12	21/2 ⁺	0.87 ps 9	T _{1/2} : from τ=1.25 ps 13 – Doppler-broadened line shape measurements (1977Ta10).
1597.0 [#] 15	(23/2 ⁺)		

[†] From least-squares fit to Eγ, assigning 1 keV uncertainty to Eγ data for which the authors stated no uncertainty.

[‡] Adopted values.

[#] Band(A): 1/2[411].

[@] Band(B): 3/2[411] + K=2 γ vibration built on 1/2[411].

Coulomb excitation **1977Ta10,1999Ro03** (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\&$	E_f	J_f^π	Mult. ^a	$\gamma(^{169}\text{Tm})$		Comments
							δ^a	α^c	
8.39	3/2 ⁺	(8.41)		0.0	1/2 ⁺				E_γ : adopted value (rounded).
118.16	5/2 ⁺	109.77 [‡] 3	100.0 4	8.39	3/2 ⁺	M1+E2	-0.141 25	2.37	$A_2=-0.456$ 24; $A_4=0.00$ 3 (1977Ta10) $A_2=-0.339$ 14 (1965As03) $\varepsilon\text{B}(E2)\uparrow=1.1$ 3 (1955He64). I_γ : from 90.6 4 (1977Ta10). Other: 100.0 (1999Ro03). δ : unweighted average of -0.116 4 from 1999Ro03 ($^{58}\text{Ni}-\gamma(\theta)$) and -0.146 16 from 1965As03 ($\alpha-\gamma(\theta)$).
		118.16 [‡] 4	10.21 5	0.0	1/2 ⁺	E2 ^b		1.643	$A_2=+0.44$ 12; $A_4=-0.39$ 15 (1977Ta10) I_γ : from 1999Ro03. Others: 11.0 20 (1967Se09), 10.4 4 (1977Ta10) – from 9.42 4), 10.3 10 (1966Bo16).
138.72	7/2 ⁺	20.8	1.68 13	118.16	5/2 ⁺				E_γ : from 1999Ro03. I_γ : from 1999Ro03. Other: 1.42 21 (1977Ta10 – from 1.40 21 average value of literature data).
		130.2 [@] 3	100.0	8.39	3/2 ⁺	E2 ^b		1.154 19	$A_2=+0.351$ 16; $A_4=-0.110$ 20 (1977Ta10) I_γ : from 1999Ro03. Other: 100 (1977Ta10 – from 98.6).
331.80	9/2 ⁺	193.0 [@] 3	100 3	138.72	7/2 ⁺	M1+E2	-0.126 21	0.480 8	$A_2=+0.534$ 17; $A_4=-0.016$ 20 (1977Ta10) I_γ : from 67 2 (1977Ta10). Other: 100.0 (1999Ro03). δ : unweighted average of -0.146 3 (1999Ro03), -0.105 11 (1977Ta10).
		213.7 [@] 3	45.6 8	118.16	5/2 ⁺	E2 ^b		0.209	$A_2=+0.455$ 24; $A_4=-0.21$ 3 (1977Ta10) I_γ : weighted average of 49 3 (from 33 2 in 1977Ta10), 45.2 5 (1999Ro03), 56 5 (1967Se09), and 48 2 (1966Bo16).
367.0	11/2 ⁺	228.3 [@] 3	100	138.72	7/2 ⁺	E2 ^b		0.1683	$A_2=+0.451$ 13; $A_4=-0.198$ 16 (1977Ta10)
571.00	3/2 ⁺	452.8 [@] 3		118.16	5/2 ⁺	M1+E2	1.5 +9-4	0.030 5	Mult., δ : from $\alpha(\text{K})\text{exp}=0.025$ 4, as deduced from $\varepsilon(\text{K})\text{B}(E2)\uparrow=6.2\times 10^{-5}$ 9 (1963Di09) and $\varepsilon(\gamma)\text{B}(E2)\uparrow=2.45\times 10^{-3}$ 25 (1967Se09).
		562.7 [@] 5		8.39	3/2 ⁺	M1+E2	0.8 +5-4	0.022 4	Mult., δ : from $\alpha(\text{K})\text{exp}=0.018$ 3, as deduced from $\varepsilon(\text{K})\text{B}(E2)\uparrow=2.4\times 10^{-4}$ 3 (1963Di09) and $\varepsilon(\gamma)\text{B}(E2)\uparrow=0.0132$ 13 (1967Se09). Other: $\varepsilon(\gamma)\text{B}(E2)\uparrow=0.010$ (1960Na13).
		571.0 [@] 5		0.0	1/2 ⁺	M1+E2	0.8 +5-4	0.021 4	Mult., δ : from $\alpha(\text{K})\text{exp}=0.017$ 3, as deduced from $\varepsilon(\text{K})\text{B}(E2)\uparrow=2.9\times 10^{-4}$ 3 (1963Di09) and $\varepsilon(\gamma)\text{B}(E2)\uparrow=0.0167$ 22 (1967Se09).
633.1	5/2 ⁺	494 [#] 1		138.72	7/2 ⁺				$\varepsilon(\text{K})\text{B}(E2)\uparrow=1.8\times 10^{-5}$ 10 (1963Di09).
		515 [#] 1		118.16	5/2 ⁺				$\varepsilon(\text{K})\text{B}(E2)\uparrow=3.6\times 10^{-5}$ 10 (1963Di09).
		625 [#] 1		8.39	3/2 ⁺				$\varepsilon(\text{K})\text{B}(E2)\uparrow=3.8\times 10^{-5}$ 9 (1963Di09).
		633 [#] 1		0.0	1/2 ⁺				$\varepsilon(\text{K})\text{B}(E2)\uparrow=1.0\times 10^{-5}$ 7 (1963Di09).
636.5	13/2 ⁺	269.5 [@] 3	92 4	367.0	11/2 ⁺	M1+E2	-0.149 21	0.191	$A_2=-0.532$ 24; $A_4=-0.04$ 3 (1977Ta10)

Coulomb excitation **1977Ta10,1999Ro03** (continued)

E _i (level)	J ^π _i	E _γ [†]	I _γ ^{&}	E _f	J ^π _f	Mult. ^a	γ(¹⁶⁹ Tm) (continued)		Comments
							δ ^a	α ^c	
									I _γ : from 48 2 (1977Ta10). Other: 99.6 12 (1999Ro03), 79 8 (1967Se09).
									δ: unweighted average of -0.174 3 (1999Ro03), -0.123 14 (1977Ta10).
636.5	13/2 ⁺	304.7 [@] 3	100 4	331.80	9/2 ⁺	E2 ^b		0.0682	A ₂ =+0.431 27; A ₄ =-0.17 3 (1977Ta10)
690.3	15/2 ⁺	323.3	100	367.0	11/2 ⁺	E2 ^b		0.0571	I _γ : from 52 2 (1977Ta10). Other: 100.0 (1999Ro03).
717.9	(7/2 ⁺)	579 [#] 1		138.72	7/2 ⁺				A ₂ =+0.45 4; A ₄ =-0.21 5 (1977Ta10)
		600 [#] 1		118.16	5/2 ⁺				
≈900?		≈900 ^d		0.0	1/2 ⁺				E _γ : from 1963Di09 .
1027.4	17/2 ⁺	337.2	58.6 9	690.3	15/2 ⁺	M1+E2	-0.18 3	0.1043 16	A ₂ =-0.58 9; A ₄ =-0.10 11 (1977Ta10)
									I _γ : weighted average of 52 5 (1977Ta10 – from 34 3) and 58.7 7 (1999Ro03).
									δ: weighted average of -0.199 20 (1999Ro03) and -0.127 35 (1977Ta10) (as recommended in 1999Ro03).
		390.9	100 5	636.5	13/2 ⁺	E2 ^b		0.0331	A ₂ =+0.42 5; A ₄ =-0.50 6 (1977Ta10)
1103.0	19/2 ⁺	412.7	100	690.3	15/2 ⁺	E2 ^b		0.0285	I _γ : from 66 3 (1977Ta10). Other: 100.0 (1999Ro03).
1190	⁺	1190 20		0.0	1/2 ⁺				A ₂ =+0.28 11; A ₄ =-0.09 13 (1977Ta10)
1497.0	21/2 ⁺	394.0		1103.0	19/2 ⁺				E _γ : from 1963De25 . Other value: ≈1170 (1963Di09).
									E _γ : from 1999Ro03 .
									I _γ : 27 (from 21.2 – calculated value in 1977Ta10). Other: 14 <1γ <44 (1999Ro03).
		469.5	100	1027.4	17/2 ⁺	E2 ^b		0.0202	A ₂ =+0.7 3; A ₄ =-0.3 3 (1977Ta10)
1597.0	(23/2 ⁺)	494		1103.0	19/2 ⁺				I _γ : from 78.8 (1977Ta10). Other: 100.0 (1999Ro03).
									E _γ : from 1999Ro03 .

[†] From **1977Ta10**, except as noted.

[‡] From **1958Ch36**.

[#] Mag spect (E(ce) measured) (**1963Di09**).

[@] Ge(Li) (**1967Se09**).

[&] Arbitrary units for E(³²S)=140 MeV (**1977Ta10**), except as noted.

^a From γ(θ) angular distributions, except where noted; Δπ=no from RUL. Q assignments were based on large positive A₂, and intraband D+Q assignments on negative A₂ and placement relative to cascading Q γ's between Coulomb-excited states. **1999Ro03** do not quote A₂ from their ⁵⁸Ni-γ(θ) data, but clearly establish that 118γ, 131γ, 214γ, 229γ, 305γ and 323γ are stretched Q, and the 110γ, 193γ, 269γ and 337γ are D+Q.

^b Stretched Q from γ(θ), not M2 from RUL.

^c Total theoretical internal conversion coefficients, calculated using the BrIcc code (**2008Ki07**) with "Frozen Orbitals" approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

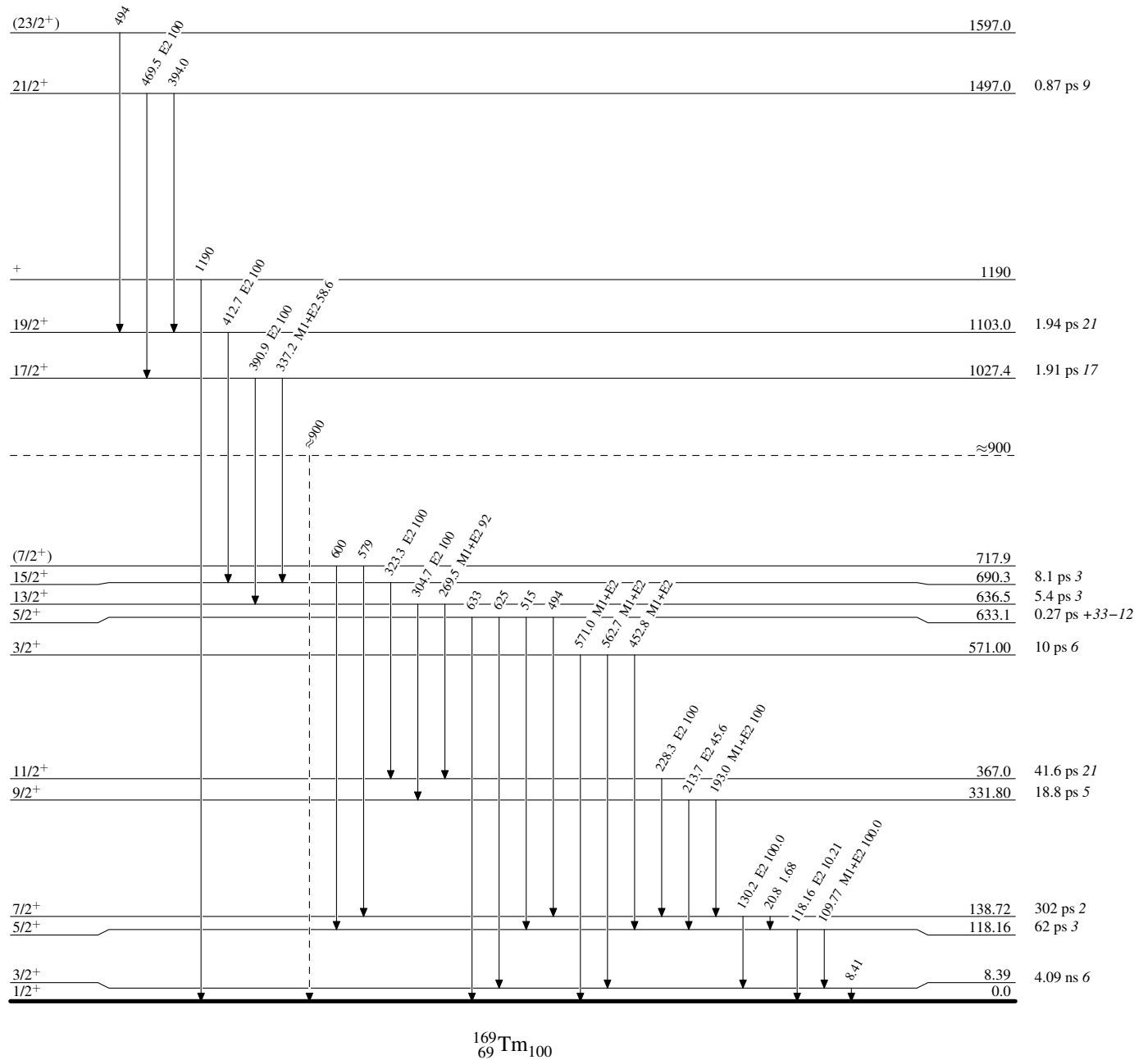
^d Placement of transition in the level scheme is uncertain.

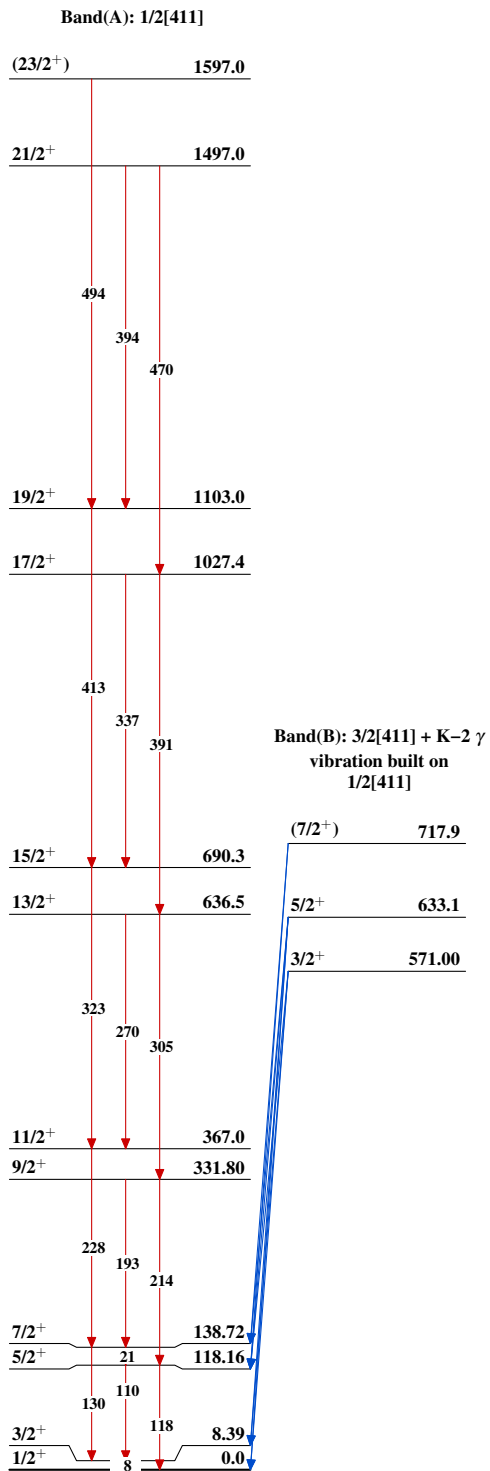
Coulomb excitation 1977Ta10,1999Ro03

Legend

Level Scheme

Intensities: Relative photon branching from each level

-----► γ Decay (Uncertain)

Coulomb excitation 1977Ta10,1999Ro03 $^{169}_{69}\text{Tm}_{100}$

$^{170}\text{Er}(\text{p},2\text{n}\gamma),(\text{d},3\text{n}\gamma)$ 1974Ba66,1973FuZF

1974Ba66: E(p)=14-20 MeV; E(d)=17-26 MeV; isotope-separated erbium targets enriched to 96% in ^{170}Er , Ge(Li) detectors; measured $\text{E}\gamma$, $\text{I}\gamma$ ($\theta=125^\circ$, E(p)=16 MeV and E(d)=23 MeV), $\gamma\gamma$ coin, $\gamma(\theta)$ (E(p)=16 MeV); interpreted levels in terms of a model coupling a particle to a rotor with a variable moment of inertia.

1973FuZF: E(p)=10 MeV; measured $\text{E}\gamma$, $\text{I}\gamma$, $\gamma\gamma$ coin.

The level scheme and all data are from 1974Ba66, unless noted to the contrary.

 ^{169}Tm Levels

E(level) [†]	J^π [‡]	Comments
0.0@	1/2 ⁺	
8.40@ 7	3/2 ⁺	E(level): from energy difference for 118.17 γ and 109.77 γ .
118.16@ 3	5/2 ⁺	
138.93@ 4	7/2 ⁺	
316.13& 4	7/2 ⁺	
332.05@ 5	9/2 ⁺	
341.94 ^a 4	1/2 ⁻	
344.99 ^a 4	5/2 ⁻	
367.66@ 6	11/2 ⁺	
379.24 ^b 5	7/2 ⁻	
430.14 ^a 6	9/2 ⁻	
433.47& 6	9/2 ⁺	
472.84 ^b 7	9/2 ⁻	
474.73 ^a 11	3/2 ⁻	
570.63 ^c 10	3/2 ⁺	
575.35& 6	11/2 ⁺	
588.16 ^b 9	11/2 ⁻	
602.82 ^a 19	13/2 ⁻	
633.10 ^c 12	5/2 ⁺	
637.05@ 14	13/2 ⁺	
646.58 ^a 11	7/2 ⁻	
691.22@ 16	15/2 ⁺	
718.65 ^c 12	7/2 ⁺	
725.40 ^b 10	13/2 ⁻	
741.18& 7	13/2 ⁺	
781.57 10	5/2 ⁽⁺⁾	Note that branching from 10 MeV (p,2n γ) (1973FuZF) disagrees with adopted branching.
832.19 ^c 15	9/2 ⁺	
865.9 ^a 4	17/2 ⁻	
883.72 ^b 16	15/2 ⁻	
884.64 ^a 21	11/2 ⁻	
929.57& 15	15/2 ⁺	
964.0 ^c 4	(11/2 ⁺)	
1027.83@ 17	17/2 ⁺	Branching from this level in (p,2n γ) and (d,3n γ) is inconsistent with adopted branching.
1039.81 16	(5/2) [#]	
1058.54 21	(1/2) [#]	
1063.51 ^b 18	17/2 ⁻	
1104.2@ 3	19/2 ⁺	
1112.6? 5	(9/2) [#]	Level established by 682 γ to 430.1 level (1973FuZF). 1974Ba66 use same transition to establish the 1548.4 level (deexcitation to 865.9 level). It is not clear which assignment is correct.
1135.89 21	(7/2) [#]	

Continued on next page (footnotes at end of table)

¹⁷⁰Er(p,2nγ),(d,3nγ) **1974Ba66,1973FuZF (continued)**

¹⁶⁹Tm Levels (continued)

E(level) [†]	Jπ [‡]	Comments
1140.52 ^{&} 15	17/2 ⁺	
1188.7 ^a 3	15/2 ⁻	
1218.1 ^a 5	21/2 ⁻	
1223.02 15	(3/2) [#]	
1262.42 ^b 22	19/2 ⁻	
1300.8 ^c 6	15/2 ⁺	
1372.3 ^{&} 6	19/2 ⁺	
1482.92 ^b 23	21/2 ⁻	
1497.8 [@] 4	21/2 ⁺	
1548.2 ^a 7	19/2 ⁻	See comment with 1112.6 level.
1598.3 [@] 3	23/2 ⁺	
1624.9 ^{&} 6	21/2 ⁺	
1658.1 ^a 5	25/2 ⁻	
1716.9 ^b 3	23/2 ⁻	

[†] From least-squares fit to E_γ, omitting multiply-placed and tentatively-placed transitions whenever possible. 8.40 was held fixed.

[‡] From **1974Ba66**, based on coincidence data, rotational structure, and γ-ray angular distributions, except where noted (inferred multipolarities not reported). Except for values indicated here as 'not adopted', these are consistent with adopted values apart from the inclusion of parentheses in Adopted Levels in some cases.

[#] From **1973FuZF**. Not adopted because of insufficient supporting information.

[@] Band(A): 1/2[411].

[&] Band(B): 7/2[404].

^a Band(C): 1/2[541].

^b Band(D): 7/2[523].

^c Band(E): 3/2[411] + K-2 γ vibration built on 1/2[411].

γ(¹⁶⁹Tm)

Assignment to ¹⁶⁹Tm is uncertain for many of the unplaced transitions.

A₂ and A₄ data are from (p,2nγ), E=16 MeV (**1974Ba66**).

E _γ [†]	I _γ [#]	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. ^a	Comments
(8.40 7)		8.40	3/2 ⁺	0.0	1/2 ⁺		E _γ : from level energy difference.
(20.74)		138.93	7/2 ⁺	118.16	5/2 ⁺		E _γ : rounded-off value from Adopted Gammas.
63.09 [‡] 5	170 17	379.24	7/2 ⁻	316.13	7/2 ⁺		
^x 72.0 5	2.3 12						
^x 74.9 5	6 ^{&} 3						
^x 80.5 2	22.1 ^{&} 22						I _γ =1.7 in 16 MeV (p,2nγ) (1974Ba66).
84.9 ^d 5	9 5	430.14	9/2 ⁻	344.99	5/2 ⁻		Assignment tentative (major component is from ¹⁷⁰ Er(d,4nγ)).
^x 90.8 5	6 3						
93.60 [‡] 5	53 5	472.84	9/2 ⁻	379.24	7/2 ⁻	D+Q	A ₂ =+0.01 3; A ₄ =0.00 5 (1974Ba66) I _γ =26.3 in 16 MeV (p,2nγ) (1974Ba66).
^x 101.0 5	5.2 26						
^x 106.0 5	6 3						
^x 106.5 5							I _γ =2.3 in 16 MeV (p,2nγ) (1974Ba66).

Continued on next page (footnotes at end of table)

¹⁷⁰Er(p,2nγ),(d,3nγ) 1974Ba66,1973FuZF (continued)

γ(¹⁶⁹Tm) (continued)

E _γ [†]	I _γ [#]	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. ^a	Comments
109.77 [‡] 5	126 [@] 13	118.16	5/2 ⁺	8.40	3/2 ⁺	D+Q	A ₂ =-0.03 1; A ₄ =-0.02 2 (1974Ba66) I _γ =100 in 16 MeV (p,2nγ) (1974Ba66).
115.32 [‡] 5	60 6	588.16	11/2 ⁻	472.84	9/2 ⁻	D+Q	A ₂ =+0.03 3; A ₄ =0.00 5 (1974Ba66) I _γ =22.7 in 16 MeV (p,2nγ) (1974Ba66).
117.32 [‡] 5	28 7	433.47	9/2 ⁺	316.13	7/2 ⁺		A ₂ =+0.13 3; A ₄ =+0.04 5 (1974Ba66) I _γ : from I _γ =39 4 for (117γ+118γ) and deduced I _γ (118γ)=11 6 (see comment on 118γ from 118 level).
118.17 [‡] 5	11 6	118.16	5/2 ⁺	0.0	1/2 ⁺		I _γ =22.2 in 16 MeV (p,2nγ) (1974Ba66). A ₂ =+0.18 10 (1974Ba66) I _γ : deduced from I _γ (110γ) and I(110γ):I(118γ)=100:8.5 in (p,2nγ) E(p)=16 MeV (1974Ba66).
^x 122.4 5							I _γ =8.5 in 16 MeV (p,2nγ) (1974Ba66).
^x 124.1 5	9 5						I _γ =1.4 in 16 MeV (p,2nγ) (1974Ba66).
130.51 [‡] 5	150 15	138.93	7/2 ⁺	8.40	3/2 ⁺		A ₂ =+0.11 1; A ₄ =0.00 2 (1974Ba66) I _γ =150 in 16 MeV (p,2nγ) (1974Ba66).
137.26 [‡] 5	50 5	725.40	13/2 ⁻	588.16	11/2 ⁻	D+Q	A ₂ =+0.10 2; A ₄ =-0.03 4 (1974Ba66) I _γ =12.1 in 16 MeV (1974Ba66).
141.85 [‡] 5	12.5 13	575.35	11/2 ⁺	433.47	9/2 ⁺		A ₂ =+0.24 6 (1974Ba66) I _γ =8.3 in 16 MeV (p,2nγ) (1974Ba66).
^x 144.3 2	35 4						A ₂ =+0.08 4 (1974Ba66) I _γ : includes component from ¹⁷⁰ Er(d,2nγ) (1974Ba66). I _γ =4.9 in 16 MeV (p,2nγ) (1974Ba66).
158.3 2	30 3	883.72	15/2 ⁻	725.40	13/2 ⁻	D(+Q)	A ₂ =-0.40 20 (1974Ba66) I _γ =5.8 in 16 MeV (p,2nγ) (1974Ba66).
^x 161.9 5	1.8 9						A ₂ =+0.20 5 (1974Ba66)
165.8 2	33 3	741.18	13/2 ⁺	575.35	11/2 ⁺		I _γ =4.5 in 16 MeV (p,2nγ) (1974Ba66).
^x 169.6 2	13.6 14						I _γ : deduced from I _γ (528.4γ) and relative branching ratios from 646.6 level for E(p)=16 MeV.
171.6 5	1.6 8	646.58	7/2 ⁻	474.73	3/2 ⁻		I _γ =1.4 in 16 MeV (p,2nγ) (1974Ba66).
172.7 5	12 6	602.82	13/2 ⁻	430.14	9/2 ⁻		I _γ : deduced from I _γ (235.1γ) and I(173γ):I(235γ)=2.9:18.4 in (p,2nγ) E(p)=16 MeV (1974Ba66).
175.0 5	13 7	865.9	17/2 ⁻	691.22	15/2 ⁺		I _γ =2.2 in 16 MeV (p,2nγ) (1974Ba66). I _γ : deduced from I _γ =25.2 25 for 172.7γ+175.0γ, and I _γ (172.7γ)=12 6.
177.18 [‡] 5	117 12	316.13	7/2 ⁺	138.93	7/2 ⁺	D+Q	A ₂ =-0.02 3; A ₄ =-0.04 5 (1974Ba66) I _γ =53 in 16 MeV (p,2nγ) (1974Ba66).
179.6 2	19.5 20	1063.51	17/2 ⁻	883.72	15/2 ⁻		
^x 181.4 2	165 17						A ₂ =+0.17 4 (1974Ba66) I _γ : partly, if not entirely, from inelastic scattering. I _γ =9.2 in 16 MeV (p,2nγ) (1974Ba66).
^x 184.2 2	15.3 [@] 15					D(+Q)	A ₂ =-0.10 20 (1974Ba66) I _γ =1.0 in 16 MeV (p,2nγ) (1974Ba66).
188.7 5	7 4	929.57	15/2 ⁺	741.18	13/2 ⁺		I _γ =1.2 in 16 MeV (p,2nγ) (1974Ba66).
193.12 [‡] 5	51 5	332.05	9/2 ⁺	138.93	7/2 ⁺	D+Q	A ₂ =-0.07 2; A ₄ =+0.02 4 (1974Ba66) I _γ =24.3 in 16 MeV (p,2nγ) (1974Ba66).
197.97 [‡] 5	185 19	316.13	7/2 ⁺	118.16	5/2 ⁺	D+Q	A ₂ =+0.03 2; A ₄ =+0.04 3 (1974Ba66) I _γ =84 in 16 MeV (p,2nγ) (1974Ba66).

Continued on next page (footnotes at end of table)

¹⁷⁰Er(p,2n γ),(d,3n γ) **1974Ba66,1973FuZF (continued)**
 $\gamma(^{169}\text{Tm})$ (continued)

E_γ [†]	I_γ [#]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	Comments
							I_γ : deduced from $I_\gamma(177\gamma)$ and $I(177\gamma):I(198.0\gamma)=53:84$ in (p,2n γ) $E(p)=16$ MeV (1974Ba66); consistent with adopted branching. See also the comment on the 198.3 γ from 1262 level.
198.3 ^d 5		1262.42	19/2 ⁻	1063.51	17/2 ⁻		I_γ : 0 23, from $I_\gamma=185$ 13 for 198.0 γ +198.3 γ , and $I_\gamma(198.0\gamma)=185$ 19.
206.07 [‡] 5	4.5 23	344.99	5/2 ⁻	138.93	7/2 ⁺		$I_\gamma=5.7$ in 16 MeV (p,2n γ) (1974Ba66), 13 in 10 MeV (p,2n γ) (1973FuZF).
208.8 5	6 3	588.16	11/2 ⁻	379.24	7/2 ⁻		
210.94 ^{b‡} 5	3.4 ^b 17	781.57	5/2 ⁽⁺⁾	570.63	3/2 ⁺		1974Ba66 assign transition to 1140.7 deexcitation only.
210.94 ^{b‡} 5	3.4 ^b 17	1140.52	17/2 ⁺	929.57	15/2 ⁺		
213.91 [‡] 5	22 4	332.05	9/2 ⁺	118.16	5/2 ⁺		$A_2=+0.20$ 3 (1974Ba66) I_γ : from $I_\gamma(193\gamma)$ and $I(193\gamma):I(241\gamma)=24.3:10.6$ in (p,2n γ) $E(p)=16$ MeV (1974Ba66); consistent with result from 1973FuZF . $I_\gamma=29$ 3 in (d,3n γ) may include component from (d,4n γ). $I_\gamma=10.6$ in 16 MeV (p,2n γ) (1974Ba66).
216.4 [‡] 2	0.84	646.58	7/2 ⁻	430.14	9/2 ⁻		I_γ : deduced from $I_\gamma(528.4\gamma)$ and relative branching ratios from 646.6 level in 1973FuZF .
^x 219.2 5	6 3						
220.5 2	13.9 14	1482.92	21/2 ⁻	1262.42	19/2 ⁻		
226.79 [‡] 5	0.34 17	344.99	5/2 ⁻	118.16	5/2 ⁺		I_γ : deduced from $I_\gamma(206.1\gamma)$ and adopted branching from 345.0 level. $I_\gamma=4.6$ in 16 MeV (p,2n γ) (1974Ba66), 2.6 in 10 MeV (p,2n γ) (1973FuZF).
228.71 [‡] 5	169 17	367.66	11/2 ⁺	138.93	7/2 ⁺	Q	$A_2=+0.22$ 2; $A_4=-0.04$ 3 (1974Ba66) I_γ : deduced from $I_\gamma=169$ 17 for 226.8 γ and 228.7 γ combined, and $I_\gamma(226.8\gamma)=0.30$ 15. $I_\gamma=59$ in 16 MeV (p,2n γ) (1974Ba66).
233 ^d		1716.9	23/2 ⁻	1482.92	21/2 ⁻		Observed only in coincidence data.
235.1 2	77 8	602.82	13/2 ⁻	367.66	11/2 ⁺	D(+Q)	$A_2=-0.14$ 3; $A_4=-0.01$ 5 (1974Ba66)
240.4 ^{‡d} 2		379.24	7/2 ⁻	138.93	7/2 ⁺		I_γ : weak.
^x 242.9 5	3.6 18						
252.5 2	14.5 15	725.40	13/2 ⁻	472.84	9/2 ⁻		$A_2=+0.31$ 12 (1974Ba66) $I_\gamma=3.9$ in 16 MeV (p,2n γ) (1974Ba66).
^x 258.4 5	38 8						I_γ : deduced from $I_\gamma=50$ 5 for 258.4 γ and 259.2 γ combined, and $I_\gamma(259.2\gamma)=12$ 6. $A_2=+0.21$ 9 for doublet in 16 MeV (p,2n γ) (1974Ba66).
259.23 [‡] 5	12 6	575.35	11/2 ⁺	316.13	7/2 ⁺		$A_2=+0.21$ 9 (1974Ba66) I_γ : deduced from $I_\gamma(141.8\gamma)$ and $I(142\gamma):I(259\gamma)$ in (p,2n γ) $E(p)=16$ MeV (1974Ba66). $I_\gamma=7.8$ in 16 MeV (p,2n γ) (1974Ba66).
261.10 [‡] 5	5 3	379.24	7/2 ⁻	118.16	5/2 ⁺		I_γ : deduced from $I_\gamma(63.1\gamma)$ and $I(261\gamma):I(63\gamma)=3.2:83.0$ in (p,2n γ) $E(p)=16$ MeV (1974Ba66). $A_2=+0.21$ 9 for doublet in 16 MeV (p,2n γ) (1974Ba66).
262.7 5	32 5	865.9	17/2 ⁻	602.82	13/2 ⁻		$I_\gamma=3.2$ in 16 MeV (p,2n γ) (1974Ba66); $A_2=+0.21$ 9 for doublet.

Continued on next page (footnotes at end of table)

¹⁷⁰Er(p,2nγ),(d,3nγ) **1974Ba66,1973FuZF (continued)**

γ(¹⁶⁹Tm) (continued)

E _γ [†]	I _γ [#]	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. ^a	Comments
							I _γ : deduced from I _γ =37 4 for 261.1γ and 262.7γ combined, and I _γ (261.1γ)=5 3.
^x 267.2 5	4.2 21						
269.4 [‡] 2	22.1 22	637.05	13/2 ⁺	367.66	11/2 ⁺	D+Q	A ₂ =-0.37 10 (1974Ba66) I _γ =6.8 in 16 MeV (p,2nγ) (1974Ba66).
281.7 ^{‡d} 2		884.64	11/2 ⁻	602.82	13/2 ⁻		I _γ =1.0 in 10 MeV (p,2nγ) (1973FuZF).
291.21 [‡] 5	44 4	430.14	9/2 ⁻	138.93	7/2 ⁺	D(+Q)	A ₂ =-0.05 6; A ₄ =-0.04 11 (1974Ba66) I _γ =29.0 in 16 MeV (p,2nγ) (1974Ba66).
295.4 2	21.2 [@] 22	883.72	15/2 ⁻	588.16	11/2 ⁻		A ₂ =+0.1 3 (1974Ba66) I _γ =2.8 in 16 MeV (p,2nγ) (1974Ba66).
301.6 [‡] 2	0.94	646.58	7/2 ⁻	344.99	5/2 ⁻		I _γ : deduced from I _γ (528.4γ) and relative branching ratios from 646.6 level in 1973FuZF.
305.2 2	21.9 22	637.05	13/2 ⁺	332.05	9/2 ⁺		A ₂ =+0.36 10 (1974Ba66) I _γ =7.4 in 16 MeV (p,2nγ) (1974Ba66).
307.74 ^{c‡} 5	53 ^{c@} 6	316.13	7/2 ⁺	8.40	3/2 ⁺		I _γ : deduced from I _γ (177.2γ) and adopted branching from 316.1 level.
							I _γ =25.1, A ₂ =+0.09 6, A ₄ =-0.03 10 in 16 MeV (p,2nγ) (1974Ba66) for doublet.
307.74 ^{c‡} 5	10 ^{c@} 9	741.18	13/2 ⁺	433.47	9/2 ⁺		I _γ =25.1, A ₂ =+0.09 6, A ₄ =-0.03 10 for multiplet in 16 MeV (p,2nγ) (1974Ba66); this includes component from (p,p'γ).
							I _γ : upper limit deduced from I _γ =63 6 for both placements of 307.7γ plus contaminant, assuming I _γ =53 6 for 316 level placement.
^x 310.5 5	9 4						
314.6 [‡] 2	3.7	646.58	7/2 ⁻	332.05	9/2 ⁺		I _γ : deduced from I _γ (528.4γ) and relative branching ratios from 646.6 level in 1973FuZF.
323.4 2	66 7	691.22	15/2 ⁺	367.66	11/2 ⁺		A ₂ =+0.27 5 (1974Ba66) I _γ =12.3 in 16 MeV (p,2nγ) (1974Ba66).
333.53 [‡] 5	6 3	341.94	1/2 ⁻	8.40	3/2 ⁺	D	A ₂ =-0.18 13 (1974Ba66) I _γ =7.6 in 16 MeV (p,2nγ) (1974Ba66).
336.60 ^{c‡} 5	13 ^c 6	344.99	5/2 ⁻	8.40	3/2 ⁺		I _γ : deduced from I _γ (206.1γ) and adopted branching from 345.0 level.
							I _γ =24.2 for doublet in 16 MeV (p,2nγ) (1974Ba66), 55 in 10 MeV (p,2nγ) (1973FuZF).
336.60 ^{c‡} 5	17 ^c 7	1027.83	17/2 ⁺	691.22	15/2 ⁺		I _γ : deduced from I _γ =30 3 for both placements of 336.6γ and I _γ =13 6 for 345.0 level placement.
							I _γ =24.2, A ₂ =-0.04 10, A ₄ =-0.04 20 for doublet in 16 MeV (p,2nγ) (1974Ba66).
338.3 2	21.7 22	1063.51	17/2 ⁻	725.40	13/2 ⁻		
341.95 [‡] 5	3.3 17	341.94	1/2 ⁻	0.0	1/2 ⁺		A ₂ =+0.25 20 (1974Ba66) I _γ =3.4 in 16 MeV (p,2nγ) (1974Ba66).
352.2 2	28 3	1218.1	21/2 ⁻	865.9	17/2 ⁻		
353.9 2	18.7 19	929.57	15/2 ⁺	575.35	11/2 ⁺		I _γ =4.0 in 16 MeV (p,2nγ) (1974Ba66).
356.7 [‡] 2	4.6 23	474.73	3/2 ⁻	118.16	5/2 ⁺		I _γ =6.6 in 16 MeV (p,2nγ) (1974Ba66).
^x 370.0 5	3.8 19						
378.7 2	12.4 13	1262.42	19/2 ⁻	883.72	15/2 ⁻		
386.7 [‡] 2		718.65	7/2 ⁺	332.05	9/2 ⁺		
^x 387.8 5	3.8 19						
391.0 2	14.9 15	1027.83	17/2 ⁺	637.05	13/2 ⁺		I _γ =2.5 in 16 MeV (p,2nγ) (1974Ba66).
394.0 5	4.5 23	1497.8	21/2 ⁺	1104.2	19/2 ⁺		
^x 395.9 5	1.7 9						

Continued on next page (footnotes at end of table)

$^{170}\text{Er}(\text{p},2\text{n}\gamma),(\text{d},3\text{n}\gamma)$ **1974Ba66,1973FuZF (continued)** $\gamma(^{169}\text{Tm})$ (continued)

E_γ [†]	I_γ [#]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
399.6 2	13.0 13	1140.52	17/2 ⁺	741.18	13/2 ⁺	$I_\gamma=2.8$ in 16 MeV (p,2n γ) (1974Ba66).
^x 402.0 5	1.7 9					
^x 407.5 5	3.1 16					
^x 409.8 5	1.5 8					
413.0 2	29 3	1104.2	19/2 ⁺	691.22	15/2 ⁺	$I_\gamma=2.8$ in 16 MeV (p,2n γ) (1974Ba66).
419.4 2	10.7 11	1482.92	21/2 ⁻	1063.51	17/2 ⁻	
^x 423.1 5	2.0 10					
440.0 2	11.3 12	1658.1	25/2 ⁻	1218.1	21/2 ⁻	
442.7 5	8 4	1372.3	19/2 ⁺	929.57	15/2 ⁺	
452.7 [‡] 2	1.7	570.63	3/2 ⁺	118.16	5/2 ⁺	I_γ : deduced from $I_\gamma(562.1\gamma+570.5\gamma)$ and relative branching ratios from 570.6 level in 1973FuZF .
454.5 ^b 2	11.0 ^b 11	884.64	11/2 ⁻	430.14	9/2 ⁻	$I_\gamma=0.6$ in 10 MeV (p,2n γ) (1973FuZF).
454.5 ^b 2	11.0 ^b 11	1716.9	23/2 ⁻	1262.42	19/2 ⁻	
^x 461.7 5	3.4 17					
464.8 ^{cd} 5	4.4 ^c 22	781.57	5/2 ⁽⁺⁾	316.13	7/2 ⁺	I_γ : doubly placed by 1973FuZF , but unplaced by 1974Ba66 (who report neither the 782 level nor the 832 level); total I_γ attributed to 781.6 level placement because I_γ data for other γ 's suggest 1974Ba66 excite only 782 level.
464.8 ^d 5		832.19	9/2 ⁺	367.66	11/2 ⁺	I_γ : see comment on 465 γ from 782 level.
466.2 [‡] 2	0.7 4	474.73	3/2 ⁻	8.40	3/2 ⁺	I_γ : deduced from $I(356.7\gamma+474.8\gamma)$, and relative branching ratios from 474.7 level in ^{169}Yb ε decay (32.016 d).
						$I_\gamma=5.2$ in 16 MeV (p,2n γ) (1974Ba66).
469.6 5	9 5	1497.8	21/2 ⁺	1027.83	17/2 ⁺	
474.8 [‡] 2	7 4	474.73	3/2 ⁻	0.0	1/2 ⁺	$I_\gamma=9.0$ in 16 MeV (p,2n γ) (1974Ba66).
^x 477.7 5	3.5 18					
484.4 5	4.4 22	1624.9	21/2 ⁺	1140.52	17/2 ⁺	
^x 492.1 5	6 3					
494.2 ^{c‡} 2	2.5 ^c 13	633.10	5/2 ⁺	138.93	7/2 ⁺	I_γ : deduced from $I_\gamma(514.9\gamma)$ and relative branching ratios from 633.0 level in ^{169}Yb ε decay (32.016 d); 1974Ba66 assign transition to 1598.3 level only.
494.2 ^{c‡d} 2	9.5 ^c 18	1598.3?	23/2 ⁺	1104.2	19/2 ⁺	I_γ : upper limit deduced from $I_\gamma=12.0$ 12 for both placements of 494.2 γ plus possible component from $^{170}\text{Er}(\text{d},2\text{n}\gamma)$, assuming $I_\gamma=2.5$ 13 for 633.0 level placement. Assignment to 1598 level is tentative.
^x 496.8 5	2.6 13					
500.0 [‡] 2		832.19	9/2 ⁺	332.05	9/2 ⁺	$I_\gamma=2.5$ in 10 MeV (p,2n γ) (1973FuZF).
507.8 ^d 5	6.8 34	646.58	7/2 ⁻	138.93	7/2 ⁺	
514.9 [‡] 2	7 4	633.10	5/2 ⁺	118.16	5/2 ⁺	
^x 521.9 5	2.4 12					
^x 524.7 5	6 3					
528.4 [‡] 2	16.7 17	646.58	7/2 ⁻	118.16	5/2 ⁺	$I_\gamma=14.6$ in 16 MeV (p,2n γ) (1974Ba66).
^x 533.5 5	3.8 19					
^x 549.5 5	3.0 15					
552.0 ^{bd} 2	19.7 ^b 20	884.64	11/2 ⁻	332.05	9/2 ⁺	$I_\gamma=2.8$ in 10 MeV (p,2n γ) (1973FuZF).
552.0 ^{bd} 2	19.7 ^b 20	1188.7	15/2 ⁻	637.05	13/2 ⁺	
^x 556.8 5	2.1 11					
562.1 [‡] 2	11.5 12	570.63	3/2 ⁺	8.40	3/2 ⁺	$I_\gamma=10.0$ in 16 MeV (p,2n γ) (1974Ba66).
565.2 [‡] 2		1039.81	(5/2)	474.73	3/2 ⁻	$I_\gamma(565.2\gamma)/I_\gamma(694.7\gamma)=0.37$ in 10 MeV (p,2n γ) (1973FuZF).
^x 568.6 5	8 4					

Continued on next page (footnotes at end of table)

¹⁷⁰Er(p,2n γ),(d,3n γ) **1974Ba66,1973FuZF (continued)**
 $\gamma(^{169}\text{Tm})$ (continued)

E_γ [†]	I_γ [#]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
570.5 [‡] 2	9 5	570.63	3/2 ⁺	0.0	1/2 ⁺	$I_\gamma=7.0$ in 16 MeV (p,2n γ) (1974Ba66).
579.7 [‡] 2	10 5	718.65	7/2 ⁺	138.93	7/2 ⁺	$I_\gamma=7.0$ in 16 MeV (p,2n γ) (1974Ba66).
585.9 2	10.4 11	1188.7	15/2 ⁻	602.82	13/2 ⁻	
^x 590.1 5	6 3					
595.9 5	3.2	964.0	(11/2 ⁺)	367.66	11/2 ⁺	$I_\gamma=9.0$ in 16 MeV (p,2n γ) (1974Ba66). I_γ : deduced from $I_\gamma(632.3\gamma)$ and relative branching ratios from 964.0 level in 1973FuZF .
600.4 [‡] 2	6.7	718.65	7/2 ⁺	118.16	5/2 ⁺	I_γ : deduced from $I_\gamma(579.7\gamma)$ and relative branching ratios from 718.6 level in 1973FuZF .
609.6 5	3.7 19	1300.8	15/2 ⁺	691.22	15/2 ⁺	
^x 618.4 5	5.2 26					
624.7 [‡] 2	8 5	633.10	5/2 ⁺	8.40	3/2 ⁺	I_γ : deduced from $I_\gamma(514.9\gamma)$ and relative branching ratios from 633.0 level in ¹⁶⁹ Yb ε decay (32.016 d).
^x 627.5 5	3.5 18					
632.3 ^d 5		633.10	5/2 ⁺	0.0	1/2 ⁺	I_γ : all intensity is attributed to 964.0 level placement (I_γ , as deduced from $I_\gamma(514.9\gamma)$ and relative branching ratios from 633.0 level, is negligible).
632.3 ^c 5	2.3 ^c 12	964.0	(11/2 ⁺)	332.05	9/2 ⁺	
^x 642.7 5	7 3					
^x 646.7 5	4.0 20					
^x 650.9 5	4.8 24					
^x 654.8 5	3.8 19					
663.5 [‡] 2		781.57	5/2 ⁽⁺⁾	118.16	5/2 ⁺	1974Ba66 report transition with $E_\gamma=662.6$, but assign it to another isotope. $I_\gamma=4$ in 10 MeV (p,2n γ) (1973FuZF).
^x 670.3 5	4.5 23					
^x 677.0 5	2.9 15					
682.5 ^d 5	4.2 21	1112.6?	(9/2)	430.14	9/2 ⁻	I_γ : value can be attributed to 1112.6 level or 1548.4 level placement, but not both (see comment with 1113 level).
682.5 ^d 5	4.2 21	1548.2?	19/2 ⁻	865.9	17/2 ⁻	
693.4 [‡] 2		832.19	9/2 ⁺	138.93	7/2 ⁺	$I_\gamma=6$ in 10 MeV (p,2n γ) (1973FuZF).
694.7 [‡] 2		1039.81	(5/2)	344.99	5/2 ⁻	
^x 711.4 5	3.4 17					
716.6 [‡] 2		1058.54	(1/2)	341.94	1/2 ⁻	
773.1 [‡] 2		781.57	5/2 ⁽⁺⁾	8.40	3/2 ⁺	$I_\gamma=6.6$ in 10 MeV (p,2n γ) (1973FuZF).
781.0 ^{‡d} 2		781.57	5/2 ⁽⁺⁾	0.0	1/2 ⁺	$I_\gamma=4$ in 10 MeV (p,2n γ) (1973FuZF).
790.9 [‡] 2		1135.89	(7/2)	344.99	5/2 ⁻	
877.9 [‡] 2		1223.02	(3/2)	344.99	5/2 ⁻	$I_\gamma(877.9\gamma)/I_\gamma(881.2\gamma)=1.33$ in 10 MeV (p,2n γ) (1973FuZF).
881.2 [‡] 2		1223.02	(3/2)	341.94	1/2 ⁻	

[†] From **1974Ba66**, except where noted. $\Delta E=0.2$ keV for strong, well-resolved peaks, and 0.5 keV for weak peaks (taken by evaluator to be those with $I_\gamma \leq 10$; guidelines taken partially from a similar work by the same authors (**1977Ba40**)).

[‡] From **1973FuZF**; uncertainties not stated, but estimated by evaluator from implied precision of authors' energies.

[#] Arbitrary units for $E(d)=23$ MeV, $\theta=125^\circ$. $\Delta I_\gamma=10\%$ for strong, well resolved peaks, and 50% for weak peaks (taken by evaluator to be those with $I_\gamma \leq 10$; guidelines taken partially from a similar work by the same authors (**1977Ba40**)). Some additional branching information is included in **1973FuZF**.

[@] Includes component from radioactive decay of irradiated target.

[&] Includes possible component from ¹⁷⁰Er(d,4n γ).

Continued on next page (footnotes at end of table)

$^{170}\text{Er}(\text{p},2\text{n}\gamma),(\text{d},3\text{n}\gamma)$ **1974Ba66,1973FuZF** (continued)

$\gamma(^{169}\text{Tm})$ (continued)

^a Based on $\gamma(\theta)$ (i.e. reported A_2 , A_4 data) by the evaluator.

^b Multiply placed with undivided intensity.

^c Multiply placed with intensity suitably divided.

^d Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

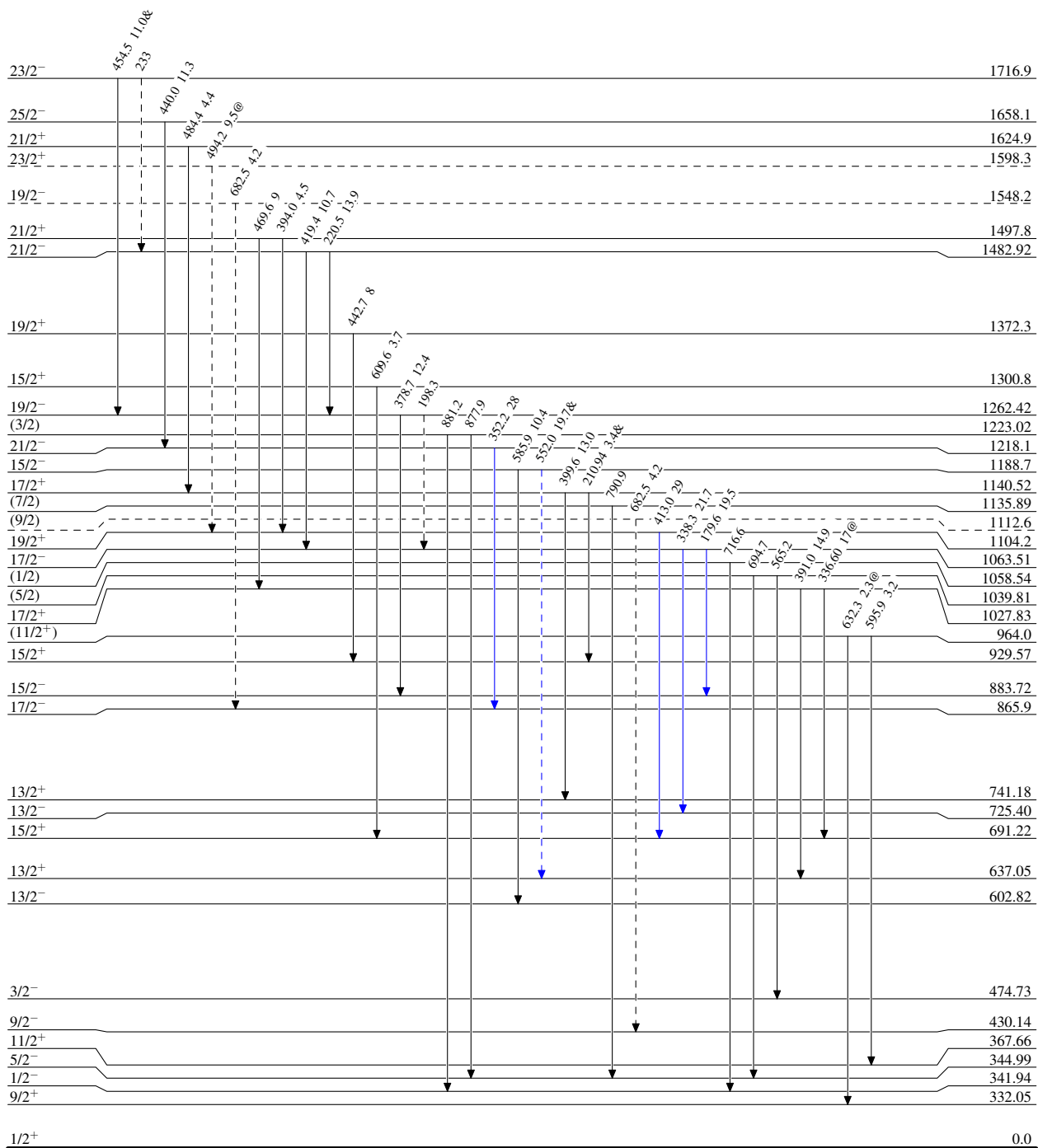
$^{170}\text{Er}(p,2n\gamma), (d,3n\gamma)$ 1974Ba66,1973FuZF

Level Scheme

Intensities: relative I_γ for $E(d)=23$ MeV, $\theta=125^\circ$
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\cdots\cdots\cdots$ γ Decay (Uncertain)



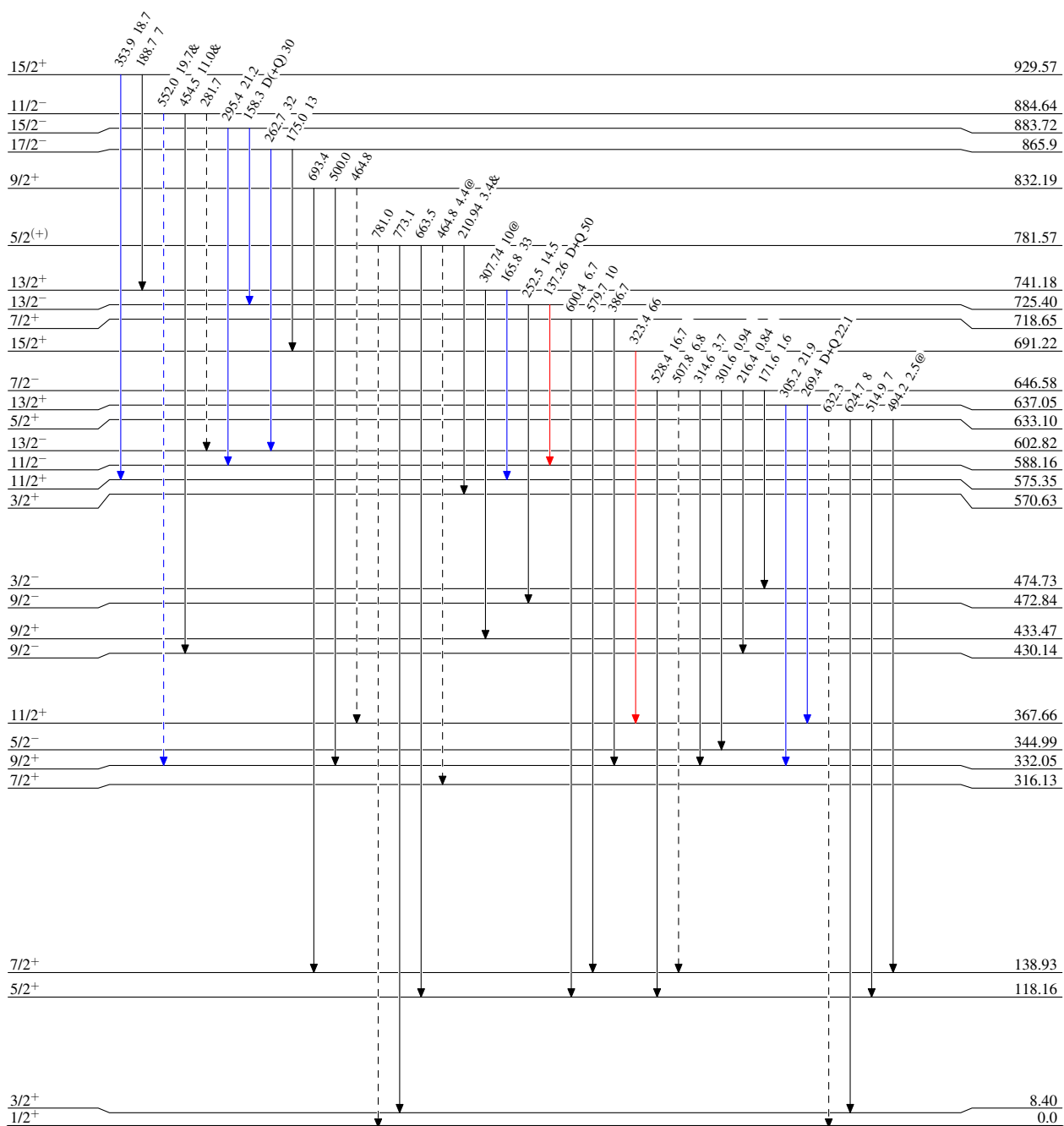
$^{170}\text{Er}(\text{p},2\text{n}\gamma),(\text{d},3\text{n}\gamma)$ 1974Ba66,1973FuZF

Level Scheme (continued)

Legend

Intensities: relative I_γ for $E(\text{d})=23\text{ MeV}$, $\theta=125^\circ$
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided

→ $I_\gamma < 2\% \times I_\gamma^{\text{max}}$
 → $I_\gamma < 10\% \times I_\gamma^{\text{max}}$
 → $I_\gamma > 10\% \times I_\gamma^{\text{max}}$
 - - - - - γ Decay (Uncertain)

 $^{169}\text{Tm}_{100}$

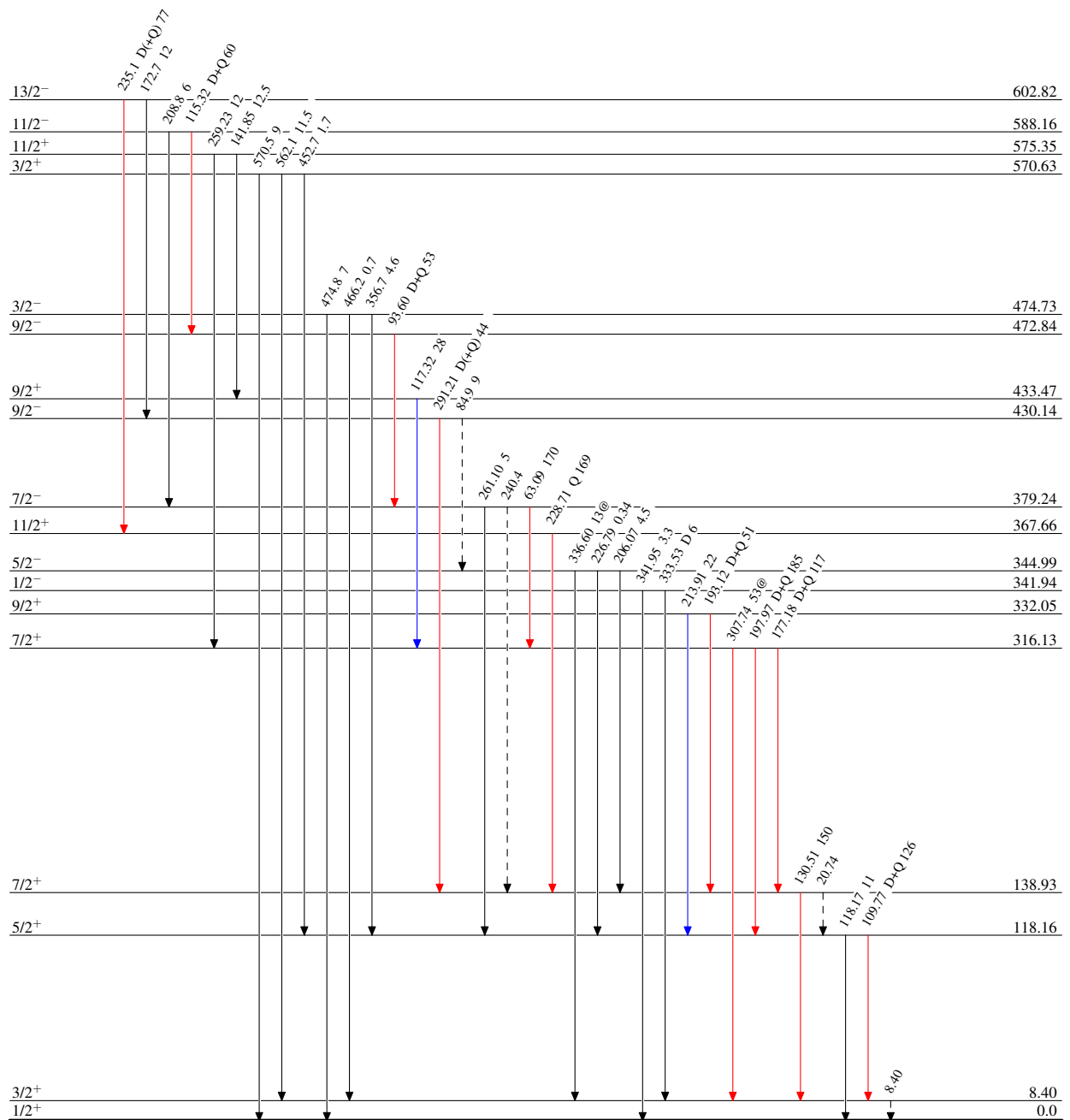
$^{170}\text{Er}(\text{p},2\text{n}\gamma),(\text{d},3\text{n}\gamma)$ 1974Ba66,1973FuZF

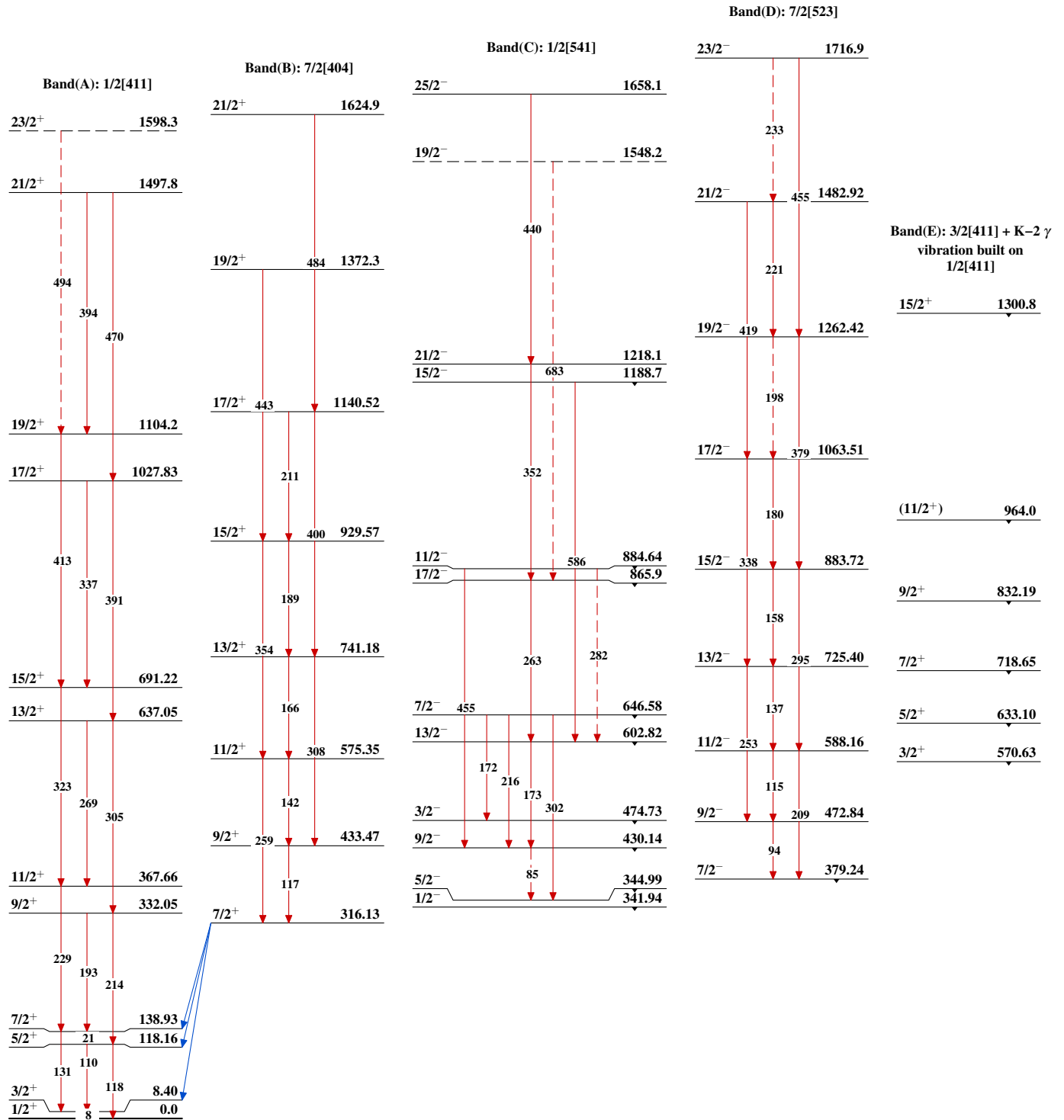
Level Scheme (continued)

Intensities: relative I_γ for $E(\text{d})=23$ MeV, $\theta=125^\circ$
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided

Legend

- $I_\gamma < 2\% \times I_\gamma^{\text{max}}$
- $I_\gamma < 10\% \times I_\gamma^{\text{max}}$
- $I_\gamma > 10\% \times I_\gamma^{\text{max}}$
- - - - -→ γ Decay (Uncertain)


 $^{169}\text{Tm}_{100}$

$^{170}\text{Er}(\text{p},2\text{n}\gamma),(\text{d},3\text{n}\gamma)$ 1974Ba66,1973FuZF

Adopted Levels, Gammas

$Q(\beta^-) = -2293.3$; $S(n) = 6866.98$ 15; $S(p) = 6352.1$ 17; $Q(\alpha) = 1720.9$ 9 2021Wa16

$S(2n) = 15928.4$, $S(2p) = 11664.2$ 3 (2021Wa16).

See, e.g., 1982Bu21 and 1983Ne13 for hfs and isotope-shift data.

¹⁶⁹Yb Levels

Cross Reference (XREF) Flags

A	¹⁶⁹ Yb IT decay (46 s)	E	¹⁶⁸ Yb(n,γ) E=thermal
B	¹⁶⁹ Lu ε decay (34.06 h)	F	¹⁶⁸ Yb(d,p), ¹⁷⁰ Yb(d,t)
C	¹²⁴ Sn(⁴⁸ Ca,3nγ)	G	¹⁷¹ Yb(p,t)
D	¹⁶⁷ Er(α,2nγ)	H	¹⁶⁸ Yb(n,γ) E=resonance

E(level) [†]	J ^π	T _{1/2}	XREF	Comments
0.0 ^a	7/2 ⁺	32.016 d 8	ABCDEF	%ε=100 $\mu = -0.633$ 8; $Q = +3.54$ 6 $\delta \langle r^2 \rangle (^{169}\text{Yb}, ^{176}\text{Yb}) = 0.372 \text{ fm}^2$ 12 (1994Ma57). J^π: 7/2 from optical spectroscopy (1974Ch38); positive parity from E3 24γ from 1/2⁻ 24. T_{1/2}: weighted average of 32.01 d 7 (2014Un01 – their earlier value 32.015 d 20 2002Un02), 32.001 d 34 (2000Iw06), 31.88 d 4 (1990Pa08), 32.07 d 8 (1988Ki12), 32.032 d 20 (1983Wa26, 1983Fu12), 32.022 d 8 (1980Ho17), 32.015 d 9 (1980RuZY, 1982HoZJ), 31.97 d 5 (1975La16), 32.015 d 30 (1975MeZJ), 33.0 d 15 (1951Ma25), 31.83 d 21 (1949Wa23). Others: 30.6 d 2 (1956Co13) statistical outliers – yield higher χ^2 than critical one, 32 d (1954Mi16), 32.4 d (1950Co16). μ,Q: collinear fast-beam LASER spectroscopy (2019StZV, from 1983Ne13); μ relative to μ = -0.67989 3, and Q relative to Q = +2.80 4, for ¹⁷³Yb. Others: μ = -0.633 16, Q = +3.52 7 (1974Ch38).
24.2003 ^b 16	1/2 ⁻	46 s 2	ABCDEF	%IT=100 μ = +0.506 8 %IT: ε decay unlikely (for ε decay to 1/2⁺ ¹⁶⁹Tm g.s., %ε + %β⁺ < 0.05% is implied by log ft > 5.9). μ: collinear fast-beam LASER spectroscopy (2019StZV, 1983Ne13); value relative to μ = -0.67989 3 for ¹⁷³Yb, and no hyperfine anomaly correction has been applied. J^π: 1/2 from collinear fast-beam LASER spectroscopy (1983Ne13); negative parity from L(p,t)=0 on 1/2⁻ target. T_{1/2}: from ¹⁶⁹Yb IT decay (46 s) (1960Ho10); other value: 50 s (1949De16), also from ¹⁶⁹Yb IT decay (46 s).
70.8816 ^{&} 8	9/2 ⁺ ‡		BCDEFG	
86.9191 ^c 16	3/2 ⁻		B DEFG	J^π : L(p,t)=2 on 1/2 ⁻ target; M1+E2 γ to 1/2 ⁻ .
99.2409 ^b 15	5/2 ⁻		BCDEFG	J^π : L(p,t)=2 on 1/2 ⁻ target; E2 γ to 1/2 ⁻ ; band member.
161.6505 ^a 10	11/2 ⁺ ‡		BCDEF	
191.2141 ^d 12	5/2 ⁻	3.35 ns 15	B DEFG	J^π: M1(+E2) γ to 3/2⁻, E1+M2 γ to 7/2⁺. T_{1/2}: γγ(t) in ¹⁶⁹Lu ε decay (34.06 h) (1968Lo10). J^π: M1+E2 γ to 5/2⁻; E2 γ to 3/2⁻, band member. J^π: M1 γ to 7/2⁻; E2 γ to 5/2⁻, band member.
243.8170 ^c 16	7/2 ⁻		B DEFG	
264.2544 ^b 21	9/2 ⁻		BCDEFG	
269.6554 ^{&} 24	13/2 ⁺ ‡		BCDEF	
278.5978 ^d 13	7/2 ⁻		B DEF	J^π : M1+E2 γ to 5/2 ⁻ ; E1(+M2) γ to 9/2 ⁺ .
389.5273 ^d 14	9/2 ⁻		B DEF	J^π : M1+E2 γ to 7/2 ⁻ ; E2 γ to 5/2 ⁻ ; 228γ to 11/2 ⁺ .
405.05 ^a 22	15/2 ⁺ ‡		CD	
486.9449 ^c 31	(11/2 ⁻)		B DEFG	J^π : (E2) intraband γ to 7/2 ⁻ , band member.

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Adopted Levels, Gammas (continued) ^{169}Yb Levels (continued)

E(level) [†]	J ^π	XREF	Comments
512.028 ^b 15	(13/2) ⁻	BCDE G	J ^π : E2 γ to 9/2 ⁻ , band member.
523.0746 ^d 32	11/2 ⁻ ‡	B DEF	
547.12 ^{&} 25	17/2 ⁺ ‡	CD	
569.8316 ^e 27	5/2 ⁻	B EFG	J ^π : M1+E2 γ to 7/2 ⁻ , M1 γ to 3/2 ⁻ .
590.692 ^f 6	(5/2) ⁺	B EF	J ^π : M1+E2 γ to 7/2 ⁺ ; band assignment.
647.288 ^f 9	7/2 ⁺	B E	J ^π : M1+E2 γ to 9/2 ⁺ , M1+E2 γ to 7/2 ⁺ ; nuclear orientation data rule out 9/2 (1982Da23).
647.8373 ^e 28	7/2 ⁻	B EF	J ^π : M1+E2 γ to 9/2 ⁻ ; M1+E2 γ to 5/2 ⁻ .
659.628 ^g 5	3/2 ⁻	B EFG	J ^π : (M1) γ to 5/2 ⁻ , M1 γ to 1/2 ⁻ ; band member.
677.107 ^d 6	13/2 ⁻ ‡	DE	
707.024 ^f 8	9/2 ⁺	B EF	J ^π : M1+E2 γ to 11/2 ⁺ ; log ft=8.7 from 7/2 ⁺ , γ to 11/2 ⁻ .
719.944 ^h 6	3/2 ⁺	B E	J ^π : E2 720γ to 7/2 ⁺ g.s.; primary γ from 1/2 ⁺ in $^{168}\text{Yb}(n,\gamma)$ E=thermal.
722.276 ^g 5	5/2 ⁻	B EF	J ^π : M1 γ to 7/2 ⁻ , M1 γ to 3/2 ⁻ .
736.23 ^a 30	19/2 ⁺ ‡	CD	
748.978 ^e 6	(9/2) ⁻	B EFG	J ^π : M1 γ to 7/2 ⁻ ; γs to 5/2 ⁻ and 11/2 ⁻ and 11/2 ⁺ .
757.872 ^f 18	(11/2) ⁺	E	J ^π : γs to 13/2 ⁺ and 11/2 ⁺ ; band assignment.
761.846 ^h 7	(5/2) ⁺	B E	J ^π : M1+E2 γ to 7/2 ⁺ g.s.; band assignment.
807.066 ^g 11	(7/2) ⁻	B EFG	J ^π : M1+E2 γ to 5/2 ⁻ , (M1) γ to 9/2 ⁻ .
807.7 ^c 5	(15/2) ⁻ ‡	D	
813.333 ⁱ 9	(1/2) ⁻	E	J ^π : M1(+E2) γ to 3/2 ⁻ ; primary γ from 1/2 ⁺ in $^{168}\text{Yb}(n,\gamma)$ E=thermal; band assignment.
831.899 ^h 10	(7/2) ⁺	B E	J ^π : M1+E2 γ to 9/2 ⁺ ; γ to 3/2 ⁺ .
833.83 ^b 30	(17/2) ⁻ ‡	CD	
851.392 ⁱ 10	3/2 ⁻	B EF	J ^π : M1+E2 γ to 5/2 ⁻ , M1 γ to 1/2 ⁻ .
851.48 ^d 31	15/2 ⁻ ‡	D	
865.155 ^e 14	(11/2) ⁻ @	EF	XREF: F(871) J ^π : γ to 13/2 ⁻ , γ to 7/2 ⁻ , band assignment.
877 ^f 3	(13/2) ⁺ @	F	
886.806 ^h 35	9/2 ⁺	B	J ^π : M1+E2 γ to 11/2 ⁺ ; log ft=8.8 from 7/2 ⁺ .
903.14 ^{&} 33	21/2 ⁺ ‡	CD	
911.638 ⁱ 10	(5/2) ⁻	B EF	J ^π : M1 γ to 7/2 ⁻ , (M1) γ to 3/2 ⁻ .
919.784 ^g 10	(9/2) ⁻	B Ef	J ^π : M1 γ to 7/2 ⁻ ; γ to (11/2) ⁻ ; band assignment.
929.113 30	11/2 ⁻	B f	J ^π : E1+M2 γ to 11/2 ⁺ ; log f ^{lt} =9.8 from 7/2 ⁺ . Proposed as 11/2[505] bandhead in 1980Ba07.
946.470? 11		E	J ^π : possible transitions to 11/2 ⁺ and 11/2 ⁻ and 9/2 ⁺ suggest J ^π =(9/2,11/2,13/2 ⁺).
960.602 ^k 13	7/2 ⁻	B EF	J ^π : E1 γ to 9/2 ⁺ , E1 γ to 7/2 ⁺ g.s.; nuclear orientation data rule out J=9/2 (1982Da23).
996.64 ⁱ 4	(7/2) ⁻	EF	J ^π : M1 γ to 5/2 ⁻ ; band assignment.
1033.892 5	(1/2 ⁺ ,3/2)	EFG	J ^π : γ to 1/2 ⁻ , γ to (5/2) ⁺ ; primary γ from 1/2 ⁺ .
1042.7 ^d 4	(17/2) ⁻ ‡	D	
1061.063 ^g 15	(11/2) ⁻	B E	J ^π : γ to 7/2 ⁻ , γ to (9/2) ⁻ ; band assignment.
1064.719 12	(5/2 ⁺ ,7/2,9/2 ⁺)	EF	J ^π : γ to (5/2) ⁺ , γ to 9/2 ⁺ .
1070.693 ^m 16	7/2 ⁺	B Ef	J ^π : E0+M1+E2 γ to 7/2 ⁺ g.s..
1078.343 ^k 18	9/2 ⁻	B Ef	J ^π : E1+M2 917γ to 11/2 ⁺ 162, E1+M2 1078γ to 7/2 ⁺ g.s..
1110.700 8	3/2 ⁻ ,5/2 ⁻	EFG	J ^π : L=2 for (p,t) on 1/2 ⁻ target. Proposed in 1988DzZW as possible β vibration on 1/2[521], but J=1/2 is inconsistent with reported L(p,t).
1134 3		F	
1141.26 ^m 10	(9/2) ⁺	B E	J ^π : E2(+M1) γ to 11/2 ⁺ , γ to 7/2 ⁺ g.s. and 13/2 ⁺ ; band assignment.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Yb Levels (continued)

E(level) [†]	J ^π	XREF	Comments
1157.2 ^a 4	23/2 ⁺ [‡]	CD	
1159.88 4	(5/2 ⁺)	E	J ^π : primary γ from 1/2 ⁺ , γ to 7/2 ⁻ , possible γ to 9/2 ⁺ .
1166.89 6	(7/2,9/2) ⁻	B Fg	J ^π : M1+E2 γ to (9/2) ⁻ , (E2) γ to 7/2 ⁻ , γ to 5/2 ⁻ 99.
1176.658 13	(7/2,9/2) ⁺	B EFg	J ^π : M1(+E2) γ to 9/2 ⁺ , γ to 7/2 ⁻ . Tentatively suggested as 9/2[624] bandhead (1980Ba07).
1198 3		F	
1198.8 ^c 7	(19/2 ⁻) [‡]	D	
1202.209 13	(5/2 ⁺)	E	J ^π : γ to 9/2 ⁺ , γ to 3/2 ⁻ and 7/2 ⁻ , primary γ from 1/2 ⁺ .
1204.55 17		B	J ^π : 614 γ to (5/2) ⁺ 591; 1118 γ to 3/2 ⁻ 87.
1218.0 ^b 4	(21/2 ⁻) [‡]	CD	
1225.42 8	1/2,3/2,5/2 ⁺ [#]	EF	
1232.243 25	(3/2 ⁻)	E	J ^π : γ to 7/2 ⁻ ; possible γ to (1/2) ⁻ ; primary γ from 1/2 ⁺ .
1250.5 ^d 5	(19/2 ⁻) [‡]	D	
1261.713 29	(5/2,7/2 ⁻)	E	J ^π : γ s to 3/2 ⁻ and 7/2 ⁺ and (7/2) ⁻ .
1270.736 8	(1/2 ⁻)	E	J ^π : primary γ from 1/2 ⁺ in $^{168}\text{Yb}(n,\gamma)$ E=thermal; M1 γ to 3/2 ⁻ ; 1246.5 γ with probable E0 component to 1/2 ⁻ .
1283.295 19	(7/2,9/2) ⁻	B F	J ^π : E1+M2 γ s to 7/2 ⁺ g.s. and to 9/2 ⁺ .
1285.120 8	(3/2 ⁺ ,5/2,7/2 ⁺)	E	J ^π : γ s to 7/2 ⁺ g.s. and 3/2 ⁺ .
1296.655 11	(3/2 ⁻ ,5/2,7/2 ⁻)	E	J ^π : γ to 3/2 ⁻ , possible γ to 7/2 ⁻ .
1311.787 13	(5/2 ⁺ ,7/2)	E	J ^π : γ s to 7/2 ⁻ and to 3/2 ⁺ and to (7/2,9/2) ⁺ 1177.
1319.824 ^j 12	(1/2 ⁻)	EF	J ^π : M1 γ to 3/2 ⁻ ; (1/2) ⁻ consistent with band assignment.
1335.6 ^{&} 5	(25/2 ⁺) [‡]	CD	
1343.65 4	(7/2 ⁻)	B	J ^π : M1 γ to 5/2 ⁻ , stronger 1272 γ to 9/2 ⁺ .
1350.153 ^j 12	(3/2 ⁻)	EfG	J ^π : (M1) γ to 1/2 ⁻ ; primary γ from 1/2 ⁺ in (n, γ) E=thermal; band assignment.
1354.815 13	(3/2 ⁻)	EfG	J ^π : (M1) γ to 5/2 ⁻ ; primary γ from 1/2 ⁺ in $^{168}\text{Yb}(n,\gamma)$ E=thermal.
1395.392 ^j 11	(5/2 ⁻) [@]	EF	J ^π : γ s to 9/2 ⁻ and to 3/2 ⁻ ,5/2 ⁻ 1110; population in (d,p).
1398.711 13	(3/2 ⁻)	E	J ^π : M1 γ s to 5/2 ⁻ and to 1/2 ⁻ .
1406.341 29	9/2 ⁻	B	J ^π : M1 γ to 9/2 ⁻ , E1+M2 γ to 7/2 ⁺ g.s.; nuclear orientation data rule out J=7/2 (1982Da23).
1420.48 10	(5/2 ⁻ ,7/2,9/2 ⁻)	B fg	J ^π : γ to 9/2 ⁻ ; possible γ to 5/2 ⁻ . Proposed as J=7/2 member of 1/2[521] β vibration band in 1980Ba07. However, level is absent in 1988DzZW.
1426.80 6	(7/2,9/2) ⁻	B fg	J ^π : M1 γ to 9/2 ⁻ ; γ s to 5/2 ⁻ and (11/2 ⁻).
1444.74 5	7/2 ⁻ ,9/2 ⁻	B	J ^π : M1(+E2) γ to 9/2 ⁻ ; nuclear orientation data rule out J=11/2 (1982Da23).
1449.796 ^l 14	7/2 ⁻	B E	J ^π : E1 γ to 9/2 ⁺ , M1+E2 γ to 5/2 ⁻ .
1463.019 17	(7/2 ⁻)	E	J ^π : γ s to (11/2 ⁻) and to 3/2 ⁻ .
1463.384 18	7/2 ⁻	B Fg	J ^π : M1+E2 γ to 9/2 ⁻ , E1(+M2) γ to 7/2 ⁺ ; nuclear orientation data rule out J=9/2 (1980DuZP).
1464.97 ^j 4	(7/2 ⁻)	EFg	XREF: F(1473)
1478.510 15	(3/2 ⁻ ,5/2 ⁺)	E G	J ^π : M1(+E2) γ to 7/2 ⁻ ; band assignment.
1509.7 9	1/2 ⁻	E G	J ^π : γ to 7/2 ⁻ ; primary γ from 1/2 ⁺ in (n, γ) E=thermal. E(level): from (n, γ) E=thermal. J ^π : L=0 for (p,t) on 1/2 ⁻ target.
1524.158 27	1/2,3/2,5/2 ⁺ [#]	Efg	
1531.562 13	(3/2 ⁻ ,5/2 ⁺)	Efg	J ^π : γ to 7/2 ⁻ ; primary γ from 1/2 ⁺ in (n, γ) E=thermal.
1540.692 34	9/2 ⁻	B	J ^π : M1 γ to 11/2 ⁻ ; M1+E2 γ to 7/2 ⁻ .
1554.862 23	(1/2 ⁻)	Ef	J ^π : primary γ from 1/2 ⁺ in $^{168}\text{Yb}(n,\gamma)$ E=thermal; possible 1531 γ with E0 component to 1/2 ⁻ .
1554.881 ^l 22	9/2 ⁻	B f	J ^π : M1+E2 γ to 11/2 ⁻ , M1 γ to 7/2 ⁻ .
1565.62 4	(7/2 ⁻)	B F	J ^π : (M1) γ s to 9/2 ⁻ and 5/2 ⁻ .
1585.873 14	(1/2 ⁻)	E G	J ^π : L=(0) for (p,t) on 1/2 ⁻ target.
1607 6		F	
1616.669 12	(1/2 ⁺ ,3/2,5/2 ⁺)	B E	J ^π : γ to (5/2 ⁺ ,7/2) 1312; primary γ from 1/2 ⁺ in (n, γ).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Yb Levels (continued)

E(level) [†]	J ^π	XREF	Comments
1618.738 17 1640 6	1/2,3/2	E G F	J ^π : strong primary γ from 1/2 ⁺ in (n,γ) E=thermal; 1595γ to 1/2 ⁻ 24.
1650.6 ^c 9	(23/2 ⁻) [‡]	D	
1655.5 ^b 5	(25/2 ⁻) [‡]	CD	
1656.51 4	5/2 ⁻ , 7/2 ⁻ , 9/2 ⁻	B	J ^π : M1+E2 γ to 7/2 ⁻ .
1658.10 4	5/2 ⁺	B	J ^π : M1+E2 γ to 7/2 ⁺ g.s.; E1(+M2) γ to 5/2 ⁻ ; nuclear orientation data rule out J=7/2 (1982Da23).
1666.1 ^a 6	(27/2 ⁺) [‡]	CD	
1689.30 5	(5/2, 7/2) ⁻	E f	J ^π : M1+E2 γ to 5/2 ⁻ ; γ to 7/2 ⁺ g.s..
1689.334 25	7/2 ⁻	B f	J ^π : M1+E2 γ to 5/2 ⁻ ; E1(+M2) γ to 9/2 ⁺ .
1694.44 6	5/2 ⁺	B f	J ^π : E1(+M2) γ to 3/2 ⁻ ; log ft=8.69 from 7/2 ⁺ .
1696.422 19	3/2 ⁻	E	J ^π : M1 γ to 5/2 ⁻ ; primary γ from 1/2 ⁺ in $^{168}\text{Yb}(n,\gamma)$ E=thermal.
1707.83 6	(7/2, 9/2) ⁺	B	J ^π : M1+E2 γ to 9/2 ⁺ 71; (M1+E2) doubly-placed 1707.97γ to 7/2 ⁺ g.s.; nuclear orientation data rule out J=5/2 (1982Da23).
1708.51 4	7/2 ⁻	B g	J ^π : M1+E2 γs to 7/2 ⁻ and to 5/2 ⁻ 191; nuclear orientation data rule out J=5/2 (1982Da23).
1716.020 29	7/2 ⁺	B g	J ^π : M1+E2 γ to 9/2 ⁺ , E1(+M2) γ to 5/2 ⁻ .
1724.502 32	(3/2 ⁻)	E	J ^π : γs to 7/2 ⁻ and to (1/2) ⁻ 1271; primary γ from 1/2 ⁺ in (n,γ) E=thermal.
1733 6		F	
1742.877 18	(3/2 ⁺ , 5/2, 7/2) ⁻	E	J ^π : γ to 7/2 ⁺ g.s.; γ to (3/2 ⁻).
1745.0 8	(1/2 ⁻)	E G	XREF: G(1740) E(level): from (n,γ) E=thermal. J ^π : L=(0) for (p,t) on 1/2 ⁻ target. Consistent with observation of primary γ from 1/2 ⁺ in (n,γ) E=thermal.
1757.3 9	1/2, 3/2, 5/2 ⁺ #	E	
1767 6		F	
1781.242 24	(3/2 ⁻ , 5/2 ⁻)	E	J ^π : γs to (1/2 ⁻) and to 7/2 ⁻ . If 1391.8γ to 9/2 ⁻ placement is correct, J ^π =3/2 ⁻ can be eliminated. Level proposed in 1988DzZW. Differs from 1781 level known from ε decay because decay pattern differs.
1781.756 21	7/2 ⁻	B g	J ^π : M1 γ to 9/2 ⁻ ; M1+E2 γ to 5/2 ⁻ .
1787.3 8	1/2, 3/2, 5/2 ⁺ #	E g	E(level): from (n,γ) E=thermal.
1796.670 21	(3/2 ⁻ , 5/2 ⁺)	E	J ^π : γ to (7/2 ⁻); primary γ from 1/2 ⁺ in (n,γ) E=thermal.
1828.110 18	1/2, 3/2, 5/2 ⁺	E	J ^π : primary γ from 1/2 ⁺ in (n,γ) E=thermal; 132γ to 3/2 ⁻ 1697. However, 1563γ to 9/2 ⁻ from 1/2, 3/2, 5/2 ⁺ is unlikely, suggesting misplacement in 1988DzZW. If the placement of 1583.6γ to 7/2 ⁻ is correct, then J=1/2 can be rejected.
1837.5 7	1/2, 3/2, 5/2 ⁺ #	E	
1844.2 ^{&} 6	(29/2 ⁺) [‡]	CD	
1857.4 9	1/2, 3/2, 5/2 ⁺ #	E	
1867.59 4	(3/2 ⁻ , 5/2 ⁺)	E	J ^π : γ to 7/2 ⁻ ; primary γ from 1/2 ⁺ in (n,γ) E=thermal.
1888.00 6	(7/2 ⁺ , 9/2 ⁺)	B	J ^π : γs to (5/2 ⁺) ⁺ and 11/2 ⁺ .
1894.0 8	1/2, 3/2, 5/2 ⁺ #	E	
1908.663 27	5/2 ⁺	B	J ^π : E1+M2 γ to 5/2 ⁻ , γ to 7/2 ⁻ ; nuclear orientation data for 1339γ rule out J=7/2 (1982Da23).
1910.9 10	1/2, 3/2, 5/2 ⁺ #	E	
1920.5 9	1/2, 3/2, 5/2 ⁺ #	E	
1939.0 7	1/2, 3/2, 5/2 ⁺ #	E G	E(level): from (n,γ) E=thermal.
1954.53 4	5/2 ⁻ , 7/2 ⁻	B	J ^π : M1 γ to 7/2 ⁻ ; M1(+E2) γ to 5/2 ⁻ .
1972.21 5	9/2 ⁻	B g	J ^π : M1+E2 1043γ to 11/2 ⁻ 929; log ft=7.5 from 7/2 ⁺ .
1974.132 26	7/2 ⁻	B g	J ^π : E1 γ to 7/2 ⁺ ; (E1+M2) γ to 9/2 ⁺ ; nuclear orientation consistent only with J=7/2 (1982Da23).
1998.4 7	1/2, 3/2, 5/2 ⁺ #	E G	E(level): from (n,γ) E=thermal.

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Adopted Levels, Gammas (continued) ^{169}Yb Levels (continued)

E(level) [†]	J ^π	XREF	Comments
2030.03 4	7/2 ⁻	B	J ^π : γ to 5/2 ⁻ ; (E1(+M2)) γ to 9/2 ⁺ ; M1+E2 1110 γ to $\pi=-$ 920; nuclear orientation data consistent only with J=7/2 (1982Da23).
2037.7 8	1/2,3/2,5/2 ⁺ #	E	
2048.2 11	1/2,3/2,5/2 ⁺ #	E G	E(level): from (n, γ) E=thermal.
2065.04 11	7/2 ⁺	B	J ^π : M1+E2+E0 γ to 7/2 ⁺ g.s..
2101.03 6	(5/2,7/2) ⁻	B	J ^π : M1,E2 γ to 3/2 ⁻ ; γ to 7/2 ⁺ g.s..
2103.6 7	1/2,3/2,5/2 ⁺ #	E	
2123.2 12	1/2,3/2,5/2 ⁺ #	E G	E(level): from (n, γ) E=thermal.
2135.4 4		B	J ^π : 2135 γ to 7/2 ⁺ g.s..
2140.2 ^b 6	(29/2 ⁻) [‡]	C	
2192.9 10	1/2,3/2,5/2 ⁺ #	E	
2217.5 10	1/2,3/2,5/2 ⁺ #	E	
2234.5 9	1/2,3/2,5/2 ⁺ #	E	
2244.5 7	1/2,3/2,5/2 ⁺ #	E	
2258.1 ^a 21	(31/2 ⁺) [‡]	C	
2286.2 12	1/2,3/2,5/2 ⁺ #	E G	E(level): from (n, γ) E=thermal.
2287.22 5	7/2 ⁻	B	J ^π : M1 γ s to 5/2 ⁻ and to 9/2 ⁻ .
2296.82 15	5/2 ⁻ ,7/2 ⁻ ,9/2 ⁻	B	J ^π : M1 γ to 7/2 ⁻ .
2299.1 9	1/2,3/2,5/2 ⁺ #	E	
2313.6 7	1/2,3/2,5/2 ⁺ #	E	
2342.4 9	1/2,3/2,5/2 ⁺ #	E	
2350.1 8	1/2,3/2,5/2 ⁺ #	E	
2355.6 8	1/2,3/2,5/2 ⁺ #	E	
2375.9 10	1/2,3/2,5/2 ⁺ #	E	
2381.4 10	1/2,3/2,5/2 ⁺ #	E	
2388.0 9	1/2,3/2,5/2 ⁺ #	E	
2401.0 9	1/2,3/2,5/2 ⁺ #	E	
2407.4 9	1/2,3/2,5/2 ⁺ #	E	
2415.4 9	1/2,3/2,5/2 ⁺ #	E	
2425.7 ^{&} 9	(33/2 ⁺) [‡]	C	
2427.5 9	1/2,3/2,5/2 ⁺ #	E	
2441.1 10	1/2,3/2,5/2 ⁺ #	E	
2449.8 8	1/2,3/2,5/2 ⁺ #	E	
2477.9 10	1/2,3/2,5/2 ⁺ #	E	
2498.7 8	1/2,3/2,5/2 ⁺ #	E	
2504.4 9	1/2,3/2,5/2 ⁺ #	E	
2517.1 10	1/2,3/2,5/2 ⁺ #	E	
2522.8 8	1/2,3/2,5/2 ⁺ #	E	
2530.3 8	1/2,3/2,5/2 ⁺ #	E	
2551.1 8	1/2,3/2,5/2 ⁺ #	E	
2620.9 10	1/2,3/2,5/2 ⁺ #	E	
2634.0 12	1/2,3/2,5/2 ⁺ #	E	
2655.4 7	1/2,3/2,5/2 ⁺ #	E	
2668.0 ^b 7	(33/2 ⁻) [‡]	C	

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Adopted Levels, Gammas (continued) ^{169}Yb Levels (continued)

E(level) [†]	J ^π	XREF	E(level) [†]	J ^π	XREF
2679.7 8	1/2,3/2,5/2 ⁺ #	E	3173.8 8	1/2,3/2,5/2 ⁺ #	E
2684.8 11	1/2,3/2,5/2 ⁺ #	E	3238.6 ^b 8	(37/2 ⁻) [‡]	C
2705.9 8	1/2,3/2,5/2 ⁺ #	E	3246.5 9	1/2,3/2,5/2 ⁺ #	E
2741.8 9	1/2,3/2,5/2 ⁺ #	E	3274.0 15	1/2,3/2,5/2 ⁺ #	E
2774.5 9	1/2,3/2,5/2 ⁺ #	E	3344.4 8	1/2,3/2,5/2 ⁺ #	E
2781.0 10	1/2,3/2,5/2 ⁺ #	E	3375.4 8	1/2,3/2,5/2 ⁺ #	E
2801.9 10	1/2,3/2,5/2 ⁺ #	E	3450.0 9	1/2,3/2,5/2 ⁺ #	E
2827.2 7	1/2,3/2,5/2 ⁺ #	E	3526.7 8	1/2,3/2,5/2 ⁺ #	E
2856.0 9	1/2,3/2,5/2 ⁺ #	E	3559.9 9	1/2,3/2,5/2 ⁺ #	E
2869.9 9	1/2,3/2,5/2 ⁺ #	E	3588.1 ^a 31	(39/2 ⁺) [‡]	C
2891.6 7	1/2,3/2,5/2 ⁺ #	E	3657.0 10	1/2,3/2,5/2 ⁺ #	E
2917.3 8	1/2,3/2,5/2 ⁺ #	E	3781.8 ^{&} 12	(41/2 ⁺) [‡]	C
2929.1 ^a 29	(35/2 ⁺) [‡]	C	3856.1 ^b 8	(41/2 ⁻) [‡]	C
2932.8 15	1/2,3/2,5/2 ⁺ #	E	4330 ^a 4	(43/2 ⁺) [‡]	C
2952.0 10	1/2,3/2,5/2 ⁺ #	E	4524.0 ^{&} 14	(45/2 ⁺) [‡]	C
2988.6 9	1/2,3/2,5/2 ⁺ #	E	4526.9 ^b 10	(45/2 ⁻) [‡]	C
2998.9 10	1/2,3/2,5/2 ⁺ #	E	5116 ^a 4	(47/2 ⁺) [‡]	C
3015.2 12	1/2,3/2,5/2 ⁺ #	E	5256.5 ^b 11	(49/2 ⁻) [‡]	C
3027.4 10	1/2,3/2,5/2 ⁺ #	E	5272.1 ^{&} 15	(49/2 ⁺) [‡]	C
3038.4 8	1/2,3/2,5/2 ⁺ #	E	6045.8 ^{&} 15	(53/2 ⁺) [‡]	C
3043.8 8	1/2,3/2,5/2 ⁺ #	E	6048.3 ^b 11	(53/2 ⁻) [‡]	C
3066.1 8	1/2,3/2,5/2 ⁺ #	E	6874.8 ^{&} 25	(57/2 ⁺) [‡]	C
3074.8 ^{&} 11	(37/2 ⁺) [‡]	C	6903.6 ^b 11	(57/2 ⁻) [‡]	C
3094.5 9	1/2,3/2,5/2 ⁺ #	E	7770.8 ^{&} 32	(61/2 ⁺) [‡]	C
3105.6 7	1/2,3/2,5/2 ⁺ #	E	7823.3 ^b 12	(61/2 ⁻) [‡]	C
3118.9 11	1/2,3/2,5/2 ⁺ #	E	8806.7 ^b 12	(65/2 ⁻) [‡]	C
3130.3 9	1/2,3/2,5/2 ⁺ #	E	9854.2 ^b 14	(69/2 ⁻) [‡]	C
3142.6 8	1/2,3/2,5/2 ⁺ #	E	10961.2 ^b 24	(73/2 ⁻) [‡]	C

[†] From least-squares fit to adopted E_γ, except where noted or where cross references clearly indicate other source. About 50 E_γ are fit poorly (deviation more than 3σ) and yield a $\chi^2=5.1$ c.f. $\chi^2_{\text{crit}}=1.2$. Increasing the uncertainty by a factor of 2 or 3 for about 40 E_γs results a better fit, $\chi^2=1.8$. Those that did not fit well were omitted from the least-squares fit. All of these facts are marked by footnote and in comments.

[‡] From band assignment, established by γ-ray multipolarities, coincidence data, and rotational structure.

Primary transition from 1/2⁺ in $^{168}\text{Yb}(n,\gamma)$ E=thermal.

@ Based on comparison of relative populations of levels within a band in $^{168}\text{Yb}(d,p)$ and $^{170}\text{Yb}(d,t)$ with population pattern expected for different J values for specific Nilsson orbitals.

& Band(A): 7/2[633], α=+1/2 band. A=7.9, B=9.5 (7/2, 11/2, 15/2, 19/2 levels); A=8.1, B=4.5 (9/2, 13/2, 17/2, 21/2 levels).

^a Band(B): 7/2[633], α=-1/2 band. A=7.9, B=9.5 (7/2, 11/2, 15/2, 19/2 levels); A=8.1, B=4.5 (9/2, 13/2, 17/2, 21/2 levels).

^b Band(C): 1/2[521], α=+1/2 band. A=11.5, a=+0.80 (1/2, 3/2, 5/2, 7/2, 9/2 levels).

^c Band(c): 1/2[521], α=-1/2 band.

^d Band(D): 5/2[512] band. A=12.7, B=-9.5 (5/2, 7/2, 9/2, 11/2 levels).

^e Band(E): 5/2[523] band. A=11.2 (5/2, 7/2, 9/2 levels).

^f Band(F): 5/2[642] band. Small admixture from β vibration built on 5/2[642] (1968Mi08).

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Adopted Levels, Gammas (continued)

 ^{169}Yb Levels (continued)

- ^g Band(G): $K^\pi=3/2[521]$ band. Includes large admixture of K-2 γ vibration built on $1/2[521]$ ([1968Mi08](#)). A=12.2, B=6.4 (3/2, 5/2, 7/2, 9/2 levels).
- ^h Band(H): $K^\pi=3/2^+$ band. $7/2[633]$ γ vibration with some $3/2[651]$ admixture ([1968Mi08](#)).
- ⁱ Band(I): $K^\pi=1/2^-$ band. K-2 γ vibration built on $5/2[512]$, with significant $1/2[510]$ admixture ([1968Mi08](#)).
- ^j Band(J): $1/2[510]$ band. Admixed with γ vibration, possibly the K-2 vibration built on $5/2[512]$. Tentative assignment; populations in (d,p) are $\approx 40\%$ of expected strength.
- ^k Band(K): $7/2[514]$ band.
- ^l Band(L): $7/2[503]?$ band. Tentative band assignment from [1980Ba07](#).
- ^m Band(M): β vibration band. Built on $7/2[633]$ g.s.; band assignment from [1988DzZW](#).

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$										
$E_i(\text{level})$	J_i^π	$E_\gamma^{\#}$	$I_\gamma^{\text{@}}$	E_f	J_f^π	Mult. [#]	$\delta^{\#}$	α^f	$I_{(\gamma+ce)}$	Comments
24.2003	1/2 ⁻	24.20 2	100	0.0	7/2 ⁺	E3		2.58×10 ⁵ 4		B(E3)(W.u.)=0.0124 6
70.8816	9/2 ⁺	70.8814 ^a 9	100	0.0	7/2 ⁺	M1+E2	-0.31 +15-26	9.4 6		
86.9191	3/2 ⁻	62.7190 ^a 6	100	24.2003	1/2 ⁻	M1+E2	0.58 3	14.97 27		
99.2409	5/2 ⁻	12.31 2	6.0 13	86.9191	3/2 ⁻	M1+E2	0.028 +11-9	3.1×10 ² 5		
		75.0404 ^a 8	100.0 23	24.2003	1/2 ⁻	E2		10.05 14		
161.6505	11/2 ⁺	90.7692 ^a 10	100.0 21	70.8816	9/2 ⁺	M1+E2	-0.28 2	4.48 6		Other δ : -0.40 9 from (α ,2n γ).
		161.6513 ^a 15	29.7 22	0.0	7/2 ⁺	E2		0.555 8		I_γ : weighted average of 31.1 17 from ¹⁶⁹ Lu ε decay, 34 7 from (α ,2n γ), and 23.9 32 from (n, γ) E=thermal.
191.2141	5/2 ⁻	91.9737 ^a 12	2.91 6	99.2409	5/2 ⁻	M1(+E2)	-0.19 5	4.30 6		B(M1)(W.u.)=1.81×10 ⁻⁴ 10; B(E2)(W.u.)=0.36 +20-16 Other I_γ : 4.3 7 in (n, γ) E=thermal.
		104.2955 ^a 17	2.34 14	86.9191	3/2 ⁻	M1(+E2)	-0.55 +65-20	2.93 7		B(M1)(W.u.)=7.9×10 ⁻⁵ +38-21 I_γ : weighted average of 2.32 8 from ¹⁶⁹ Lu ε decay and 3.2 5 from (n, γ) E=thermal.
		167.0141 ^a 25	0.103 13	24.2003	1/2 ⁻	[E2]		0.495 7		B(E2)(W.u.)=0.0184 25
		191.2137 ^a 15	100.0 23	0.0	7/2 ⁺	E1+M2	-0.017 16	0.0631 25		B(E1)(W.u.)=7.21×10 ⁻⁶ +35-32; B(M2)(W.u.)=0.3 +8-2 δ : -0.058 9 from nuclear orientation (1982Da23) in ε decay; <0.041 from α (K)exp=0.049 8 (weighted average of 0.046 10 from ε decay and 0.052 12 from (n, γ) E=thermal). B(M2)(W.u.)≤1.0 (from RUL) implies δ ≤0.033, so evaluator adopts δ =-0.017 16.
243.8170	7/2 ⁻	144.5758 ^a 9	40.1 10	99.2409	5/2 ⁻	M1+E2	+0.52 +12-9	1.104 32		
		156.8977 ^a 10	100.0 18	86.9191	3/2 ⁻	E2		0.616 9		
264.2544	9/2 ⁻	20.44 2	0.42 7	243.8170	7/2 ⁻	M1		59.0 8		
		165.0134 ^a 15	100.0 19	99.2409	5/2 ⁻	E2		0.517 7		
269.6554	13/2 ⁺	108.0053 ^a 25	100 5	161.6505	11/2 ⁺	M1+E2	-0.29 4	2.68 4		Other δ : -0.32 12 (from (α ,2n γ)).
		198.771 ^a 5	52 8	70.8816	9/2 ⁺	[E2]		0.274 4		I_γ : from (n, γ) E=thermal. Others: 51 11 (ε decay), 139 from (α ,2n γ).
278.5978	7/2 ⁻	14.22 4		264.2544	9/2 ⁻				<17	I_γ : <0.1 from $I(\gamma+ce)$ limit and α (theory)=173 for M1, 3.06×10 ⁴ for E2.
		34.79 4	<1.57	243.8170	7/2 ⁻	M1+E2	≈0.022	≈12.36	<21	I_γ : from $I(\gamma+ce)$ and α in ε decay.
		87.3836 ^a 10	100.0 18	191.2141	5/2 ⁻	M1+E2	-0.23 2	5.00 7		

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^{\#}$	$I_\gamma^{\text{@}}$	E_f	J_f^π	Mult. [#]	$\delta^{\#}$	α^f	Comments
278.5978	7/2 ⁻	179.356 ^a 4	1.39 18	99.2409	5/2 ⁻				
		207.713 ^a 3	17.5 6	70.8816	9/2 ⁺	E1(+M2)	-0.09 +14-16	0.07 11	Other I_γ : 13.0 17 in (n, γ) E=thermal.
		278.595 ^a 5	5.3 4	0.0	7/2 ⁺	(E1)		0.02391 33	Other I_γ : 4.1 5 in (n, γ) E=thermal.
389.5273	9/2 ⁻	110.9291 ^a 10	100.0 24	278.5978	7/2 ⁻	M1+E2	-0.17 +4-3	2.499 35	Other δ : -0.11 +16-25 from (α ,2n γ).
		198.3136 ^a 17	43.9 15	191.2141	5/2 ⁻	E2		0.276 4	Other I_γ : 31 4 in (n, γ) E=thermal, 21 4 in (α ,2n γ).
		227.878 ^a 3	11.0 12	161.6505	11/2 ⁺	[E1]		0.0396 6	I_γ : weighted average of 12.3 23 from ¹⁶⁹ Lu ε decay and 10.5 14 from (n, γ) E=thermal.
		318.646 ^a 15	5.13 24	70.8816	9/2 ⁺	(E1)		0.01720 24	Other I_γ : 4.4 6 in (n, γ) E=thermal.
		389.53 ^a 3	8.4 4	0.0	7/2 ⁺	(E1)		0.01067 15	Other I_γ : 7 5 in (n, γ) E=thermal.
405.05	15/2 ⁺	135.3 ^b 5	50 ^b 5	269.6554	13/2 ⁺	(M1+E2) ^b	-0.32 ^b 8	1.389 30	Mult.: D+Q from (⁴⁸ Ca,3n γ), (M1+E2) from $\Delta\pi$ =no.
		243.4 3	100 ^b 10	161.6505	11/2 ⁺	(E2)		0.1415 21	E_γ : weighted average of 243.4 3 from (⁴⁸ Ca,3n γ) and 243.0 5 from (α ,2n γ).
									Mult.: Q from (⁴⁸ Ca,3n γ), (E2) from $\Delta\pi$ =no.
486.9449	(11/2 ⁻)	208.336 ^a 15	7.4 ^d 12	278.5978	7/2 ⁻				
		222.694 ^a 6	18.3 20	264.2544	9/2 ⁻				I_γ : weighted average of 15 8 from ¹⁶⁹ Lu ε decay, 17.5 35 from (α ,2n γ), and 19.0 26 from (n, γ) E=thermal.
		243.127 ^a 3	100 ^b 10	243.8170	7/2 ⁻	(E2)		0.1420 20	
512.028	(13/2 ⁻)	247.766 15	100	264.2544	9/2 ⁻	E2 ^b		0.1337 19	
523.0746	11/2 ⁻	133.542 ^a 4	100.0 26	389.5273	9/2 ⁻	M1+E2	-0.16 4	1.469 21	I_γ : weighted average from (α ,2n γ), ε decay and (n, γ) E=thermal.
									δ : other: -0.20 +10-12 (α ,2n γ).
		244.474 ^a 5	82 8	278.5978	7/2 ⁻	(E2)		0.1395 20	I_γ : weighted average of 97 18 from ¹⁶⁹ Lu ε decay, 78 16 from (α ,2n γ), and 79 10 from (n, γ) E=thermal.
547.12	17/2 ⁺	141.9 ^b 5	28.8 ^b 29	405.05	15/2 ⁺	(M1+E2) ^b	-0.23 ^b 9	1.227 26	
		277.5 3	100 ^b 10	269.6554	13/2 ⁺	(E2) ^b		0.0938 13	E_γ : weighted average of 277.6 3 from (⁴⁸ Ca,3n γ) and 277.1 5 from (α ,2n γ).
569.8316	5/2 ⁻	291.233 ^a 3	21.1 8	278.5978	7/2 ⁻	M1+E2	-0.10 9	0.1696 33	I_γ : weighted average of 21.1 8 from ¹⁶⁹ Lu ε decay and 20.3 26 from (n, γ) E=thermal.
		325.987 ^a 12	0.70 ^d 8	243.8170	7/2 ⁻				
		378.625 5	100.0 26	191.2141	5/2 ⁻	M1+E2	-0.41 +19-25	0.078 8	E_γ : weighted average of 378.632 11 from ¹⁶⁹ Lu ε decay and 378.624 5 from (n, γ) E=thermal.
		470.557 ^{ia} 17	5.2 ⁱ 5	99.2409	5/2 ⁻				
		482.890 15	7.1 4	86.9191	3/2 ⁻	M1		0.0448 6	E_γ : weighted average of 482.84 4 from ¹⁶⁹ Lu ε

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)

<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}[#]</u>	<u>I_{γ}[@]</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.[#]</u>	<u>δ[#]</u>	<u>α^f</u>	<u>Comments</u>
569.8316	5/2 ⁻	569.80 3	7.0 3	0.0	7/2 ⁺	[E1]		0.00457 6	decay and 482.894 12 from (n, γ) E=thermal. I _{γ} : weighted average of 6.99 33 from ¹⁶⁹ Lu ϵ decay and 8.5 11 from (n, γ) E=thermal. E _{γ} : weighted average of 569.79 4 from ¹⁶⁹ Lu ϵ decay and 569.81 3 from (n, γ) E=thermal. I _{γ} : weighted average of 6.88 33 from ¹⁶⁹ Lu ϵ decay and 8.9 13 from (n, γ) E=thermal.
590.692	(5/2) ⁺	312.082 ^{ha} 15 503.88 ^a 10 519.788 ^{ia} 15	<0.13 ^{hd} 0.42 ^d 11 2.65 ^{id} 34	278.5978 86.9191 70.8816	7/2 ⁻ 3/2 ⁻ 9/2 ⁺	[E2]		0.01617 23	α (K)exp exceeds α (K)(M1) in (n, γ) E=thermal, inconsistent with level scheme.
		590.695 14	100 5	0.0	7/2 ⁺	M1+E2	+0.34 +8-7	0.0252 8	E _{γ} : weighted average of 590.664 28 from ¹⁶⁹ Lu ϵ decay and 590.701 12 from (n, γ) E=thermal.
647.288	7/2 ⁺	485.69 ^a 4 576.398 12	2.2 ^d 4 100 8	161.6505 70.8816	11/2 ⁺ 9/2 ⁺	M1+E2	+0.09 4	0.0283 4	E _{γ} : weighted average of 576.42 4 from ¹⁶⁹ Lu ϵ decay and 576.396 12 from (n, γ) E=thermal.
		647.272 ^a 17	43 5	0.0	7/2 ⁺	M1+E2	+0.5 +6-4	0.019 4	I _{γ} : weighted average of 40.9 30 from ¹⁶⁹ Lu ϵ decay and 54 7 from (n, γ) E=thermal.
647.8373	7/2 ⁻	258.311 ^a 3	40.3 16	389.5273	9/2 ⁻	M1+E2	+1.4 +19-6	0.157 32	I _{γ} : weighted average of 40.5 17 from ¹⁶⁹ Lu ϵ decay and 39 5 from (n, γ) E=thermal.
		369.234 6	100.0 25	278.5978	7/2 ⁻	M1(+E2)	-0.02 5	0.0904 13	E _{γ} : weighted average of 369.251 15 from ¹⁶⁹ Lu ϵ decay and 369.232 5 from (n, γ) E=thermal.
		383.595 ^a 15	9.5 10	264.2544	9/2 ⁻				I _{γ} : weighted average of 8.9 14 from ¹⁶⁹ Lu ϵ decay and 10.0 13 from (n, γ) E=thermal.
		403.957 ^a 25	14.8 11	243.8170	7/2 ⁻	(M1)		0.07137 99	
		456.636 9	85 4	191.2141	5/2 ⁻	M1+E2	-0.24 +10-9	0.0502 15	E _{γ} : weighted average of 456.621 27 from ¹⁶⁹ Lu ϵ decay and 456.638 9 from (n, γ) E=thermal.
		548.546 ^a 25	42 4	99.2409	5/2 ⁻	M1+E2	+0.53 +13-10	0.0283 16	I _{γ} : weighted average of 40.8 23 from ¹⁶⁹ Lu ϵ decay and 53 7 from (n, γ) E=thermal.
		560.73 7	11.7 9	86.9191	3/2 ⁻	(E2)		0.01340 19	E _{γ} : for doublet dominated by this transition. I _{γ} : divided intensity from ϵ decay (34.06 h). Mult., δ : M1+E2, δ =1.1 3 from α (K)exp in ϵ decay for doublet dominated by this transition; other component is known from (n, γ) to have

Adopted Levels, Gammas (continued)

$E_i(\text{level})$	J_i^π	$\gamma(^{169}\text{Yb})$ (continued)							Comments
		E_γ #	I_γ @	E_f	J_f^π	Mult. #	δ #	α^f	
659.628	$3/2^-$	89.809 ^{aj} 15	0.16 ^d 4	569.8316	$5/2^-$				$\alpha(K)\text{exp} > \alpha(K)(M1)$ so mult=E2(+M1) is likely for this transition. An M1 component is inconsistent with level scheme.
		468.434 ^{ha} 12	4.1 ^{hd} 6	191.2141	$5/2^-$				
		560.369 ^{aa} 15	25 ^d 3	99.2409	$5/2^-$	(M1) ^a		0.0306 4	Mult.: $\alpha(K)\text{exp}$ in (n, γ) E=thermal exceeds $\alpha(K)(M1)$.
		572.731 ^a 12	100 ^d 13	86.9191	$3/2^-$	M1+E2	-0.7 +4-6	0.024 5	
677.107	$13/2^-$	635.410 ^{ga} 15	<235 ^d	24.2003	$1/2^-$	M1		0.02218 31	I_γ : weighted average of 53 11 from (α ,2n γ) and 31 17 from (n, γ) E=thermal.
		154.020 ^a 10	47 10	523.0746	$11/2^-$	(M1+E2) ^b	-0.29 ^b +9-7	0.962 19	
		287.585 ^a 7	100 ^d 15	389.5273	$9/2^-$	[E2] ^b		0.0840 12	
		183.920 ^a 12	0.9 ^d 4	523.0746	$11/2^-$				
707.024	$9/2^+$	436.98 ^a 10	7.8 ^d 19	269.6554	$13/2^+$				
		545.54 ^{ac} 2	75 ^e 5	161.6505	$11/2^+$	M1+E2	-0.12 7	0.0325 6	
		636.11 ^a 7	100 ^d 26	70.8816	$9/2^+$	E2(+M1)		0.016 6	
		129.221 ^a 10	0.035 6	590.692	$(5/2)^+$				
719.944	$3/2^+$	528.672 ^a 25	1.20 ^d 16	191.2141	$5/2^-$				
		695.53 ^a 10	0.85 ^d 14	24.2003	$1/2^-$				
		719.979 ^a 25	100	0.0	$7/2^+$	E2		0.00747 10	
		443.659 ^a 25	1.51 ^d 24	278.5978	$7/2^-$				
722.276	$5/2^-$	478.449 ^a 10	13.6 ^d 20	243.8170	$7/2^-$	M1 ^a		0.0459 6	
		531.04 ^a 3	2.03 ^d 32	191.2141	$5/2^-$				
		623.026 ^a 15	100 ^d 9	99.2409	$5/2^-$	M1(+E2)		0.017 6	
		635.410 ^{ga} 15	<183	86.9191	$3/2^-$	M1		0.02218 31	
736.23	$19/2^+$	189.1 ^b 5	32 ^b 3	547.12	$17/2^+$	M1+E2 ^b	-0.32 ^b 8	0.535 13	E_γ : weighted average of 331.3 3 from (^{48}Ca ,3n γ) and 330.9 5 from (α ,2n γ).
		331.2 3	100 ^b 10	405.05	$15/2^+$	E2 ^b		0.0551 8	
748.978	$(9/2)^-$	179.116 ^a 12	2.9 ^d 12	569.8316	$5/2^-$				I_γ : from ε decay. $I(471\gamma):I(225\gamma)=100$ 43:11.6 11 in (n, γ) E=thermal.
		225.901 ^a 6	16 8	523.0746	$11/2^-$				
		262.164 ^{a‡} 8	8 ^d 3	486.9449	$(11/2^-)$				E_γ : very poor fit and omitted in the fitting; level-energy difference=262.033. E_γ : weighted average of 359.38 7 from ^{169}Lu ε decay and 359.495 17 from (n, γ) E=thermal.
		359.489 27	38.0 22	389.5273	$9/2^-$	(M1+E2)	1.5 +15-6	0.060 13	

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	E_γ [#]	I_γ [@]	E_f	J_f^π	Mult. [#]	δ [#]	α ^f	Comments
748.978	(9/2) ⁻	470.557 ^{ia} 17	100 ⁱ 14	278.5978	7/2 ⁻	M1		0.0479 7	E_γ : very poor fit and omitted in the fitting; level-energy difference=470.379.
		484.65 [†] 4	37.4 16	264.2544	9/2 ⁻	(M1)		0.0444 6	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=484.722. Transition not seen in $^{168}\text{Yb}(n,\gamma)$ E=thermal, but would be expected, if placement in ^{169}Lu ε decay (34.06 h) were correct.
		505.10 17	32 5	243.8170	7/2 ⁻	M1		0.0399 6	
		587.29 ^a 20	43 ^d 19	161.6505	11/2 ⁺				
		649.72 12	12.8 16	99.2409	5/2 ⁻				E_γ : not observed in (n, γ) E=thermal.
757.872	(11/2 ⁺)	488.22 ^a 2	63 ^d 8	269.6554	13/2 ⁺				
		596.15 ^a 6	100 ^d 22	161.6505	11/2 ⁺				
761.846	(5/2 ⁺)	171.156 ^a 7	0.13 ^d 3	590.692	(5/2 ⁺)				
		518.07 ^{ha} 7	<1.8 ^{hd}	243.8170	7/2 ⁻				
		690.921 ^a 34	93 5	70.8816	9/2 ⁺	(E2)		0.00820 11	E_γ : weighted average of 690.87 3 from ^{169}Lu ε decay and 690.943 20 from (n, γ) E=thermal.
		761.864 ^a 25	100 ^d 13	0.0	7/2 ⁺	M1+E2	0.76 +28-25	0.0113 12	
807.066	(7/2) ⁻	417.50 ^{ha} 11	<4.1 ^{hd}	389.5273	9/2 ⁻				
		542.82 ^a 2	18.1 24	264.2544	9/2 ⁻	(M1)		0.0331 5	Other I_γ : 31 5 from (n, γ) E=thermal.
		563.243 ^a 15	100 6	243.8170	7/2 ⁻	(E2)		0.01326 19	
		616.14 ^a 12	8.1 ^d 17	191.2141	5/2 ⁻				
		707.86 8	87 5	99.2409	5/2 ⁻	M1+E2	+0.30 13	0.0161 7	E_γ : unweighted average of 707.94 6 from ^{169}Lu ε decay and 707.78 3 from (n, γ) E=thermal.
									I_γ : other: 168 21 from (n, γ) E=thermal. Source of discrepancy unknown.
807.7	(15/2 ⁻)	320.7 ^b 5	100	486.9449	(11/2 ⁻)	[E2]		0.0606 9	
813.333	(1/2) ⁻	153.732 ^a 12	0.09 ^d 6	659.628	3/2 ⁻				
		622.092 ^a 15	82 ^d 11	191.2141	5/2 ⁻				
		726.417 25	100 ^d 13	86.9191	3/2 ⁻	M1(+E2) ^a	0.7 9	0.0130 33	
831.899	(7/2 ⁺)	111.961 ^a 9	0.42 ^d 7	719.944	3/2 ⁺				
		640.51 ^a 10	4.7 ^d 13	191.2141	5/2 ⁻				
		670.32 7	46 ^d 6	161.6505	11/2 ⁺	E2		0.00879 12	E_γ : unweighted average of 670.39 3 from ^{169}Lu ε decay and 670.25 3 from (n, γ) E=thermal.

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^{\#}$	$I_\gamma^{\text{@}}$	E_f	J_f^π	Mult. [#]	$\delta^{\#}$	α^f	Comments
831.899	(7/2) ⁺	760.95 ^a 4 831.87 15	100 ^d 14 27 ^d 5	70.8816 0.0	9/2 ⁺ 7/2 ⁺	M1+E2 (M1)	0.76 +29-25	0.0114 12 0.01128 16	E_γ : unweighted average of 832.01 9 from ^{169}Lu ε decay and 831.72 7 from (n, γ) E=thermal.
833.83	(17/2) ⁻	321.8 ^{&} 3	100	512.028	(13/2) ⁻	(E2)		0.0600 9	
851.392	3/2 ⁻	607.67 ^a 5 660.193 ^g 17 752.19 ^a 5 764.46 ^a 4 827.15 ^a 3	5.0 ^d 7 <78 ^d 15.3 ^d 19 32 ^d 4 100 ^d 14	243.8170 191.2141 99.2409 86.9191 24.2003	7/2 ⁻ 5/2 ⁻ 5/2 ⁻ 3/2 ⁻ 1/2 ⁻	M1+E2 ^a M1 ^a	1.3 7	0.013 4 0.01144 16	
851.48	15/2 ⁻	174.5 ^b 5 328.4 ^b 5	33 ^b 7 100 ^b 21	677.107 523.0746	13/2 ⁻ 11/2 ⁻	(M1+E2) ^b (E2) ^b	-0.6 ^b +5-3	0.62 7 0.0565 8	
865.155	(11/2) ⁻	217.321 ^a 15 342.32 ^{a†} 5	43 ^d 12 100 ^d 26	647.8373 523.0746	7/2 ⁻ 11/2 ⁻				E_γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=342.080.
886.806	9/2 ⁺	353.04 ^a 5 725.07 7 815.95 4	71 ^d 16 100 5 65 3	512.028 161.6505 70.8816	(13/2) ⁻ 11/2 ⁺ 9/2 ⁺	M1+E2 M1+E2	1.06 +27-21 -0.80 +17-24	0.0114 10 0.0094 8	
903.14	21/2 ⁺	166.8 ^b 5 356.0 3	16 ^b 3 100 ^b 11	736.23 547.12	19/2 ⁺ 17/2 ⁺	(M1+E2) ^b (E2) ^b	-0.14 ^b 8	0.784 15 0.0447 6	E_γ : weighted average of 356.2 3 from (^{48}Ca ,3n γ) and 355.6 5 from (α ,2n γ).
911.638	(5/2) ⁻	149.790 ^a 20 522.112 ^a 17 633.071 ^a 20 667.73 14	0.72 ^d 18 26 ^d 3 100 12 92 ^d 10	761.846 389.5273 278.5978 243.8170	(5/2) ⁺ 9/2 ⁻ 7/2 ⁻ 7/2 ⁻	M1 ^a		0.01957 27	E_γ : unweighted average of 667.59 7 from ^{169}Lu ε decay and 667.872 25 from (n, γ) E=thermal.
		812.41 ^a 8 824.68 ^a 6	35 ^d 6 58 ^d 8	99.2409 86.9191	5/2 ⁻ 3/2 ⁻	(M1)		0.01153 16	
919.784	(9/2) ⁻	170.731 ^a 20 197.508 ^a 30 212.783 ^a 10 272.66 ⁱ 16 432.75 ^{a†} 3	2.5 ^d 6 5.2 ^d 6 <8.4 ^d 17 ⁱ 6 26 ^d 3	748.978 722.276 707.024 647.288 486.9449	(9/2) ⁻ 5/2 ⁻ 9/2 ⁺ 7/2 ⁺ (11/2) ⁻				E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=432.838.
		530.32 10	38 10	389.5273	9/2 ⁻	(M1)		0.0352 5	E_γ : weighted average of 529.7 5 from ^{169}Lu ε

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^{\#}$	$I_\gamma^{\text{@}}$	E_f	J_f^π	Mult. $\#$	$\delta^\#$	α^f	Comments
919.784	(9/2) ⁻	655.45 8	100 12	264.2544	9/2 ⁻	(M1)		0.02051 29	decay and 530.34 8 from (n, γ) E=thermal. I $_\gamma$: weighted average of 29 15 from ¹⁶⁹ Lu ϵ decay and 44 13 from (n, γ) E=thermal. E $_\gamma$: weighted average of 655.61 13 from ¹⁶⁹ Lu ϵ decay and 655.41 6 from (n, γ) E=thermal.
929.113	11/2 ⁻	675.90 11 920.2 ^a 10 406.03 ^g 7 539.37 15 657.9 ^{†j} 3	46 6 <13.5 27 4	243.8170 7/2 ⁻ 0.0 7/2 ⁺ 523.0746 11/2 ⁻ 389.5273 9/2 ⁻ 269.6554 13/2 ⁺	7/2 ⁻ 7/2 ⁺ 11/2 ⁻ 9/2 ⁻ 13/2 ⁺	M1 (E1)		0.01898 27 0.00338 5	 E $_\gamma$: uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=659.456. Mult.: E2(+M1) for doubly-placed γ in ϵ decay.
		664.69 ^h 8	<39 ^h	264.2544	9/2 ⁻	[E2(+M1)]		0.014 5	
946.470?		767.55 4 239.464 ^{ha} 15 423.376 ^{ha} 17 784.88 ^{ha} 15	100 8 6.9 ^{hd} 11 66 ^{hd} 8 100 ^{hd} 20	161.6505 11/2 ⁺ 707.024 9/2 ⁺ 523.0746 11/2 ⁻ 161.6505 11/2 ⁺	11/2 ⁺ 9/2 ⁺ 11/2 ⁻ 11/2 ⁺	E1+M2	-0.17 +12-10	0.0034 14	
960.602	7/2 ⁻	682.12 28 889.753 21 960.622 20	0.09 4 22.9 6 100 2	278.5978 7/2 ⁻ 70.8816 9/2 ⁺ 0.0 7/2 ⁺	7/2 ⁻ 9/2 ⁺ 7/2 ⁺	E1 E1		1.86 $\times 10^{-3}$ 3 1.61 $\times 10^{-3}$ 2	
996.64	(7/2) ⁻	348.77 ^{aj} 5 805.47 ^{gaj} 25 897.45 ^a 6	0.92 ^d 26 <8.3 ^d 100 ^d 14	647.8373 7/2 ⁻ 191.2141 5/2 ⁻ 99.2409 5/2 ⁻	7/2 ⁻ 5/2 ⁻ 5/2 ⁻	M1 ^a		0.00935 13	
1033.892	(1/2 ⁺ , 3/2)	272.053 ^a 10 311.619 ^a 5 313.940 ^a 5 374.266 ^a 7 934.87 ^a 20 947.37 ^{a†} 15	1.22 ^d 22 4.2 ^d 5 6.8 ^d 9 10.0 ^d 12 13.0 ^d 22 23 ^d 3	761.846 (5/2) ⁺ 722.276 5/2 ⁻ 719.944 3/2 ⁺ 659.628 3/2 ⁻ 99.2409 5/2 ⁻ 86.9191 3/2 ⁻	(5/2) ⁺ 5/2 ⁻ 3/2 ⁺ 3/2 ⁻ 5/2 ⁻ 3/2 ⁻				E $_\gamma$: uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=946.970.
1042.7	(17/2 ⁻)	1009.64 ^a 6 191.0 ^{bj} 5	100 ^d 14	24.2003 1/2 ⁻ 851.48 15/2 ⁻	1/2 ⁻ 15/2 ⁻				E $_\gamma$: for multiply-placed γ .

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^{\#}$	$I_\gamma^@$	E_f	J_f^π	Mult. [#]	$\delta^{\#}$	α^f	Comments
1042.7	(17/2 ⁻)	365.5 ^b 5	100 ^b 21	677.107	13/2 ⁻	(E2) ^b		0.0415 6	
1061.063	(11/2 ⁻)	254.01 ^a 4	6.0 ^d 11	807.066	(7/2) ⁻				
		312.082 ^{ha} 15	<11 ^{hd}	748.978	(9/2) ⁻				
		574.10 ^a 8	56 ^d 21	486.9449	(11/2 ⁻)				
		781.77 ^{a†} 25	63 ^d 13	278.5978	7/2 ⁻				E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=782.463.
1064.719	(5/2 ⁺ , 7/2, 9/2 ⁺)	796.36 ^a 25	100 ^d 20	264.2544	9/2 ⁻				
		357.686 ^a 9	100 ^d 19	707.024	9/2 ⁺				
		417.50 ^{ha} 11	<100 ^{hd}	647.288	7/2 ⁺				
		474.28 ^{a†} 6	81 ^d 15	590.692	(5/2) ⁺				E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=474.026.
1070.693	7/2 ⁺	1064.7 ^{ha} 4	<846 ^{hd}	0.0	7/2 ⁺				
		423.376 ^{ha} 17	<7.5 ^h	647.288	7/2 ⁺	M1		0.0631 9	Other I_γ : 86 10 from (n, γ) E=thermal; this suggests transition may be complex there.
		480.06 4	38 5	590.692	(5/2) ⁺	(M1)		0.0455 6	E_γ : weighted average of 480.00 8 from ^{169}Lu ε decay and 480.08 4 from (n, γ) E=thermal.
		908.64 [†] 7	29 4	161.6505	11/2 ⁺				E_γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=909.040.
		999.96 7	100 6	70.8816	9/2 ⁺	M1+E2	+1.9 5	0.0045 4	
		1070.81 7	95 5	0.0	7/2 ⁺	E0+M1+E2		0.042 3	Mult., α : from ε decay.
1078.343	9/2 ⁻	814.02 ^{aj} 20		264.2544	9/2 ⁻				
		916.710 29	48.1 14	161.6505	11/2 ⁺	E1(+M2)	-0.010 27	0.00176 4	
		1007.465 32	100.0 25	70.8816	9/2 ⁺	E1+M2	-0.08 5	0.00158 17	
		1078.28 4	59.4 23	0.0	7/2 ⁺	E1(+M2)	-0.16 +6-8	0.0016 4	
1110.700	3/2 ⁻ , 5/2 ⁻	297.40 ^a 4	0.64 ^d 12	813.333	(1/2) ⁻				
		390.748 ^a 8	10.4 ^d 13	719.944	3/2 ⁺				
		451.15 ^{aj} 11	1.5 ^d 5	659.628	3/2 ⁻				
		1023.72 ^a 7	100 ^d 15	86.9191	3/2 ⁻				
		1086.35 ^a 10	90 ^d 13	24.2003	1/2 ⁻				
1141.26	(9/2) ⁺	871.51 ^a 25	38 ^d 13	269.6554	13/2 ⁺				
		979.74 ^a 12	100 ^d 15	161.6505	11/2 ⁺	E2(+M1)		0.0057 18	

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^{\#}$	$I_\gamma^{\text{@}}$	E_f	J_f^π	Mult. $\#$	$\delta^{\#}$	α^f	Comments
1141.26	(9/2) ⁺	1140.78 ^a 25	78 ^d 45	0.0	7/2 ⁺				
1157.2	23/2 ⁺	253.3 ^b 5	24 ^b 5	903.14	21/2 ⁺	(M1+E2) ^b	-0.33 ^b 9	0.237 7	
		421.0 3	100 ^b 10	736.23	19/2 ⁺	(E2) ^b		0.0280 4	E_γ : weighted average of 421.3 3 from (⁴⁸ Ca,3n γ) and 420.2 5 from (α ,2n γ).
1159.88	(5/2 ⁺)	512.03 ^a 5	59 ^d 12	647.8373	7/2 ⁻				
		590.04 ^a 6	62 ^d 11	569.8316	5/2 ⁻				
		968.77 ^a 17	57 ^d 9	191.2141	5/2 ⁻				
1166.89	(7/2,9/2) ⁻	1088.9 ^{aj} 4	100 ^d 24	70.8816	9/2 ⁺				
		247.2 3	18 6	919.784	(9/2) ⁻	M1+E2	1.0 +26-8	0.20 6	
		519.02 6	15.4 22	647.8373	7/2 ⁻	(E2)		0.01623 23	
		903.42 [†] 23	13 5	264.2544	9/2 ⁻				E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=902.63.
		1068.54 [‡] 8	100 6	99.2409	5/2 ⁻				E_γ : very poor fit and omitted in the fitting; level-energy difference=1067.64.
1176.658	(7/2,9/2) ⁺	230.193 ^a 25	1.5 ^d 3	946.470?					
		418.76 ^{ha} 5	<9 ^{hd}	757.872	(11/2 ⁺)				
		469.50 ^{a†} 2	26 ^d 4	707.024	9/2 ⁺				E_γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=469.634.
		585.983 ^a 25	77 ^d 10	590.692	(5/2) ⁺				
		1015.4 4		161.6505	11/2 ⁺				E_γ : seen only in ce spectrum in ε decay.
		1106.11 [†] 6	<127 ^d	70.8816	9/2 ⁺	M1(+E2)		0.0043 13	E_γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=1105.773.
									E_γ : 1105.5 3 for doublet in (n, γ) E=thermal.
									E_γ : 1177.7 4 for doublet in ε decay.
1198.8	(19/2 ⁻)	1177.1 ^a 4	100 ^d 18	0.0	7/2 ⁺				
		391.1 ^b 5	100	807.7	(15/2 ⁻)	(E2) ^b		0.0343 5	
1202.209	(5/2 ⁺)	137.487 ^a 8	1.9 ^d 3	1064.719	(5/2 ⁺ ,7/2,9/2 ⁺)				
		350.99 ^a 10	5.3 ^d 9	851.392	3/2 ⁻				
		554.44 ^a 17	6.9 ^d 28	647.8373	7/2 ⁻				

Adopted Levels, Gammas (continued)

$E_i(\text{level})$	J_i^π	$\gamma(^{169}\text{Yb})$ (continued)							Comments
		E_γ [#]	I_γ [@]	E_f	J_f^π	Mult. [#]	δ [#]	α ^f	
1202.209	(5/2 ⁺)	611.626 ^{ha†} 17	<180 ^{hd}	590.692	(5/2) ⁺				E_γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=611.516.
		632.38 ^{ha} 7	<44 ^{hd}	569.8316	5/2 ⁻				
		1115.1 ^a 4	59 ^d 14	86.9191	3/2 ⁻				
		1131.29 ^a 17	100 ^d 45	70.8816	9/2 ⁺				
1204.55		613.9 3	100 53	590.692	(5/2) ⁺				
		1117.61 20	87 27	86.9191	3/2 ⁻				
1218.0	(21/2 ⁻)	384.2 2	100 ^b	833.83	(17/2 ⁻)	[E2]		0.0360 5	E_γ : weighted average of 384.7 6 from (⁴⁸ Ca,3n γ) and 383.9 5 from (α ,2n γ).
1225.42	1/2,3/2,5/2 ⁺	634.73 ^h 8	100 ^h	590.692	(5/2) ⁺				
1232.243	(3/2 ⁻)	271.70 3	7.0 10	960.602	7/2 ⁻				
		418.76 ^{ha†} 5	<32 ^{hd}	813.333	(1/2) ⁻				E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=418.910.
		509.88 ^a 6	100 ^d 26	722.276	5/2 ⁻				
1250.5?	(19/2 ⁻)	207.4 ^{bj} 5	63 ^b 14	1042.7	(17/2 ⁻)				
		399.4 ^{bj} 5	100 ^b 20	851.48	15/2 ⁻				
1261.713	(5/2,7/2 ⁻)	454.65 ^a 3	78 ^d 11	807.066	(7/2) ⁻				
		539.10 ^a 25	96 ^d 32	722.276	5/2 ⁻				
		602.08 ^a 7	100 ^d 17	659.628	3/2 ⁻				
		614.5 ^a 4	52 ^d 13	647.288	7/2 ⁺				
		1018.0 ^{ha} 3	<234 ^{hd}	243.8170	7/2 ⁻				
1270.736	(1/2) ⁻	160.035 ^a 4	1.0 ^d 3	1110.700	3/2 ⁻ ,5/2 ⁻				
		419.39 ^a 3	35 ^d 5	851.392	3/2 ⁻	M1 ^a		0.0647 9	
		457.43 ^a 2	8.5 ^d 12	813.333	(1/2) ⁻				
		1183.63 ^a 25	100 ^d 21	86.9191	3/2 ⁻	M1 ^a		0.00475 7	
		1246.5 ^a 3	72 ^d 13	24.2003	1/2 ⁻				Large $\alpha(K)_{\text{exp}}=0.024$ 7 ((n, γ) E=thermal) suggests probable E0 component.
1283.295	(7/2,9/2) ⁻	476.38 15	1.4 3	807.066	(7/2) ⁻				
		1212.52 8	22.7 18	70.8816	9/2 ⁺	E1(+M2)	-0.02 7	0.00109 8	
		1283.28 4	100 5	0.0	7/2 ⁺	E1+M2	-0.01 +6-5	1.01×10^{-3} 3	

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	E_γ [#]	I_γ [@]	E_f	J_f^π	Mult. [#]	$\delta^\#$	α^f	Comments
1285.120	(3/2 ⁺ , 5/2, 7/2 ⁺)	174.420 ^a 2	1.47 ^d 19	1110.700	3/2 ⁻ , 5/2 ⁻				
		453.34 ^a 6	1.5 ^d 5	831.899	(7/2) ⁺				
		565.13 ^a 9	2.3 ^d 12	719.944	3/2 ⁺				
		1284.7 ^a 8	100 ^d 36	0.0	7/2 ⁺				
1296.655	(3/2 ⁻ , 5/2, 7/2 ⁻)	185.941 ^a 25	0.41 ^d 6	1110.700	3/2 ⁻ , 5/2 ⁻				
		262.753 ^a 17	0.73 ^d 14	1033.892	(1/2 ⁺ , 3/2)				
		445.17 ^a 7	1.2 ^d 4	851.392	3/2 ⁻				
		1018.0 ^{ha} 3	<24 ^{hd}	278.5978	7/2 ⁻				
		1105.5 ^{ha} 3	33 ^{hd} 6	191.2141	5/2 ⁻				
		1197.8 ^a 7	100 ^d 29	99.2409	5/2 ⁻				
		1209.8 ^a 3	55 ^d 11	86.9191	3/2 ⁻				
1311.787	(5/2 ⁺ , 7/2)	135.130 ^a 15	0.60 ^d 13	1176.658	(7/2, 9/2) ⁺				
		504.64 ^a 7	9.5 ^d 25	807.066	(7/2) ⁻				
		549.90 ^a 10	5.0 ^d 10	761.846	(5/2) ⁺				
		591.78 ^a 6	22 ^d 7	719.944	3/2 ⁺				
		1033.72 ^a 25	50 ^d 10	278.5978	7/2 ⁻				
		1067.64 ^a 20	100 ^d 18	243.8170	7/2 ⁻				
1319.824	(1/2) ⁻	468.434 ^{ha} 12	<13.0 ^{hd}	851.392	3/2 ⁻				
		660.193 ^{ga} 17	<102 ^d	659.628	3/2 ⁻	M1+E2 ^a		0.015 6	
		1232.64 ^a 17	100 ^d 13	86.9191	3/2 ⁻	M1 ^a		0.00431 6	
		1295.6 ^a 4	99 ^d 16	24.2003	1/2 ⁻	(M1) ^a		0.00384 5	
1335.6	(25/2) ⁺	177.9 ^{bj} 5	<14.2 ^b	1157.2	23/2 ⁺				
		433.0 5	100 ^b 10	903.14	21/2 ⁺	(E2) ^b		0.0260 4	E_γ : weighted average of 433.3 3 from (⁴⁸ Ca, 3n γ) and 432.3 5 from (α , 2n γ).
1343.65	(7/2) ⁻	272.66 16	8.6 28	1070.693	7/2 ⁺				
		432.27 [†] 7	4.1 5	911.638	(5/2) ⁻	M1+E2	1.2 +45-7	0.040 13	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=432.01.
		1065.09 5	69 6	278.5978	7/2 ⁻	M1		0.00614 9	
		1099.89 11	9.3 10	243.8170	7/2 ⁻				
		1244.24 12	11.0 14	99.2409	5/2 ⁻	M1		0.00422 6	
		1272.46 [†] 6	100 5	70.8816	9/2 ⁺				E_γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=1272.76.

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ [#]	I_γ [@]	E_f	J_f^π	Mult. [#]	δ [#]	α ^f	Comments
1343.65	(7/2) ⁻	1343.56 ¹³	21.6 ¹⁷	0.0	7/2 ⁺				
1350.153	(3/2) ⁻	239.464 ^{ha} ¹⁵	<0.31 ^{hd}	1110.700	3/2 ⁻ , 5/2 ⁻				
		498.77 ^a ⁴	2.1 ^d ³	851.392	3/2 ⁻				
		627.852 ^a ²⁵	19.5 ^d ²⁴	722.276	5/2 ⁻				
		630.23 ^a ³	10.3 ^d ¹⁴	719.944	3/2 ⁺				
		1263.08 ^a ²⁰	100 ^d ¹⁶	86.9191	3/2 ⁻	(M1) ^a		0.00407 ⁶	
		1325.5 ^a ⁶	44 ^d ¹⁰	24.2003	1/2 ⁻	(M1) ^a		0.00364 ⁵	
1354.815	(3/2) ⁻	443.182 ^a ⁹	27 ^d ⁴	911.638	(5/2) ⁻	(M1) ^a		0.0560 ⁸	
		632.38 ^{ha} ⁷	<19 ^{hd}	722.276	5/2 ⁻				
		634.73 ^{ha} ⁸	<29 ^{hd}	719.944	3/2 ⁺				
		1163.14 ^a ²⁰	100 ^d ²⁰	191.2141	5/2 ⁻	(M1) ^a		0.00495 ⁷	
1395.392	(5/2) ⁻	284.691 ^a ⁸	2.0 ^d ³	1110.700	3/2 ⁻ , 5/2 ⁻				
		588.46 ^{a†} ⁴	20 ^d ³	807.066	(7/2) ⁻				E _γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=588.326.
		1131.29 ^a ¹⁷	66 ^d ³⁰	264.2544	9/2 ⁻				
		1151.36 ^a ²⁰	100 ^d ¹⁶	243.8170	7/2 ⁻				
1398.711	(3/2) ⁻	113.569 ^a ¹⁵	4.6 ^d ⁶	1285.120	(3/2 ⁺ , 5/2, 7/2 ⁺)				
		547.45 ^a ^j ²⁰	2.5 ⁶	851.392	3/2 ⁻				
		678.67 ^a ¹⁰	2.7 ^d ²⁷	719.944	3/2 ⁺				
		739.02 ^a ^j ¹⁰	7.3 ^d ¹²	659.628	3/2 ⁻				
		1207.5 ^a ³	86 ^d ¹⁷	191.2141	5/2 ⁻	M1 ^a		0.00453 ⁶	
		1373.6 ^a ⁵	100 ^d ¹⁵	24.2003	1/2 ⁻	(M1) ^a		0.00336 ⁵	
1406.341	9/2 ⁻	657.86 ³⁰	<95	748.978	(9/2) ⁻				
		1141.96 ¹⁰	18.3 ²⁴	264.2544	9/2 ⁻	M1		0.00518 ⁷	
		1162.49 ⁸ ⁷	<85	243.8170	7/2 ⁻	M1		0.00496 ⁷	
		1215.28 ¹¹	47 ⁴	191.2141	5/2 ⁻				
		1307.20 ⁵	50 ⁸	99.2409	5/2 ⁻	E2		2.20×10 ⁻³ ³	
		1406.23 ⁵	100 ⁴	0.0	7/2 ⁺	E1+M2	+0.38 +21-35	0.0018 ⁸	
1420.48	(5/2 ⁻ , 7/2, 9/2 ⁻)	1156.03 ¹⁶	100 ¹⁸	264.2544	9/2 ⁻				
		1176.48 ²²	<340	243.8170	7/2 ⁻				I _γ : undivided I _γ for doublet.
		1321.53 ^g ¹⁶	<164	99.2409	5/2 ⁻				
1426.80	(7/2, 9/2) ⁻	466.93 [†] ²¹	87 ²²	960.602	7/2 ⁻	(E2)		0.02128 ³⁰	E _γ : uncertainty multiplied by a factor of 2 in the

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^{\#}$	$I_\gamma^@$	E_f	J_f^π	Mult. [#]	$\delta^{\#}$	α^f	Comments
1426.80	$(7/2, 9/2)^-$	664.69 ^{h†} 8	<248 ^h	761.846	$(5/2)^+$				fitting; level-energy difference=466.19. E _γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=664.95. Mult.: E2(+M1) for doubly-placed γ in ε decay.
		857.15 24	65 35	569.8316	$5/2^-$				
		939.7 ⁸ 5	<326	486.9449	$(11/2^-)$				
		1037.49 13	87 43	389.5273	$9/2^-$				
		1148.0 6	100 52	278.5978	$7/2^-$				
		1162.49 ⁸ 7	<366	264.2544	$9/2^-$	M1		0.00496 7	
1444.74	$7/2^-, 9/2^-$	796.93 7	42 9	647.8373	$7/2^-$	E2		0.00597 8	
		1180.45 6	100 11	264.2544	$9/2^-$	M1(+E2)		0.0037 11	
		1201.0 9		243.8170	$7/2^-$				
1449.796	$7/2^-$	166.509 19	1.29 6	1283.295	$(7/2, 9/2)^-$	M1+E2	+0.5 3	0.73 6	
		187.817 ^{a†} 17	0.17 ^d 3	1261.713	$(5/2, 7/2^-)$				E _γ : very poor fit and omitted in the fitting; level-energy difference=188.084.
		489.25 6	1.42 17	960.602	$7/2^-$	M1		0.0433 6	
		617.682 [†] 25	2.38 19	831.899	$(7/2)^+$	E1		0.00386 5	E _γ : very poor fit and omitted in the fitting; level-energy difference=617.896.
		642.65 8	0.57 10	807.066	$(7/2)^-$	(M1)		0.02156 30	
		687.93 4	2.71 14	761.846	$(5/2)^+$	(E1(+M2))	+0.01 8	0.0031 4	
		701.04 24	0.59 12	748.978	$(9/2)^-$				
		802.34 [†] 4	2.67 21	647.8373	$7/2^-$				E _γ : very poor fit and omitted in the fitting; level-energy difference=801.957.
		879.93 4	3.44 19	569.8316	$5/2^-$	M1+E2	-0.9 4	0.0076 12	
		926.49 ^a 12	0.24 12	523.0746	$11/2^-$				
		1060.28 4	19.3 7	389.5273	$9/2^-$	M1+E2	+0.036 22	0.00620 9	
		1171.20 4	8.1 3	278.5978	$7/2^-$	M1+E2	+0.22 +74-15	0.0048 9	
		1206.00 4	5.1 3	243.8170	$7/2^-$	M1+E2	≥0.83	0.0031 6	
		1258.59 6	3.59 10	191.2141	$5/2^-$	M1		0.00411 6	
		1350.65 9	1.95 5	99.2409	$5/2^-$	M1+E2	-0.19 +15-21	0.00344 15	
		1379.04 ^{8†} 4	21	70.8816	$9/2^+$	E1		9.54×10^{-4} 13	E _γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=1378.909.

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	E_γ [#]	I_γ [@]	E_f	J_f^π	Mult. [#]	δ [#]	α ^f	Comments
1449.796	7/2 ⁻	1449.74 4	100.0 21	0.0	7/2 ⁺	E1(+M2)	0.00 4	9.32×10 ⁻⁴ 16	
1463.019	(7/2 ⁻)	177.94 ^a 4	2.4 ^d 14	1285.120	(3/2 ⁺ , 5/2, 7/2 ⁺)				
		401.87 ^a 7	3.8 ^d 11	1061.063	(11/2 ⁻)				
		597.83 ^a 7	40 ^d 7	865.155	(11/2 ⁻)				
		611.626 ^{ha} 17	<260 ^{hd}	851.392	3/2 ⁻				
1463.384	7/2 ⁻	1218.7 ^a 7	100 ^d 30	243.8170	7/2 ⁻				
		502.8 3	6.2 10	960.602	7/2 ⁻				
		939.78 ^g 5	<8	523.0746	11/2 ⁻				
		1073.79 3	51 3	389.5273	9/2 ⁻	M1+E2	+0.18 7	0.00593 11	
		1184.875 [†] 24	100 4	278.5978	7/2 ⁻	M1+E2	-0.15 7	0.00469 8	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1184.782.
		1199.10 6	10.1 8	264.2544	9/2 ⁻	M1+E2	+0.22 +25-19	0.00451 28	
		1219.61 4	13.5 18	243.8170	7/2 ⁻	M1+E2	-1.0 +3-9	0.0035 5	
		1463.39 4	67.9 16	0.0	7/2 ⁺	E1(+M2)	+0.02 +11-9	0.00093 9	
1464.97	(7/2 ⁻)	518.56 ^a 8	3.5 ^d 7	946.470?					
		553.31 ^a 5	4.4 ^d 8	911.638	(5/2 ⁻)				
		1200.9 ^a 10	20 ^d 6	264.2544	9/2 ⁻				
		1221.1 ^a 2	100 ^d 15	243.8170	7/2 ⁻	M1(+E2) ^a	0.9 10	0.0036 9	
1478.510	(3/2 ⁻ , 5/2 ⁺)	79.793 ^a 9	12.9 ^d 24	1398.711	(3/2 ⁻)				
		444.69 ^{aj} 11	31 ^d 6	1033.892	(1/2 ⁺ , 3/2)				
		518.07 ^h 7	<60 ^h	960.602	7/2 ⁻				
		756.30 ^a 9	100 ^d 15	722.276	5/2 ⁻				
		758.89 ^{aj} 20	66 ^d 18	719.944	3/2 ⁺				
		908.8 ^a 4	<81 ^d	569.8316	5/2 ⁻				E_γ : for doubly-placed γ . Undivided I_γ from (n, γ) E=thermal.
1524.158	1/2, 3/2, 5/2 ⁺	1391.8 ^{ha} 17	<588 ^{hd}	86.9191	3/2 ⁻				
		174.017 ^a 25	22 7	1350.153	(3/2 ⁻)				
		459.25 ^{a†} 5	100 27	1064.719	(5/2 ⁺ , 7/2, 9/2 ⁺)				E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=459.439.
1531.562	(3/2 ⁻ , 5/2 ⁺)	181.27 ^a 45	8 ^d 3	1350.153	(3/2 ⁻)				
		234.904 ^a 7	0.64 ^d 8	1296.655	(3/2 ⁻ , 5/2, 7/2 ⁻)				

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^\#$	$I_\gamma^\text{@}$	E_f	J_f^π	Mult.#	$\delta^\#$	α^f	Comments
1531.562	$(3/2^-, 5/2^+)$	497.68 ^a 7	1.6 ^d 3	1033.892	$(1/2^+, 3/2)$				
		571.36 ^a 20	4.1 ^d 9	960.602	$7/2^-$				
		1432.5 ^a 7	100 ^d 20	99.2409	$5/2^-$				
		1445.2 ^{ha} 17	<34 ^{hd}	86.9191	$3/2^-$				
1540.692	$9/2^-$	1017.58 5	100 7	523.0746	$11/2^-$	M1		0.00686 10	
		1151.70 [‡] 7	79 10	389.5273	$9/2^-$	M1+E2	≥ 0.36	0.0038 10	E_γ : very poor fit and omitted in the fitting; level-energy difference=1151.160.
		1276.62 ^g 23	<74	264.2544	$9/2^-$	M1		0.00397 6	
		1296.90 5	64 4	243.8170	$7/2^-$	M1+E2	$0.9 +8-5$	0.0031 5	
1540.63	15	1540.63 15	15 4	0.0	$7/2^+$				
		204.705 ^a 25	1.2 ^d 3	1350.153	$(3/2^-)$				
		703.38 ^a 9	75 ^d 11	851.392	$3/2^-$				
		741.54 ^a 12	54 ^d 11	813.333	$(1/2)^-$				
1554.862	$(1/2^-)$	792.97 ^a 12	29 ^d 5	761.846	$(5/2)^+$				
		834.94 ^a 8	85 ^d 13	719.944	$3/2^+$				
		1467.3 ^a 12	100 ^d 48	86.9191	$3/2^-$				
		1530.5 ^{ha} 10	<490 ^{hd}	24.2003	$1/2^-$				Large $\alpha(K)\text{exp}=0.013$ 5 ((n, γ) E=thermal) suggests probable E0 component for doubly-placed γ .
1554.881	$9/2^-$	1031.91 6	11.5 6	523.0746	$11/2^-$	M1+E2	$-0.28 +19-29$	0.0064 6	
		1165.21 11	14.9 10	389.5273	$9/2^-$	M1		0.00493 7	
		1276.62 ^g 23	<16.7	278.5978	$7/2^-$	M1		0.00397 6	
		1290.59 3	100 5	264.2544	$9/2^-$	M1+E2	$0.8 +5-4$	0.0032 4	
1565.62	$(7/2^-)$	1311.13 7	5.7 10	243.8170	$7/2^-$	M1		0.00373 5	
		1363.83 9	6.1 8	191.2141	$5/2^-$	E2		2.04×10^{-3} 3	
		1483.97 ^j 9	17.6 12	70.8816	$9/2^+$	[E1]		9.25×10^{-4} 13	Note that $\alpha(K)\text{exp}$ in ε decay favors mult=E2, inconsistent with this placement.
		1554.4 ^g 5	<11.7	0.0	$7/2^+$				
1585.873	$(1/2^-)$	1301.33 5	73 4	264.2544	$9/2^-$	(M1)		0.00380 5	
		1321.53 ^g 16	<40	243.8170	$7/2^-$				
		1374.53 8	100 5	191.2141	$5/2^-$	(M1)		0.00335 5	
		187.159 ^a 9	3.9 ^d 6	1398.711	$(3/2)^-$				
1585.873	$(1/2^-)$	315.151 ^a 20	13.9 ^d 21	1270.736	$(1/2)^-$				
		674.29 ^a 15	100 ^d 17	911.638	$(5/2)^-$				

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	E_γ #	I_γ @	E_f	J_f^π	Mult. #	δ #	α^f	Comments
1616.669	$(1/2^+, 3/2, 5/2^+)$	304.880 ^a 7	46 ^d 6	1311.787	$(5/2^+, 7/2)$				E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=505.969.
		320.013 ^a 7	44 ^d 6	1296.655	$(3/2^-, 5/2, 7/2^-)$				
		506.06 ^{a†} 3	100 ^d 13	1110.700	$3/2^-, 5/2^-$				
		705.07 ^a 10	83 ^d 32	911.638	$(5/2)^-$				E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1529.743. Large $\alpha(K)_{\text{exp}}$, suggesting probable E0 component for doubly-placed γ , probably results from the alternative placement.
		1518.5 ^{ha} 8	<1070 ^{hd}	99.2409	$5/2^-$				
		1529.87 ^{h†} 4	<1451 ^{hd}	86.9191	$3/2^-$				
1618.738	$1/2, 3/2$	416.528 ^a 10	6.8 ^d 9	1202.209	$(5/2^+)$				
		767.29 ^a 20	6.7 ^d 17	851.392	$3/2^-$				
		805.47 ^{gaj} 25	<6.0 ^d	813.333	$(1/2)^-$				
		1594.5 ^a 11	100 ^d 29	24.2003	$1/2^-$				
1650.6	$(23/2^-)$	451.8 ^b 5	100	1198.8	$(19/2^-)$	(E2) ^b		0.02320 33	E_γ : weighted average of 437.9 6 from ($^{48}\text{Ca}, 3n\gamma$) and 437.2 5 from ($\alpha, 2n\gamma$). Mult.: Q from ($\alpha, 2n\gamma$) for intraband γ , (E2) from $\Delta\pi=\text{no}$.
1655.5	$(25/2^-)$	437.5 4	100 ^b	1218.0	$(21/2^-)$	(E2)		0.0253 4	
1656.51	$5/2^-, 7/2^-, 9/2^-$	934.5 5	53 26	722.276	$5/2^-$				
		1266.68 25	100 18	389.5273	$9/2^-$	E2		2.33×10^{-3} 3	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1412.68.
		1392.27 ^g 4	79	264.2544	$9/2^-$	E2		1.97×10^{-3} 3	
		1412.39 [†] 10	86 9	243.8170	$7/2^-$	M1(+E2)	-0.08 18	0.00315 8	
1658.10	$5/2^+$	1556.7 4	42 7	99.2409	$5/2^-$				
		587.44 6	1.9 4	1070.693	$7/2^+$	M1		0.0271 4	
		1088.23 8	3.0 5	569.8316	$5/2^-$				

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^{\#}$	$I_\gamma^{\text{@}}$	E_f	J_f^π	Mult. [#]	$\delta^{\#}$	α^f	Comments
1658.10	$5/2^+$	1379.04 ^{8‡} 4	32	278.5978	$7/2^-$	E1		9.54×10^{-4} 13	E_γ : very poor fit and omitted in the fitting; level-energy difference=1379.49.
		1466.84 [†] 4	100 3	191.2141	$5/2^-$	E1(+M2)	-0.03 4	9.34×10^{-4} 26	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1466.87.
		1658.08 [†] 5	23.9 6	0.0	$7/2^+$	M1+E2	+0.28 11	0.00222 5	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1658.09.
1666.1	$(27/2^+)$	508.9 4	100	1157.2	$23/2^+$				E_γ : weighted average of 509.1 6 from ($^{48}\text{Ca}, 3n\gamma$) and 508.7 5 from ($\alpha, 2n\gamma$).
1689.30	$(5/2, 7/2)^-$	624.00 ^a 25	10 ^d 5	1064.719	$(5/2^+, 7/2, 9/2^+)$				
		777.31 ^a 15	5.5 ^d 9	911.638	$(5/2)^-$				
		1410.6 ^a 6	100 ^d 49	278.5978	$7/2^-$				
		1497.6 ^a 20	65 ^d 19	191.2141	$5/2^-$	M1+E2 ^a	0.24 6	0.00273 5	
		1689.35 5	47 ^d 23	0.0	$7/2^+$				
1689.334	$7/2^-$	406.03 ^g 7	<6.0	1283.295	$(7/2, 9/2)^-$				
		728.73 6	34.2 20	960.602	$7/2^-$	(M1)		0.01570 22	
		1497.92 [†] 4	39.5 16	191.2141	$5/2^-$	M1+E2	+0.24 6	0.00273 5	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1498.113.
		1618.48 4	100.0 23	70.8816	$9/2^+$	E1(+M2)	+0.04 6	0.00093 4	
		1689.35 5	73 4	0.0	$7/2^+$	E1(+M2)	-0.03 7	0.00093 4	
1694.44	$5/2^+$	1595.89 [†] 23	34 8	99.2409	$5/2^-$				E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1595.19.
		1607.51 6	100 8	86.9191	$3/2^-$	E1(+M2)	+0.04 18	0.00093 20	
1696.422	$3/2^-$	1694.38 14	64 5	0.0	$7/2^+$	(M1)		2.19×10^{-3} 3	
		399.621 ^{a‡} 17	4.3 ^d 6	1296.655	$(3/2^-, 5/2, 7/2^-)$				E_γ : very poor fit and omitted in the fitting; level-energy difference=399.767.
		425.77 ^a 6	0.85 ^d 23	1270.736	$(1/2)^-$				
		784.88 ^{ha} 15	<6.0 ^{hd}	911.638	$(5/2)^-$				

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^{\#}$	$I_\gamma^{\text{@}}$	E_f	J_f^π	Mult. $\#$	$\delta^{\#}$	α^f	Comments
1696.422	3/2 ⁻	845.10 ^a 25	4.7 ^d 11	851.392	3/2 ⁻				
		1417.7 ^a 5	54 ^d 25	278.5978	7/2 ⁻				
		1505.9 ^a 10	100 ^d 20	191.2141	5/2 ⁻	M1 ^a		0.00275 4	
1707.83	(7/2,9/2) ⁺	875.9 ^g	<25	831.899	(7/2) ⁺				
		1636.82 8	100 4	70.8816	9/2 ⁺	M1+E2		0.0019 4	
		1707.97 ^g 9	<98	0.0	7/2 ⁺	(M1+E2)		0.00181 35	
1708.51	7/2 ⁻	1318.53 ^{g†} 12	<26	389.5273	9/2 ⁻	(M1)		0.00368 5	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1318.98.
		1429.87 9	57 3	278.5978	7/2 ⁻	M1(+E2)	+0.02 +18-13	0.00307 6	
		1517.31 4	100 6	191.2141	5/2 ⁻	M1+E2	-5.9 +7-9	1.75×10 ⁻³ 3	
1716.020	7/2 ⁺	1326.85 ^{g‡} 3	95	389.5273	9/2 ⁻	E1		9.81×10 ⁻⁴ 14	E_γ : very poor fit and omitted in the fitting; level-energy difference=1326.487.
		1437.43 4	100 3	278.5978	7/2 ⁻	E1(+M2)	-0.07 +9-8	0.00096 10	
		1524.77 5	82 4	191.2141	5/2 ⁻	E1(+M2)	+0.03 4	9.26×10 ⁻⁴ 24	
		1554.4 ^g 5	<21	161.6505	11/2 ⁺				
		1645.14 8	12.7 8	70.8816	9/2 ⁺	M1+E2	+0.34 +21-15	0.00223 10	
1724.502	(3/2 ⁻)	439.42 ^a 4	2.2 6	1285.120	(3/2 ⁺ ,5/2,7/2 ⁺)				
		453.69 ^a 7	1.1 4	1270.736	(1/2) ⁻				
		522.58 ^{ha†} 6	<3.6 ^h	1202.209	(5/2 ⁺)				E_γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=522.292.
		917.4 ^a 4	3.3 ^d 11	807.066	(7/2) ⁻				
		1064.7 ^{ha} 4	<12 ^{hd}	659.628	3/2 ⁻				
		1076.56 ^a 8	71 ^d 11	647.8373	7/2 ⁻				$\alpha(\text{K})_{\text{exp}}$ in (n, γ) E=thermal suggests M1 multipolarity, inconsistent with this placement, but line appears to be complex.
		1445.2 ^{ha} 17	<21 ^{hd}	278.5978	7/2 ⁻				
		1480.1 ^a 20	65 ^d 37	243.8170	7/2 ⁻				
		1625.3 ^a 8	≈100 ^d	99.2409	5/2 ⁻				
		1637.2 ^{ha} 12	53 ^{hd} 16	86.9191	3/2 ⁻				

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	E_γ [#]	I_γ [@]	E_f	J_f^π	Mult. [#]	δ [#]	α ^f	Comments
1742.877	(3/2 ⁺ , 5/2, 7/2 ⁻)	264.365 ^a 10	0.75 ^d 10	1478.510	(3/2 ⁻ , 5/2 ⁺)				
		510.70 ^a 5	13.6 ^d 19	1232.243	(3/2 ⁻)				
		671.94 ^a 15	6.8 ^d 25	1070.693	7/2 ⁺				
		1095.58 ^a 12	69 ^d 10	647.288	7/2 ⁺				
		1551.5 ^a 15	46 ^d 23	191.2141	5/2 ⁻				
		1743.8 ^a 15	100 ^d 31	0.0	7/2 ⁺				
1781.242	(3/2 ⁻ , 5/2 ⁻)	226.379 ^a 5	2.8 ^d 4	1554.862	(1/2 ⁻)				
		869.64 ^a 8	52 ^d 8	911.638	(5/2 ⁻)				
		1061.60 ^a 17	100 ^d 18	719.944	3/2 ⁺				
		1133.4 ^a 5	59 ^d 15	647.8373	7/2 ⁻				
		1391.8 ^{ha} 17	<147 ^{hd}	389.5273	9/2 ⁻				
1781.756	7/2 ⁻	703.33 10	10.2 12	1078.343	9/2 ⁻	M1		0.01717 24	
		821.18 4	26.4 10	960.602	7/2 ⁻	M1(+E2)	+0.13 +31-13	0.0116 9	
		862.4 ^g 5	<4.5	919.784	(9/2 ⁻)				
		1392.27 ^g 4	100	389.5273	9/2 ⁻	E2		1.97×10 ⁻³ 3	
		1502.89 [†] 6	18.0 10	278.5978	7/2 ⁻	(M1)		0.00276 4	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1503.151.
		1590.35 [†] 5	40.1 16	191.2141	5/2 ⁻	M1+E2	+0.117 23	2.45×10 ⁻³ 4	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1590.534.
		1682.49 5	24.5 26	99.2409	5/2 ⁻	M1+E2	+0.53 +8-6	0.00206 5	
		1781.75 5	78.5 22	0.0	7/2 ⁺	E1+M2	+0.08 +6-5	0.00097 4	
1796.670	(3/2 ⁻ , 5/2 ⁺)	511.55 ^a 2	38 ^d 6	1285.120	(3/2 ⁺ , 5/2, 7/2 ⁺)				
		989.34 ^a 25	20 ^d 4	807.066	(7/2 ⁻)				
		1227.3 ^a 7	35 ^d 11	569.8316	5/2 ⁻				
		1518.5 ^{ha} 8	<140 ^{hd}	278.5978	7/2 ⁻				
		1604.8 12	100 ^d 39	191.2141	5/2 ⁻				
		131.6883 ^a 20	1.37 ^d 30	1696.422	3/2 ⁻				
1828.110	1/2, 3/2, 5/2 ⁺	296.53 ^a 2	1.52 ^d 11	1531.562	(3/2 ⁻ , 5/2 ⁺)				
		477.98 ^a 3	11.9 ^d 20	1350.153	(3/2 ⁻)				
		717.34 ^a 12	22 ^d 7	1110.700	3/2 ⁻ , 5/2 ⁻				
		1105.5 ^{ha} 3	<52 ^{hd}	722.276	5/2 ⁻				

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	E_γ #	I_γ @	E_f	J_f^π	Mult. #	$\delta^\#$	α^f	Comments
1828.110	1/2,3/2,5/2 ⁺	1563.0 ^{aj} 10	144 ^d 44	264.2544	9/2 ⁻				
		1583.6 ^a 10	100 ^d 39	243.8170	7/2 ⁻				
		1637.2 ^{ha} 12	<243 ^{hd}	191.2141	5/2 ⁻				
1844.2	(29/2 ⁺)	508.6 4	100	1335.6	(25/2 ⁺) ⁺				E_γ : weighted average of 508.4 6 from (⁴⁸ Ca,3n γ) and 508.7 5 from (α ,2n γ).
1867.59	(3/2 ⁻ ,5/2 ⁺)	143.087 ^a 25	0.83 ^d 19	1724.502	(3/2 ⁻)				
1888.00	(7/2 ⁺ ,9/2 ⁺)	1623.6 ^a 9	100 ^d 66	243.8170	7/2 ⁻				
		817.6 4	100 5	1070.693	7/2 ⁺				
		1055.8 4	39 13	831.899	(7/2 ⁺) ⁺				
		1127.1 6		761.846	(5/2 ⁺) ⁺				
1908.663	5/2 ⁺	1726.30 9	29 3	161.6505	11/2 ⁺				
		1817.12 7	16.1 11	70.8816	9/2 ⁺				
		1146.92 13	4.5 9	761.846	(5/2 ⁺) ⁺	(M1)		0.00513 7	
		1260.86 6	19.6 12	647.8373	7/2 ⁻				
		1318.53 ^{g†} 12	<8.7	590.692	(5/2 ⁺) ⁺	(M1)		0.00368 5	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1317.965.
		1338.82 4	100 3	569.8316	5/2 ⁻	E1+M2	-0.04 3	9.85×10 ⁻⁴ 28	
		1630.02 13	4.0 7	278.5978	7/2 ⁻				
		1717.41 6	6.9 6	191.2141	5/2 ⁻				
1954.53	5/2 ⁻ ,7/2 ⁻	1908.46 [†] 6	5.1 3	0.0	7/2 ⁺	(M1,E2)		0.00156 26	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1908.651.
		875.9 ^g	<29	1078.343	9/2 ⁻				
		883.81 9	44 9	1070.693	7/2 ⁺				
		993.96 13	29 9	960.602	7/2 ⁻	(M1)		0.00727 10	
		1122.21 [†] 7	84 10	831.899	(7/2 ⁺) ⁺				E_γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=1122.63.
		1676.46 [‡] 8	47.9 23	278.5978	7/2 ⁻	M1		2.23×10 ⁻³ 3	E_γ : very poor fit and omitted in the fitting; level-energy difference=1675.93.
		1763.35 5	100 5	191.2141	5/2 ⁻	M1(+E2)		0.00173 32	
		1954.48 9	23.3 15	0.0	7/2 ⁺				
1972.21	9/2 ⁻	1043.20 8	100 7	929.113	11/2 ⁻	M1+E2	-1.1 7	0.0048 13	
		1223.07 ^g 8	<92	748.978	(9/2 ⁻) ⁻				
		1707.97 ^g 9	<146	264.2544	9/2 ⁻	(M1+E2)		0.00181 35	
		1810.64 13	15.9 28	161.6505	11/2 ⁺				

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^{\#}$	$I_\gamma^{\text{@}}$	E_f	J_f^π	Mult. [#]	$\delta^{\#}$	α^f	Comments
1974.132	$7/2^-$	419.39 8	12.8 12	1554.881	$9/2^-$				
		895.82 11	50 18	1078.343	$9/2^-$				
		1013.08 [†] 10	28 5	960.602	$7/2^-$	(M1)		0.00694 10	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1013.527.
		1251.74 25	23 8	722.276	$5/2^-$	(E2)		2.38×10^{-3} 3	
		1326.85 ⁸ 3	40	647.288	$7/2^+$	E1		9.81×10^{-4} 14	
		1487.21 24	12.8 17	486.9449	(11/2 ⁻)				
		1710.17 [†] 10	99 25	264.2544	$9/2^-$				E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1709.869.
		1730.8 6	7 4	243.8170	$7/2^-$				
		1903.04 [†] 5	25.5 13	70.8816	$9/2^+$	(E1(+M2))	+0.08 15	0.00100 12	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1903.239.
		1973.68 [†] 6	100 3	0.0	$7/2^+$	(E1+M2)	-0.13 +9-8	0.00104 6	E_γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=1974.120.
2030.03	$7/2^-$	862.4 ⁸ 5	<8	1166.89	(7/2,9/2) ⁻				
		1109.99 [†] 7	27.3 14	919.784	(9/2) ⁻	M1+E2	-0.19 +24-37	0.0055 5	E_γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1110.24.
		1223.07 ⁸ 8	<21	807.066	(7/2) ⁻				
		1751.2 4	2.0 5	278.5978	$7/2^-$				
		1838.30 [†] 8	5.2 3	191.2141	$5/2^-$				E_γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=1838.80.
		1959.24 9	40.8 14	70.8816	$9/2^+$	(E1(+M2))	+0.03 4	1.00×10^{-3} 2	
2065.04	$7/2^+$	2030.00 6	100 3	0.0	$7/2^+$	(E1(+M2))	+0.03 5	1.03×10^{-3} 2	
		2065.03 11	100	0.0	$7/2^+$	M1+E2+E0		0.0073	α : from ε decay.
2101.03	(5/2,7/2) ⁻	1822.42 11	100 7	278.5978	$7/2^-$				Mult.: E1 or E2 from $\alpha(\text{K})\text{exp}$ in ε decay.
2135.4	(29/2 ⁻)	2014.06 9	90 11	86.9191	$3/2^-$	M1,E2		0.00148 22	
		2101.09 13	35.3 27	0.0	$7/2^+$				
		2135.4 4	100	0.0	$7/2^+$				
2140.2	(29/2 ⁻)	484.7 ⁸ 3	100	1655.5	(25/2 ⁻)	(E2)		0.01931 27	Mult.: Q from ($^{48}\text{Ca}, 3n\gamma$) for intraband γ , (E2) from $\Delta\pi=\text{no}$.
2258.1	(31/2 ⁺)	592 ⁸ 2	100	1666.1	(27/2 ⁺)				
2287.22	$7/2^-$	1367.56 7	100 6	919.784	(9/2) ⁻				

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Yb})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ [#]	I_γ [@]	E_f	J_f^π	Mult. [#]	α ^f	Comments
2287.22	7/2 ⁻	1897.60 <i>10</i>	21.4 <i>13</i>	389.5273	9/2 ⁻	M1	1.83×10^{-3} <i>3</i>	
		2095.90 <i>7</i>	86 <i>3</i>	191.2141	5/2 ⁻	M1	1.63×10^{-3} <i>2</i>	
2296.82	5/2 ⁻ , 7/2 ⁻ , 9/2 ⁻	847.9 <i>7</i>	43 <i>22</i>	1449.796	7/2 ⁻	M1	0.01076 <i>15</i>	
		1547.69 <i>18</i>	100 <i>13</i>	748.978	(9/2) ⁻			
		2018.40 <i>27</i>	27 <i>8</i>	278.5978	7/2 ⁻			
2425.7	(33/2 ⁺)	581.5 & <i>6</i>	100	1844.2	(29/2 ⁺)			
2668.0	(33/2 ⁻)	527.8 & <i>3</i>	100	2140.2	(29/2 ⁻)	(E2)	0.01556 <i>22</i>	Mult.: Q from (⁴⁸ Ca,3n γ) for intraband γ , (E2) from $\Delta\pi=\text{no.}$
2929.1	(35/2 ⁺)	671 & <i>2</i>	100	2258.1	(31/2 ⁺)			
3074.8	(37/2 ⁺)	649.1 & <i>6</i>	100	2425.7	(33/2 ⁺)			
3238.6	(37/2 ⁻)	570.6 & <i>3</i>	100	2668.0	(33/2 ⁻)	(E2)	0.01285 <i>18</i>	Mult.: Q from (⁴⁸ Ca,3n γ) for intraband γ , (E2) from $\Delta\pi=\text{no.}$
3588.1	(39/2 ⁺)	659 & <i>1</i>	100	2929.1	(35/2 ⁺)			
3781.8	(41/2 ⁺)	707.0 & <i>6</i>	100	3074.8	(37/2 ⁺)			
3856.1	(41/2 ⁻)	617.5 & <i>3</i>	100	3238.6	(37/2 ⁻)			
4330	(43/2 ⁺)	742 & <i>2</i>	100	3588.1	(39/2 ⁺)			
4524.0	(45/2 ⁺)	742.2 & <i>6</i>	100	3781.8	(41/2 ⁺)			
4526.9	(45/2 ⁻)	670.8 & <i>6</i>	100	3856.1	(41/2 ⁻)			
5116	(47/2 ⁺)	786 & <i>1</i>	100	4330	(43/2 ⁺)			
5256.5	(49/2 ⁻)	729.6 & <i>3</i>	100	4526.9	(45/2 ⁻)			
5272.1	(49/2 ⁺)	748.1 & <i>6</i>	100	4524.0	(45/2 ⁺)			
6045.8	(53/2 ⁺)	773.7 & <i>3</i>	100	5272.1	(49/2 ⁺)			
6048.3	(53/2 ⁻)	791.8 & <i>3</i>	100	5256.5	(49/2 ⁻)	(E2)	0.00606 <i>8</i>	Mult.: Q from (⁴⁸ Ca,3n γ) for intraband γ , (E2) from $\Delta\pi=\text{no.}$
6874.8	(57/2 ⁺)	829 & <i>2</i>	100	6045.8	(53/2 ⁺)			
6903.6	(57/2 ⁻)	855.3 & <i>3</i>	100	6048.3	(53/2 ⁻)			
7770.8	(61/2 ⁺)	896 & <i>2</i>	100	6874.8	(57/2 ⁺)			
7823.3	(61/2 ⁻)	919.7 & <i>3</i>	100	6903.6	(57/2 ⁻)			
8806.7	(65/2 ⁻)	983.3 & <i>3</i>	100	7823.3	(61/2 ⁻)			
9854.2	(69/2 ⁻)	1047.5 & <i>6</i>	100	8806.7	(65/2 ⁻)			
10961.2	(73/2 ⁻)	1107 & <i>2</i>	100	9854.2	(69/2 ⁻)			

[†] Poor fit; uncertainty multiplied by a factor in the fitting.

Adopted Levels, Gammas (continued)

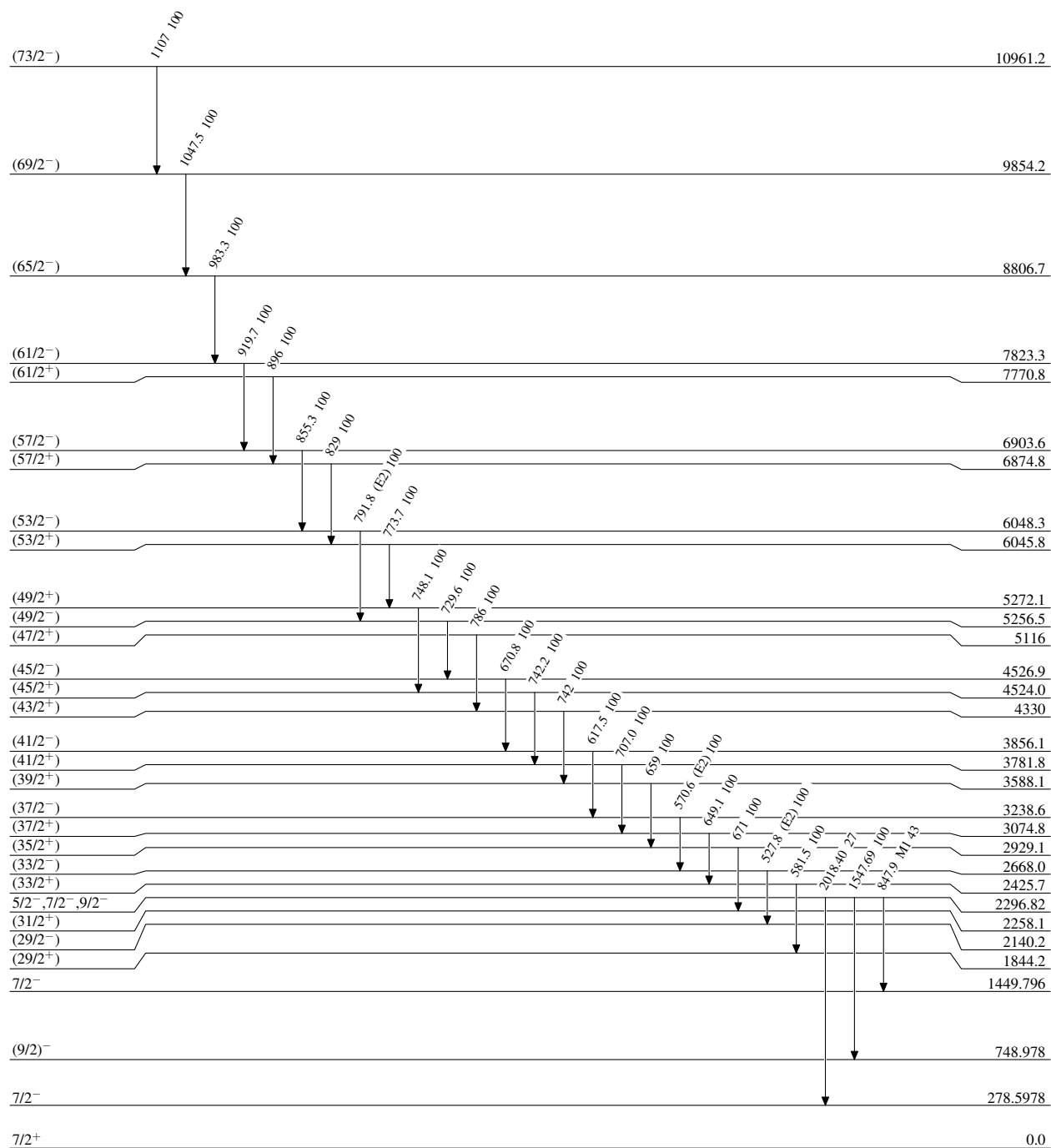
$\gamma(^{169}\text{Yb})$ (continued)

- [‡] Very Poor fit and omitted in the fitting.
- # From ¹⁶⁹Lu ε decay (34.06 h), except where noted otherwise.
- @ Relative photon branching from each level; values are from ¹⁶⁹Lu ε decay (34.06 h), except where noted. Upper limits are shown for photon branching ratios affected by multiple placement.
- & From ¹²⁴Sn(⁴⁸Ca,3n γ).
- ^a From ¹⁶⁸Yb(n, γ) E=thermal.
- ^b From ¹⁶⁷Er(α ,2n γ).
- ^c Complex peak (broader than normal).
- ^d From (n, γ) E=thermal.
- ^e Weighted average from ε decay and (n, γ) E=thermal.
- ^f Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with “Frozen Orbitals” approximation based on γ -ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.
- ^g Multiply placed.
- ^h Multiply placed with undivided intensity.
- ⁱ Multiply placed with intensity suitably divided.
- ^j Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

Level Scheme

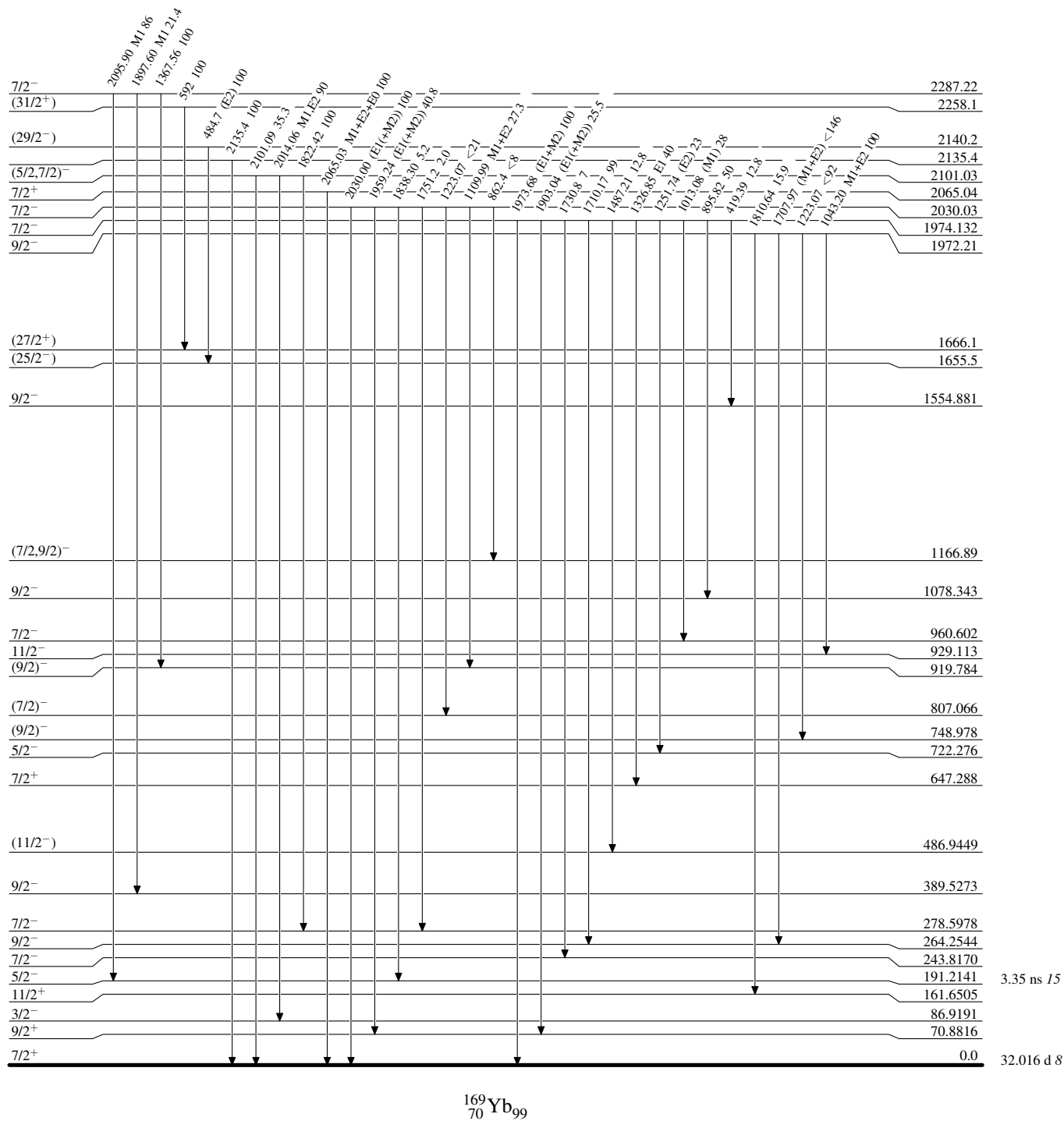
Intensities: Relative photon branching from each level



Adopted Levels, Gammas

Level Scheme (continued)

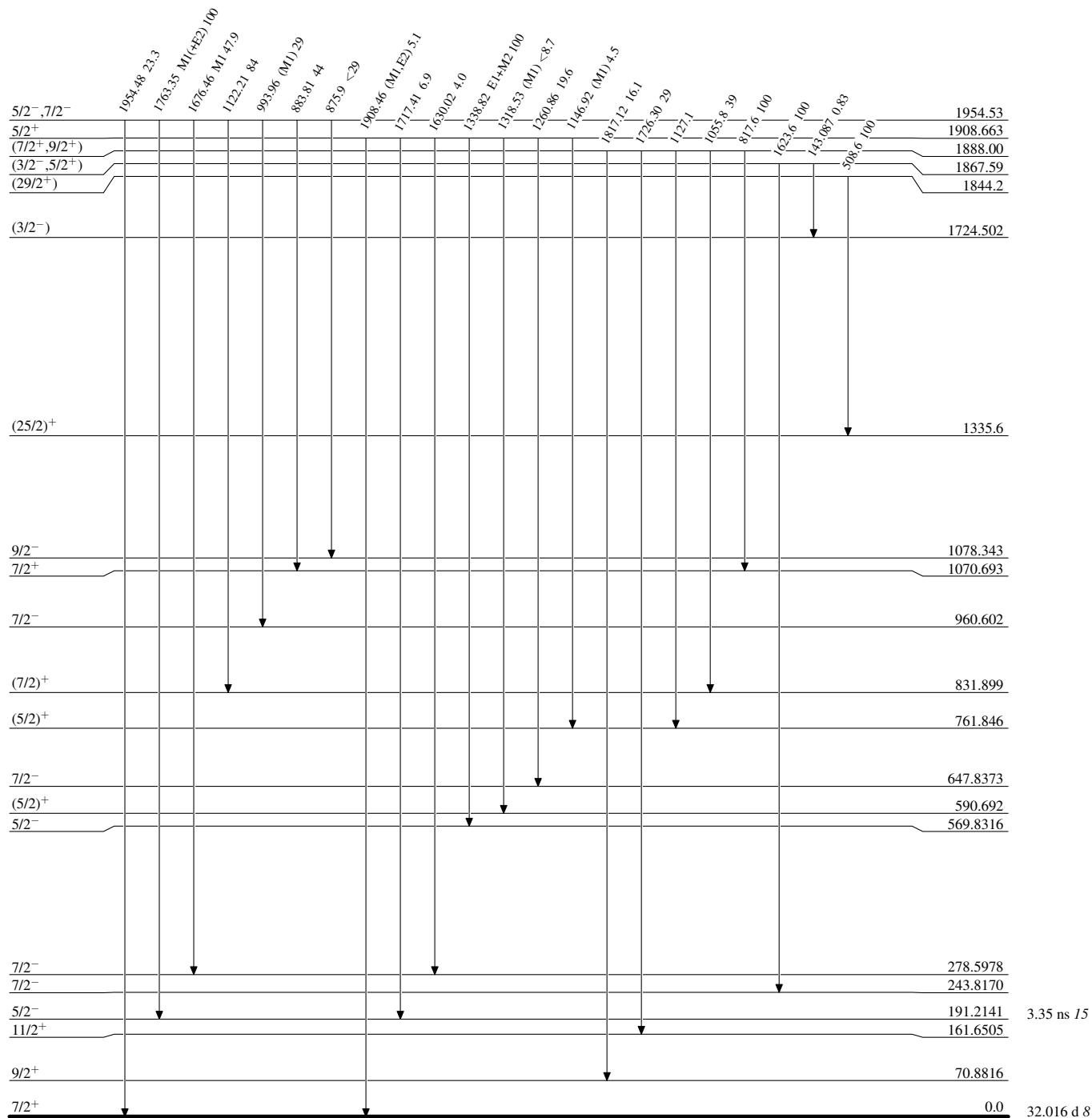
Intensities: Relative photon branching from each level



Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level



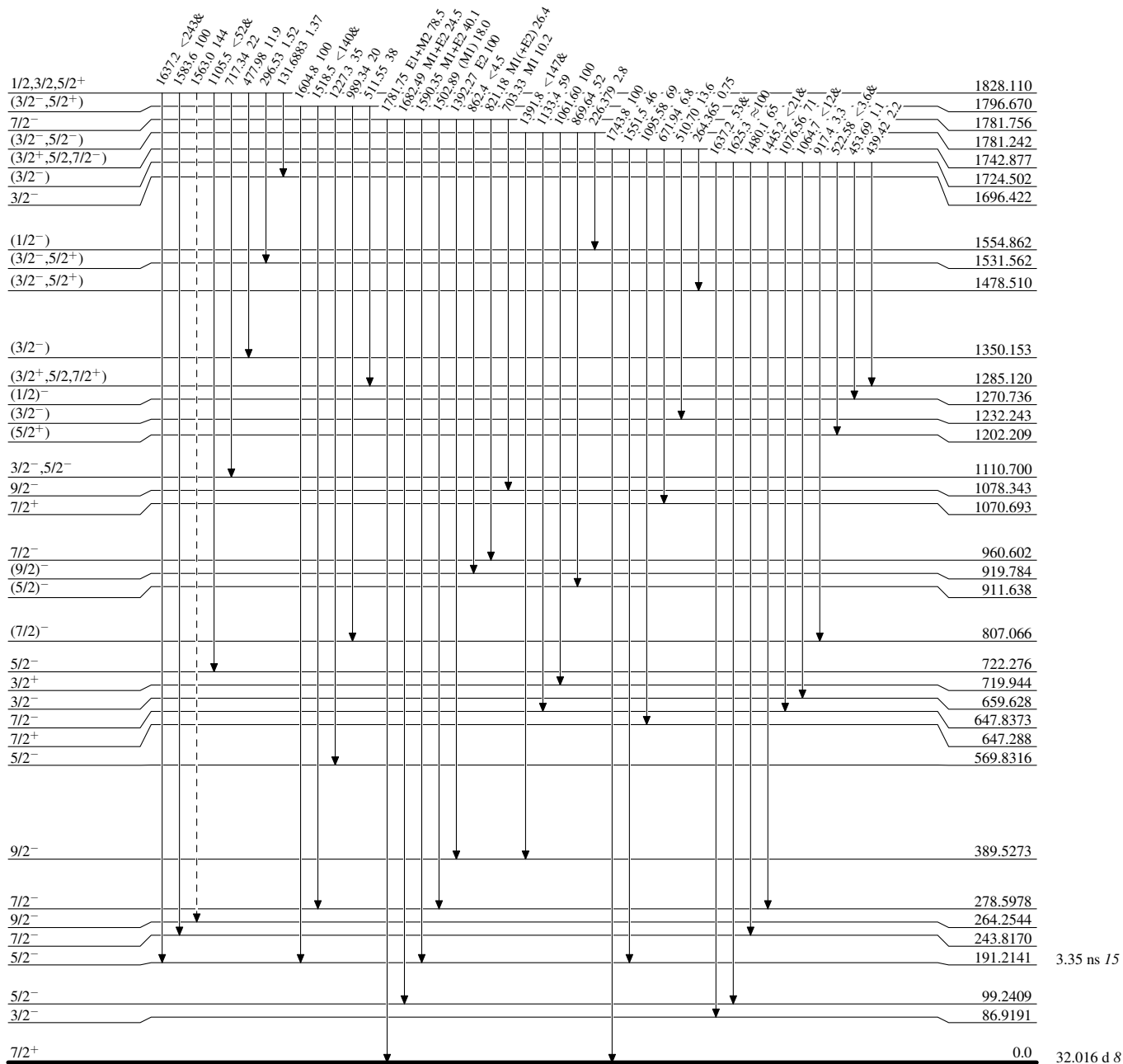
Adopted Levels, Gammas

Level Scheme (continued)

Legend

Intensities: Relative photon branching from each level
& Multiplied placed: undivided intensity given

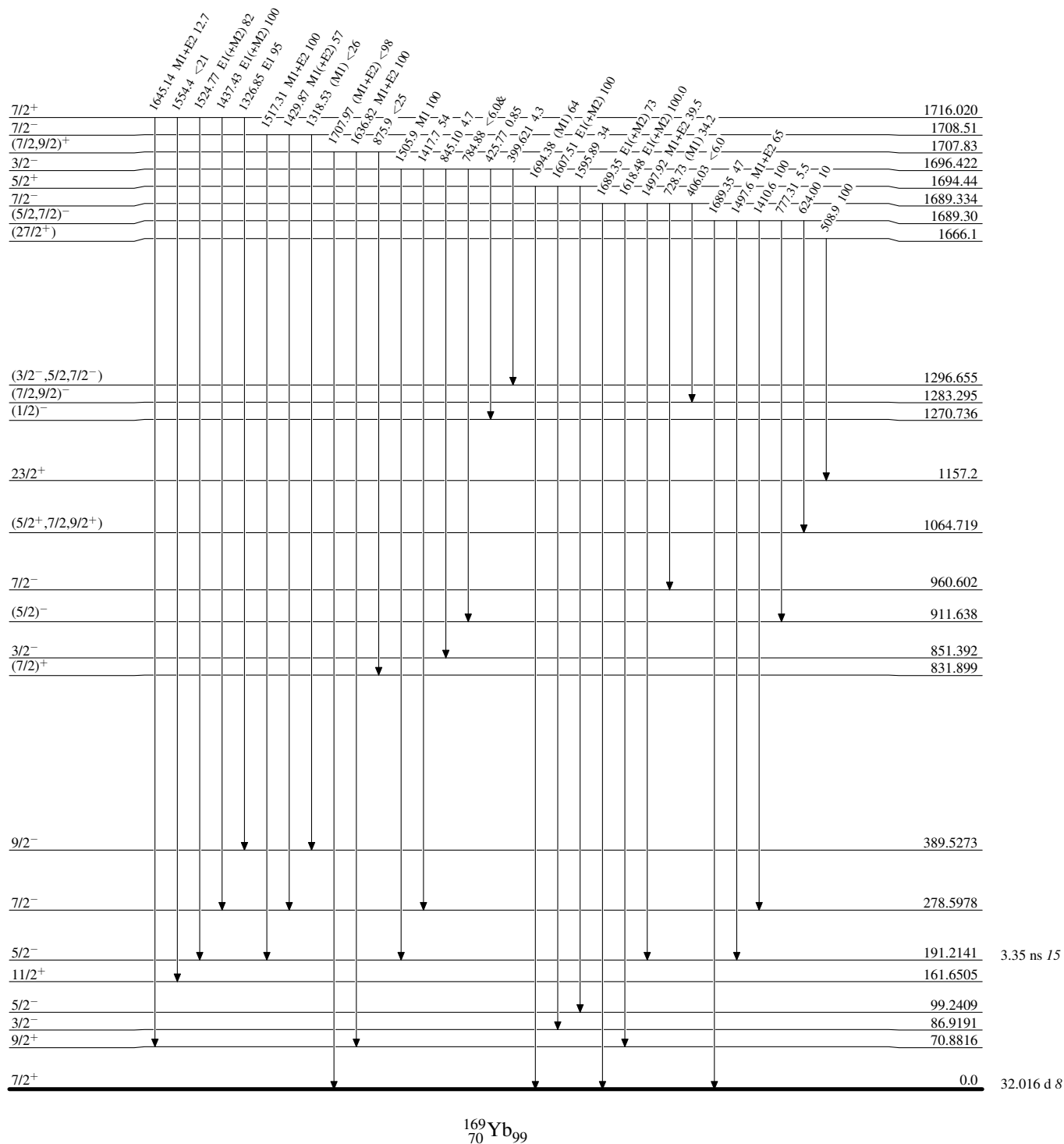
-----▶ γ Decay (Uncertain)



¹⁶⁹₇₀Yb₉₉

Adopted Levels, Gammas

Level Scheme (continued)

 Intensities: Relative photon branching from each level
 & Multiply placed: undivided intensity given


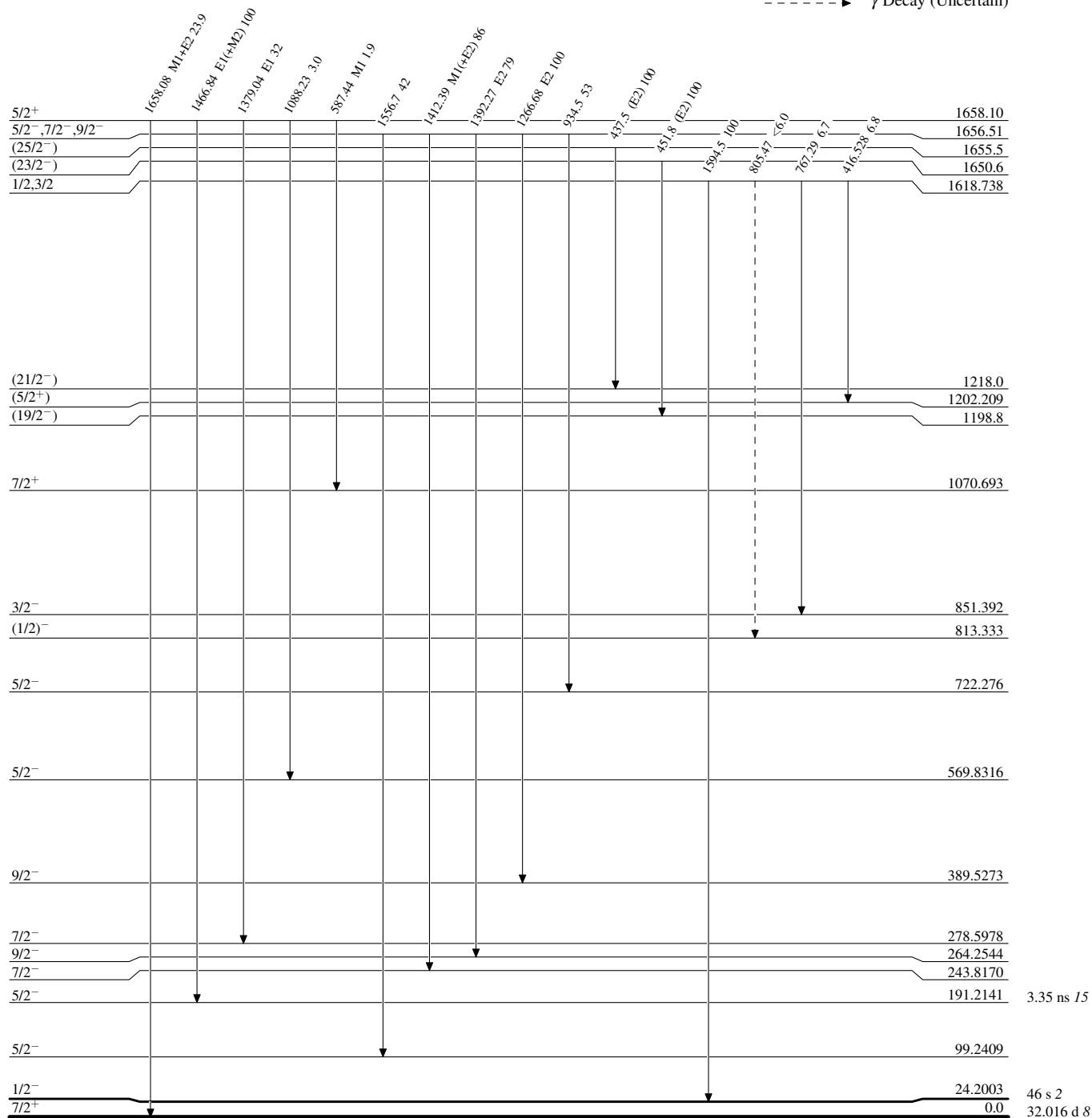
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given

-----► γ Decay (Uncertain)



¹⁶⁹₇₀Yb₉₉

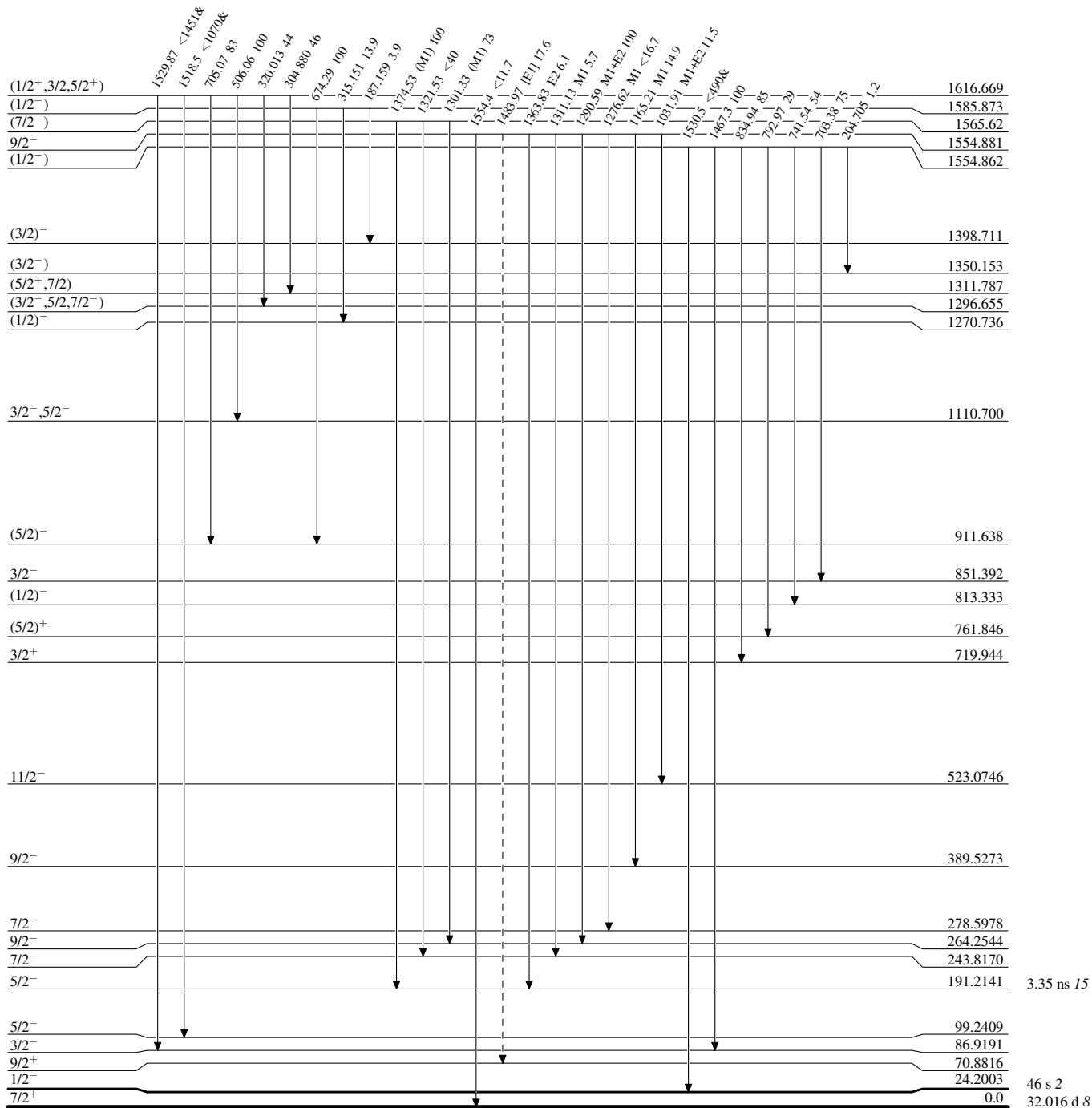
Adopted Levels, Gammas

Level Scheme (continued)

Legend

Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given

-----► γ Decay (Uncertain)



¹⁶⁹₇₀Yb₉₉

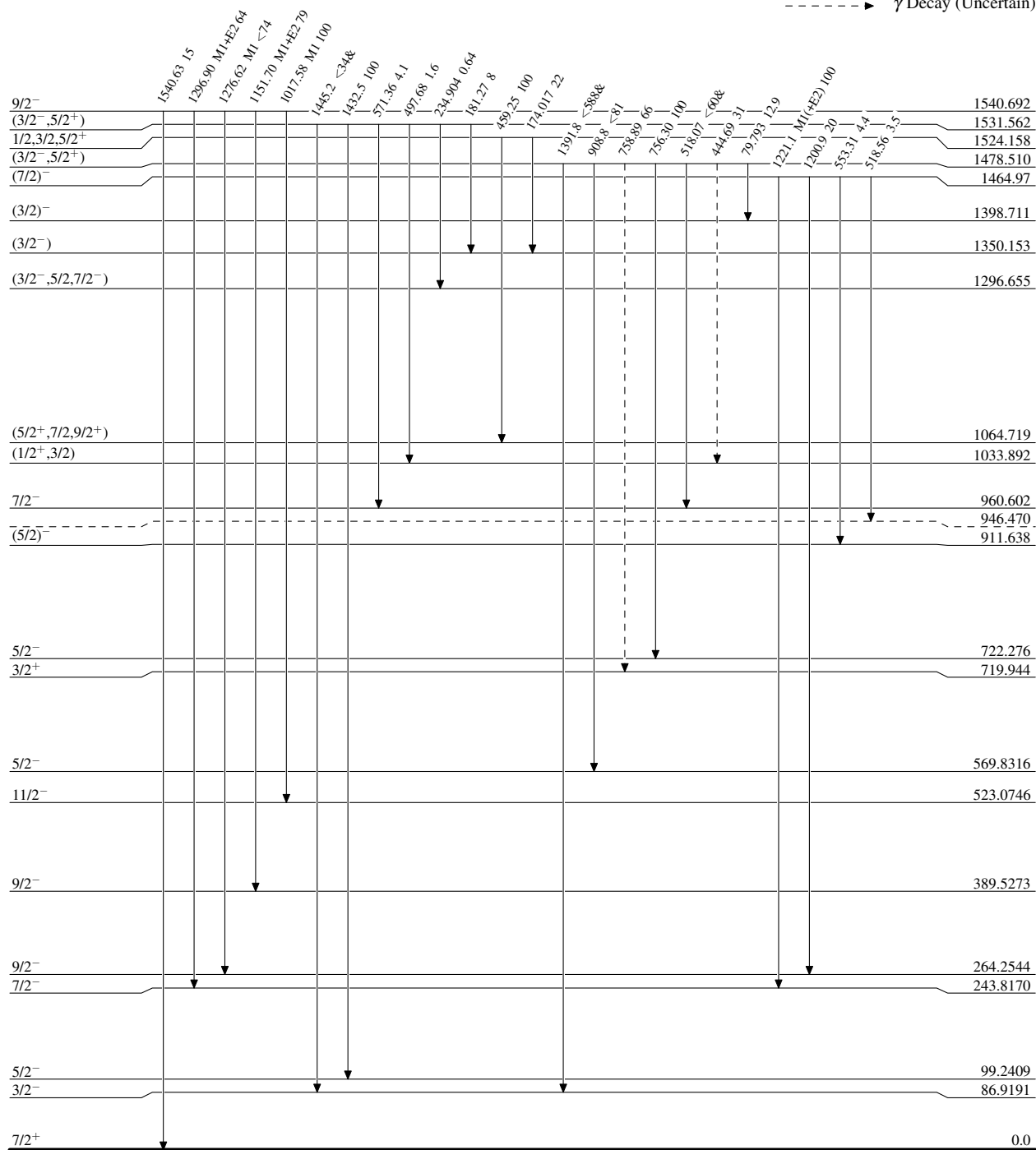
Adopted Levels, Gammas

Level Scheme (continued)

Legend

Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given

-----► γ Decay (Uncertain)



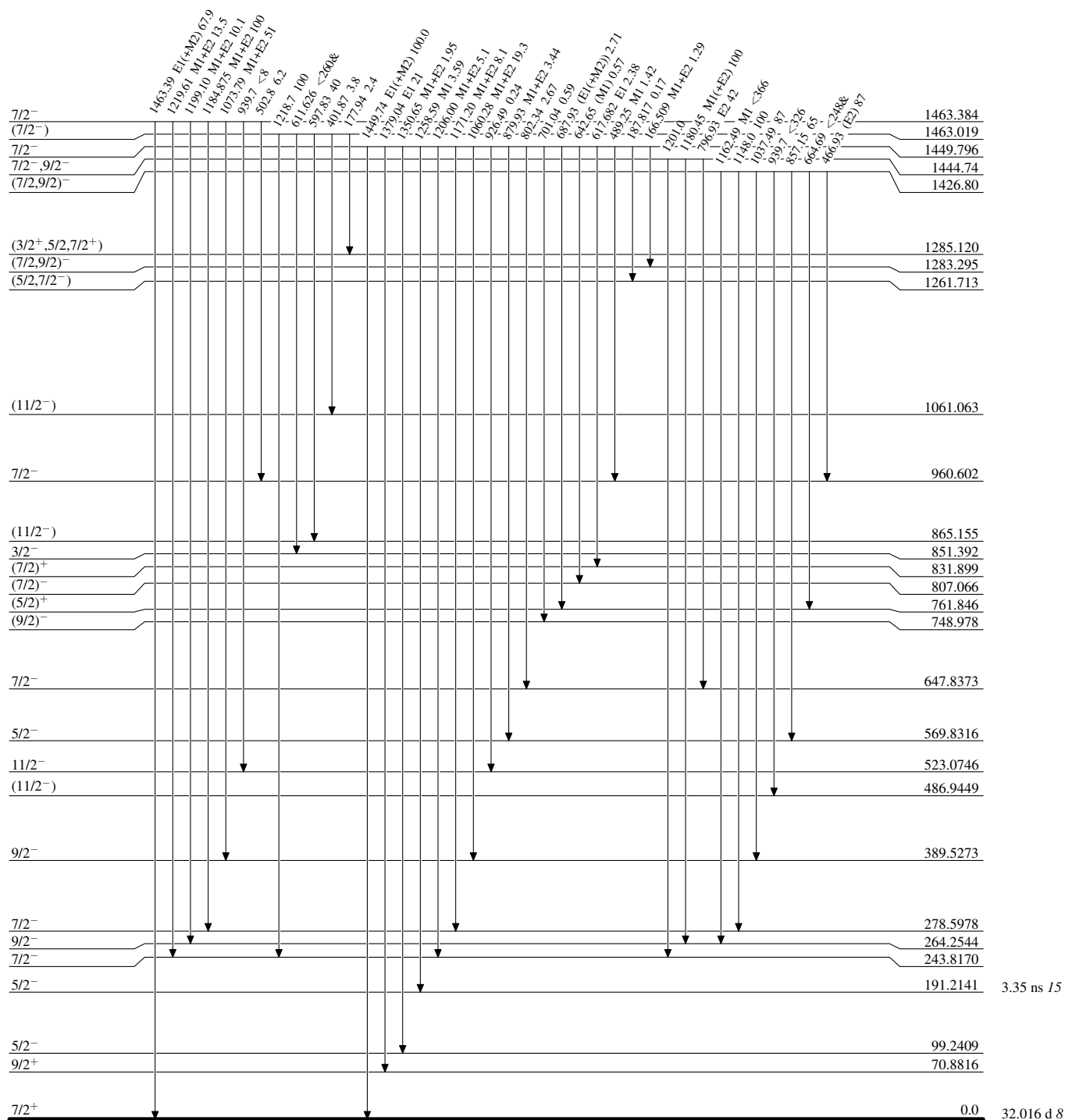
$^{169}_{70}\text{Yb}_{99}$

32.016 d 8

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level
 & Multiply placed: undivided intensity given



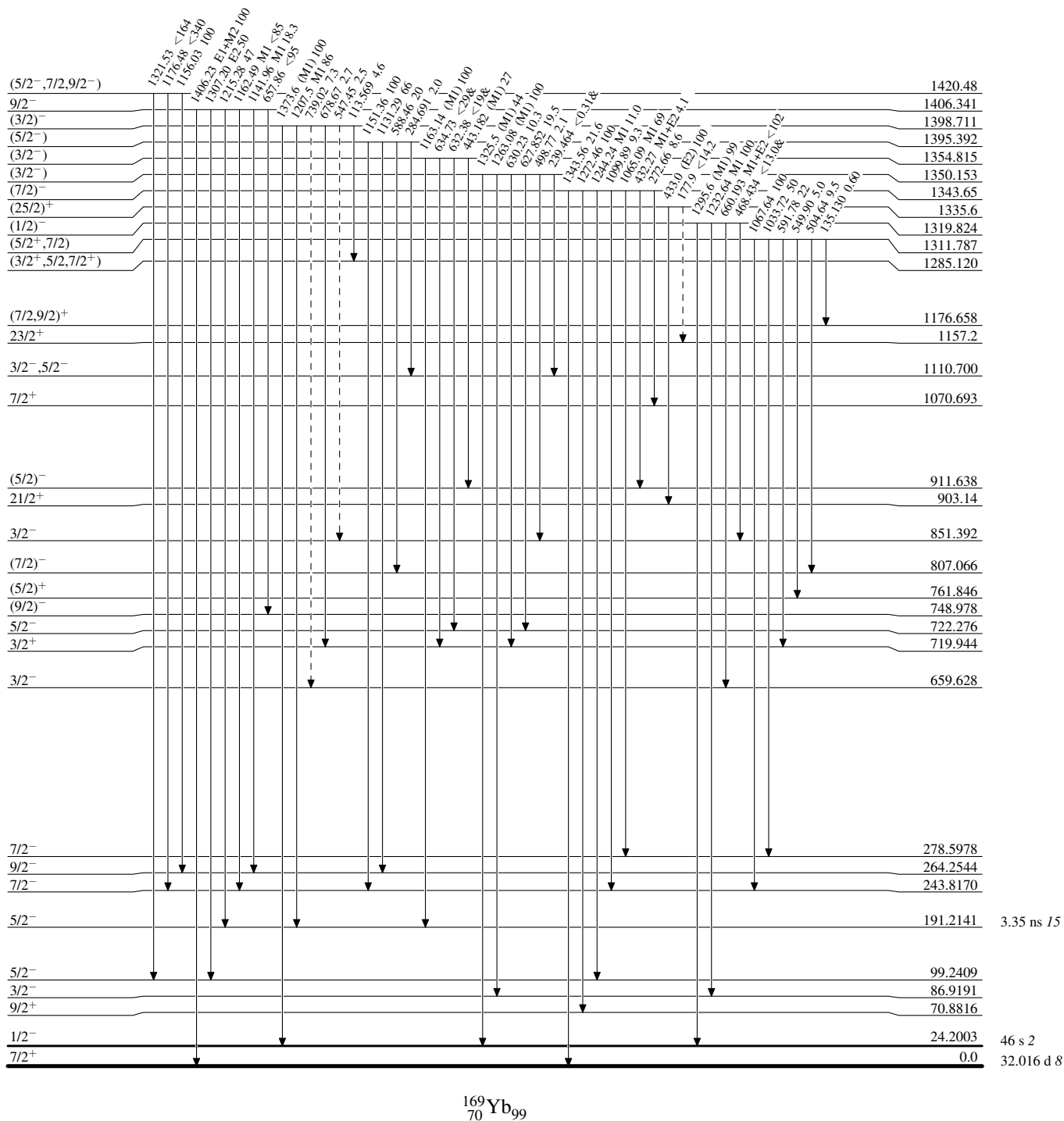
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given

-----► γ Decay (Uncertain)



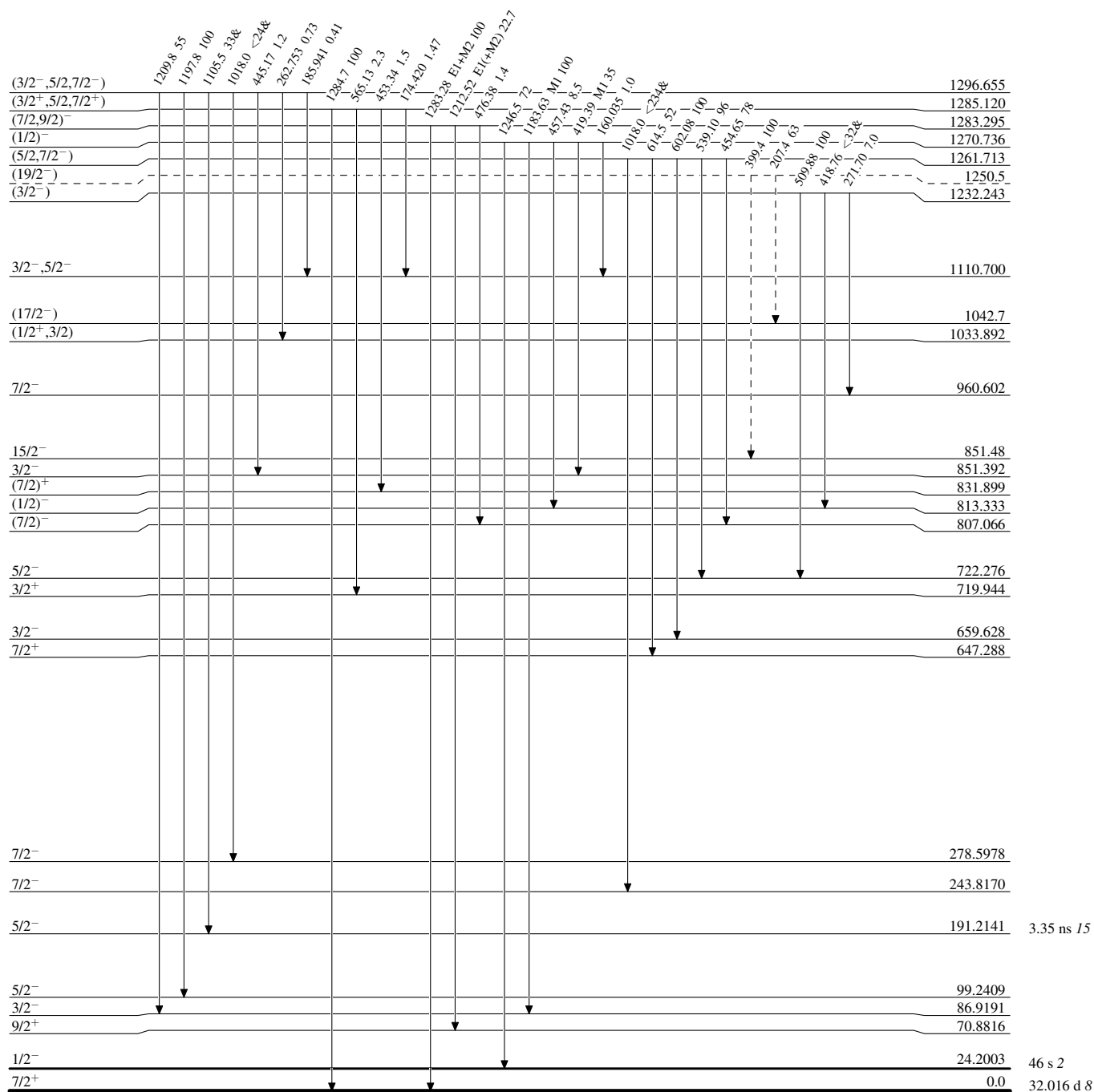
$^{169}_{70}\text{Yb}_{99}$

Adopted Levels, Gammas

Legend

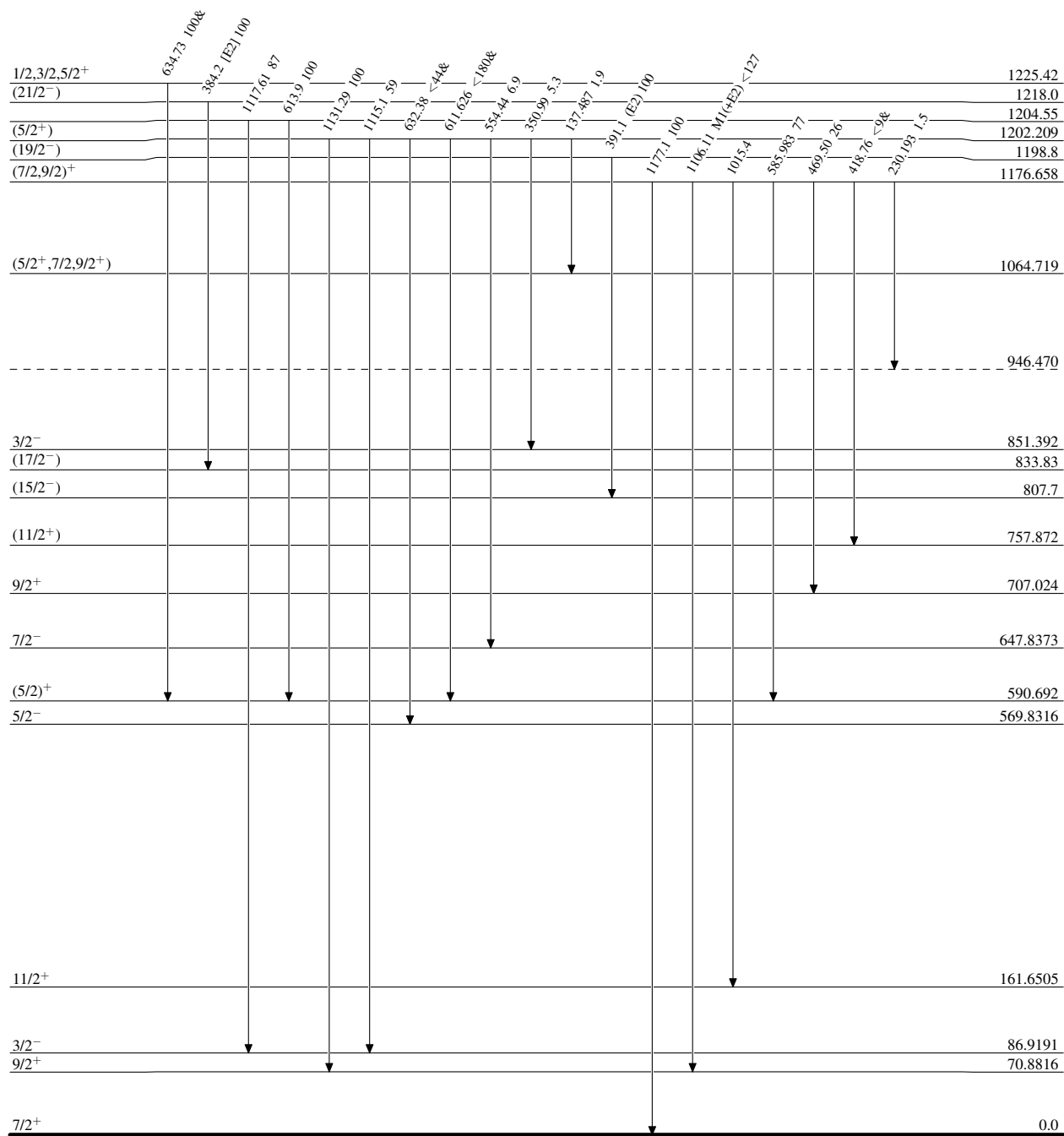
Level Scheme (continued)

 Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given

 -----► γ Decay (Uncertain)

 $^{169}_{70}\text{Yb}_{99}$

Adopted Levels, GammasLevel Scheme (continued)

Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given



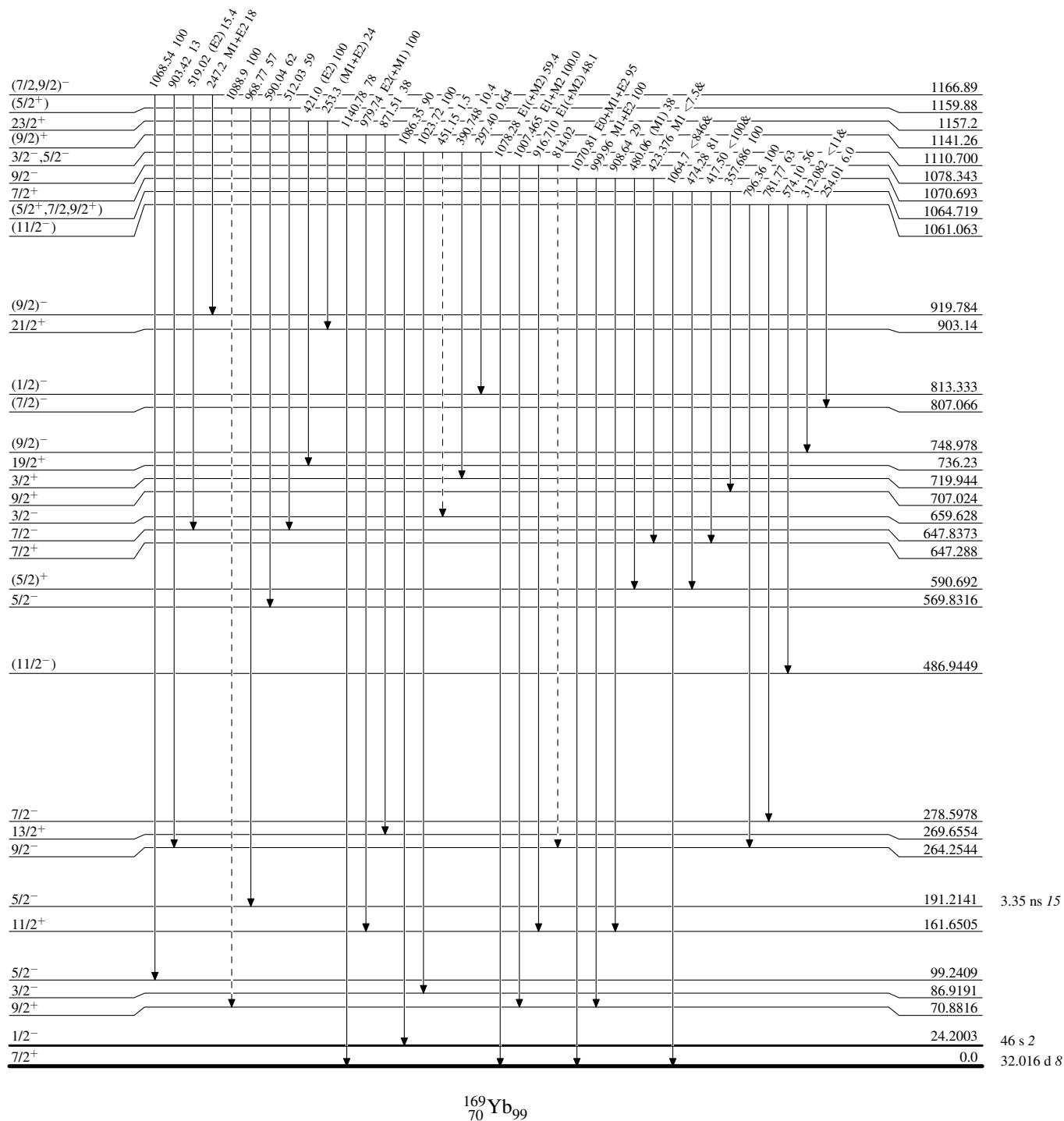
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given

-----► γ Decay (Uncertain)



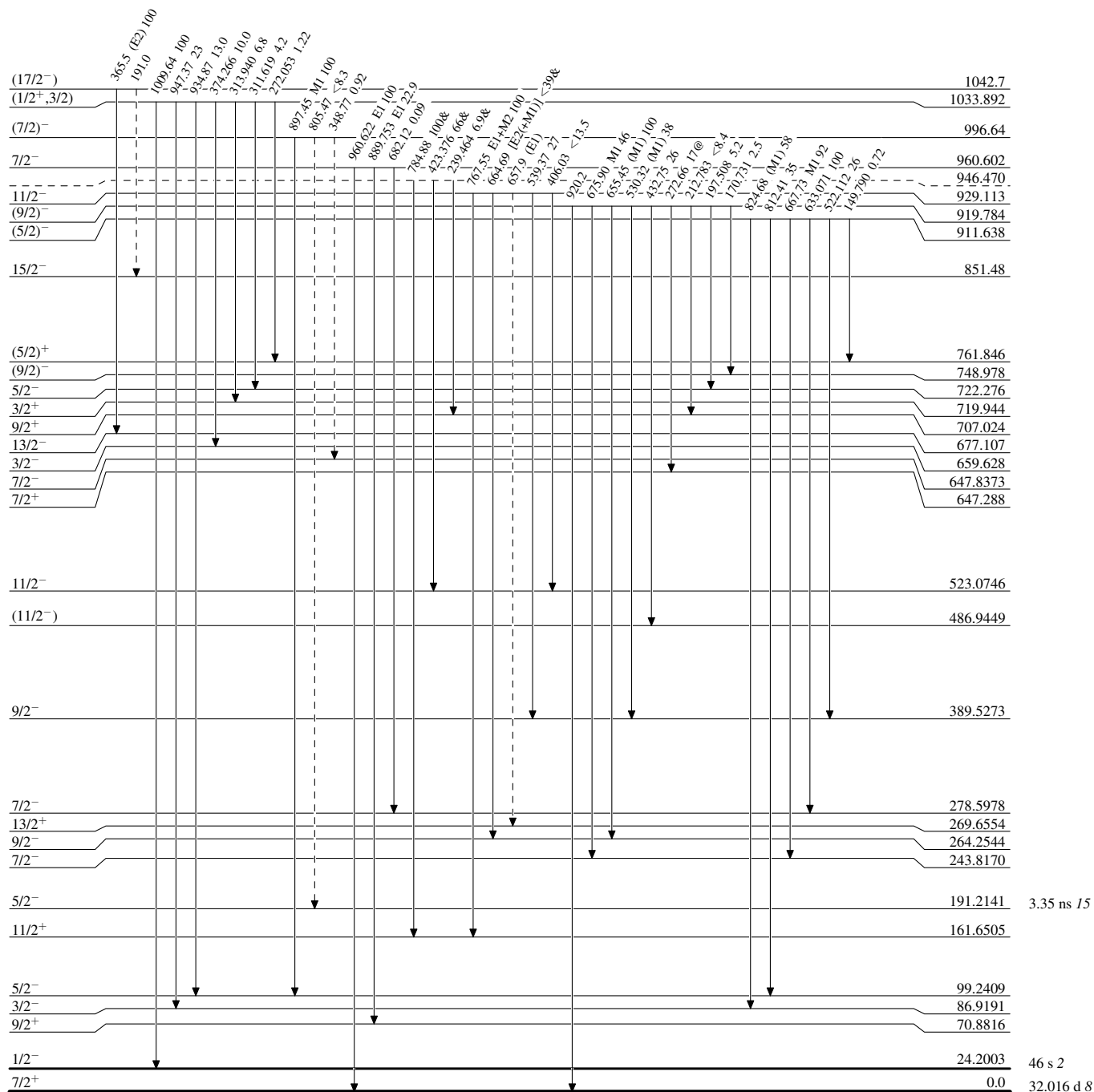
Adopted Levels, Gammas

Level Scheme (continued)

Legend

Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided

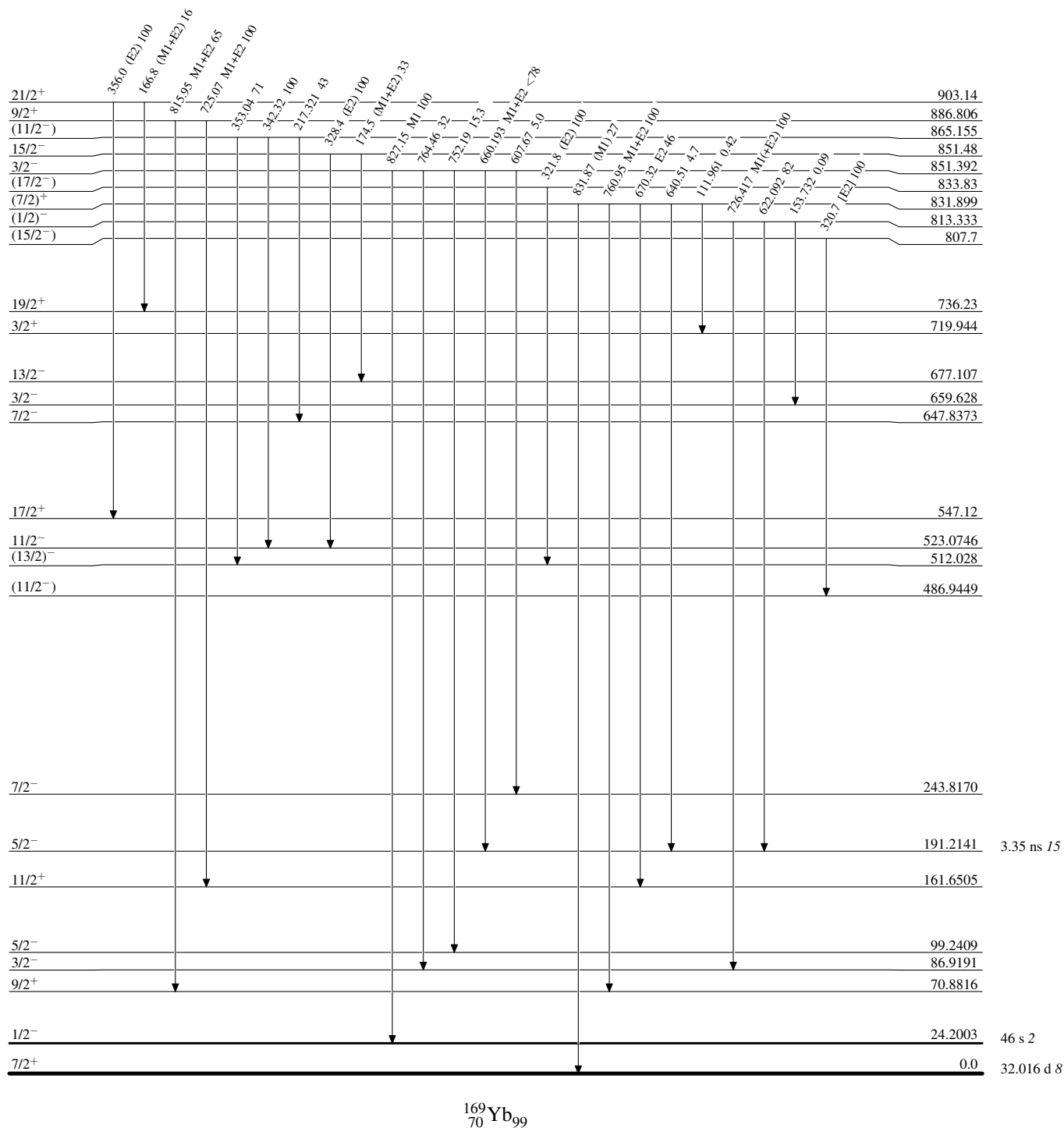
-----► γ Decay (Uncertain)



¹⁶⁹₇₀Yb₉₉

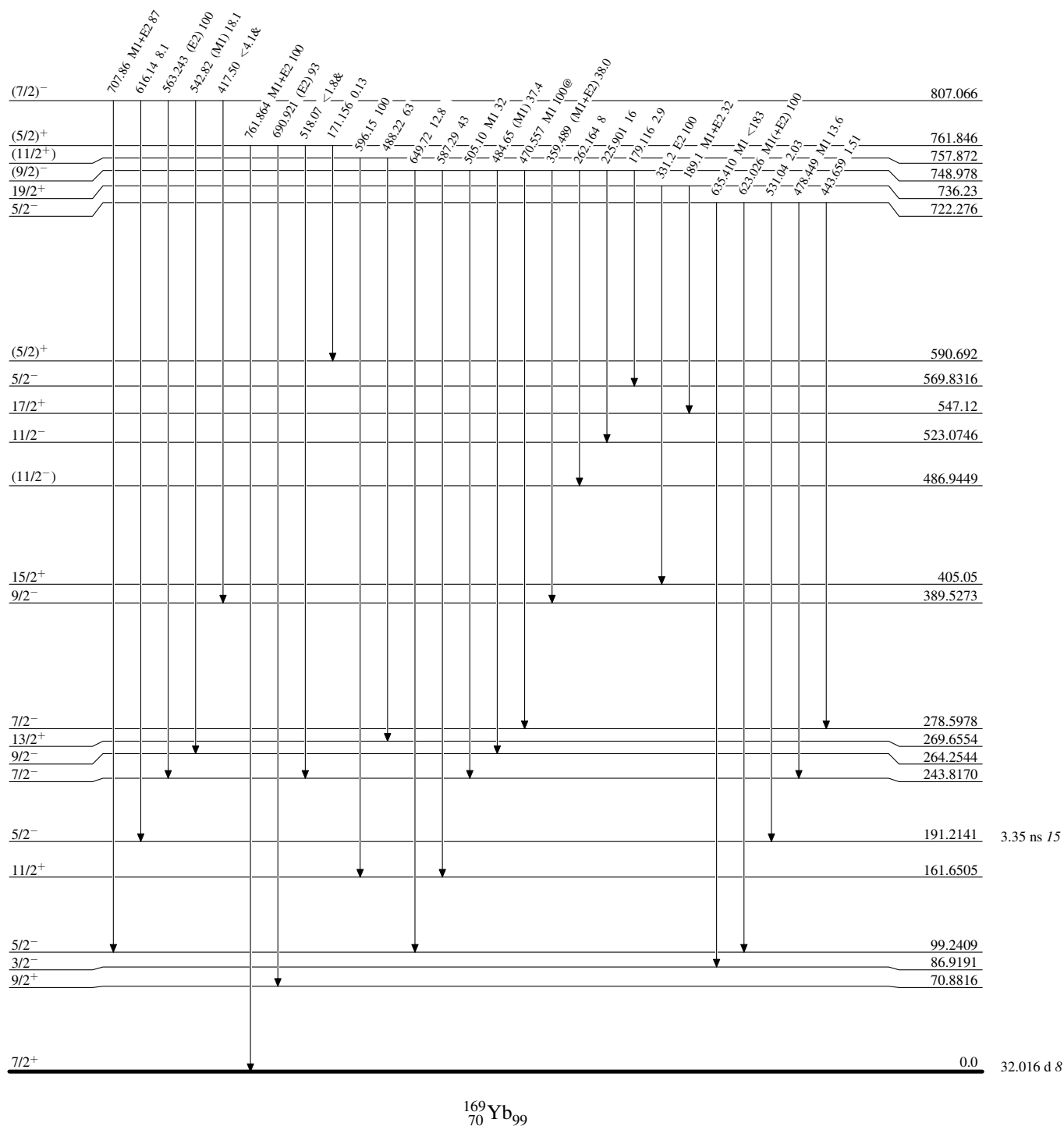
Adopted Levels, GammasLevel Scheme (continued)

Intensities: Relative photon branching from each level
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided



Adopted Levels, GammasLevel Scheme (continued)

Intensities: Relative photon branching from each level
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided



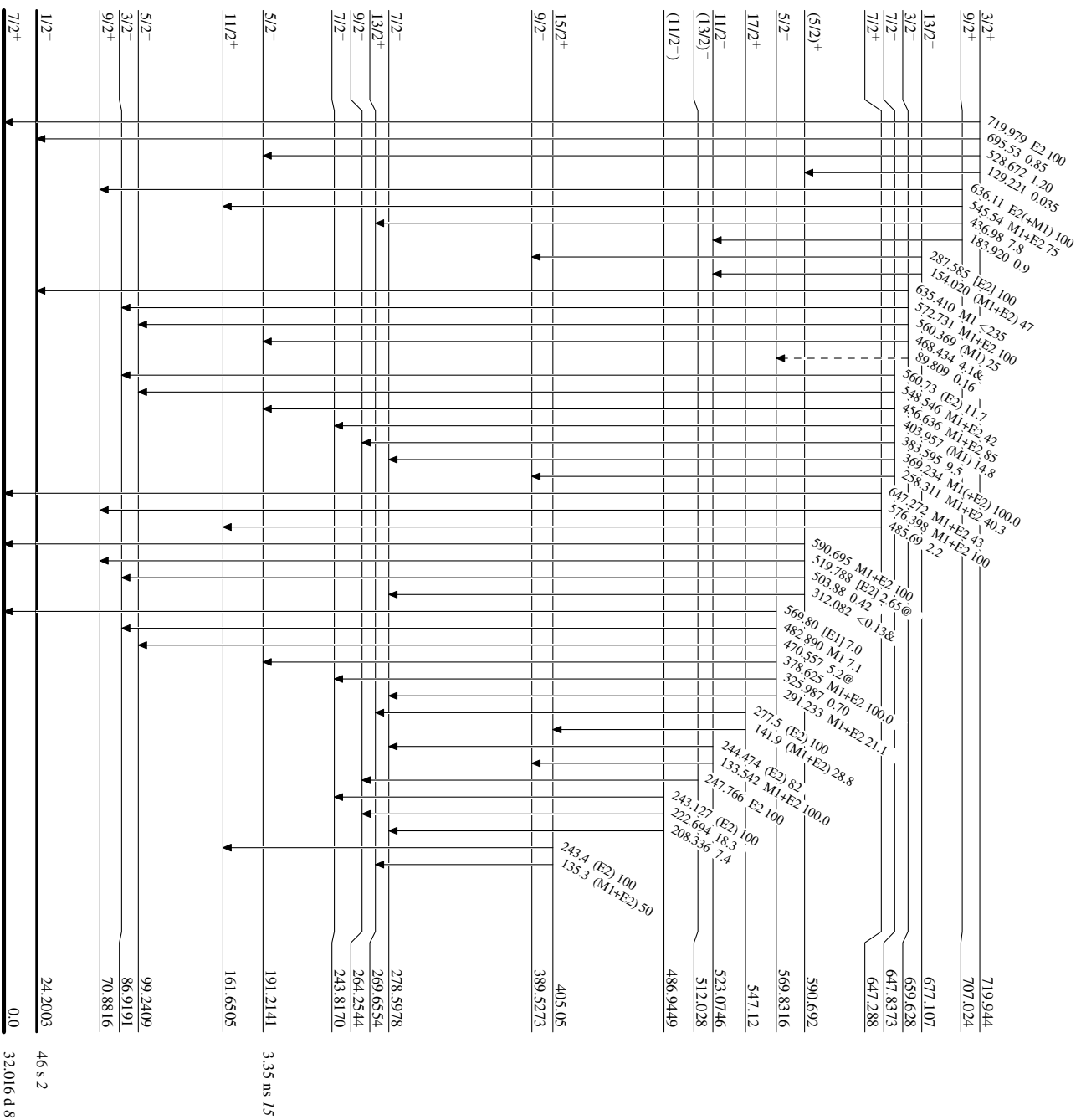
Adopted Levels, Gammas

Level Scheme (continued)

Legend

Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided

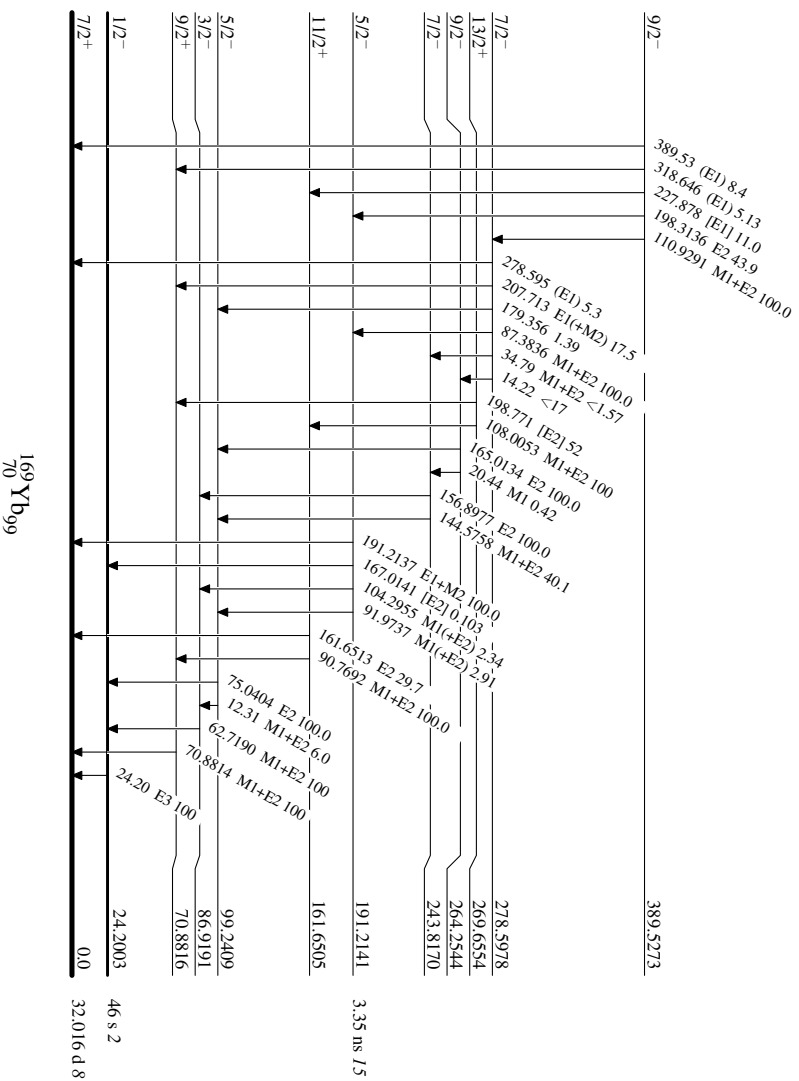
-----▶ γ Decay (Uncertain)



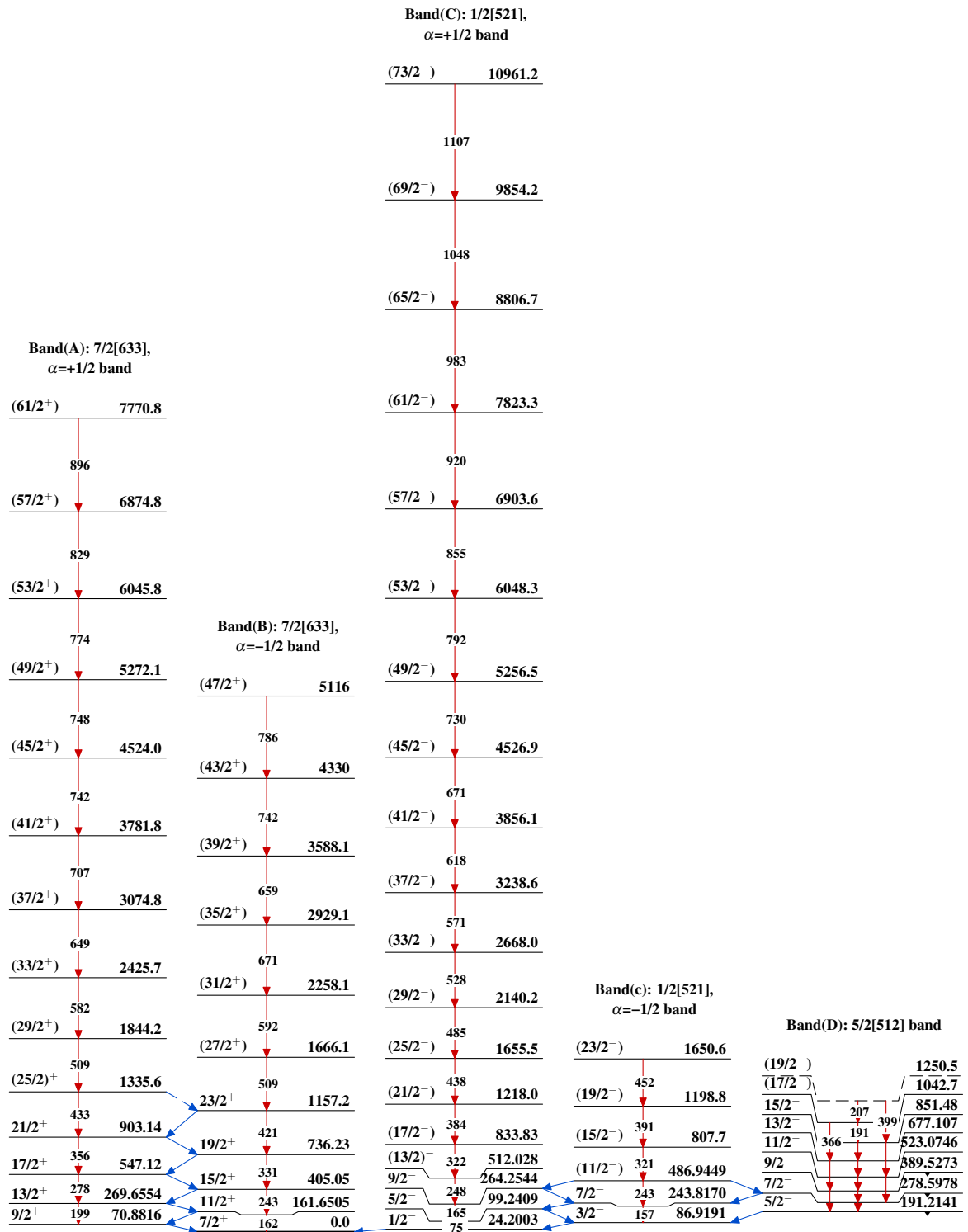
Adopted Levels, Gammas

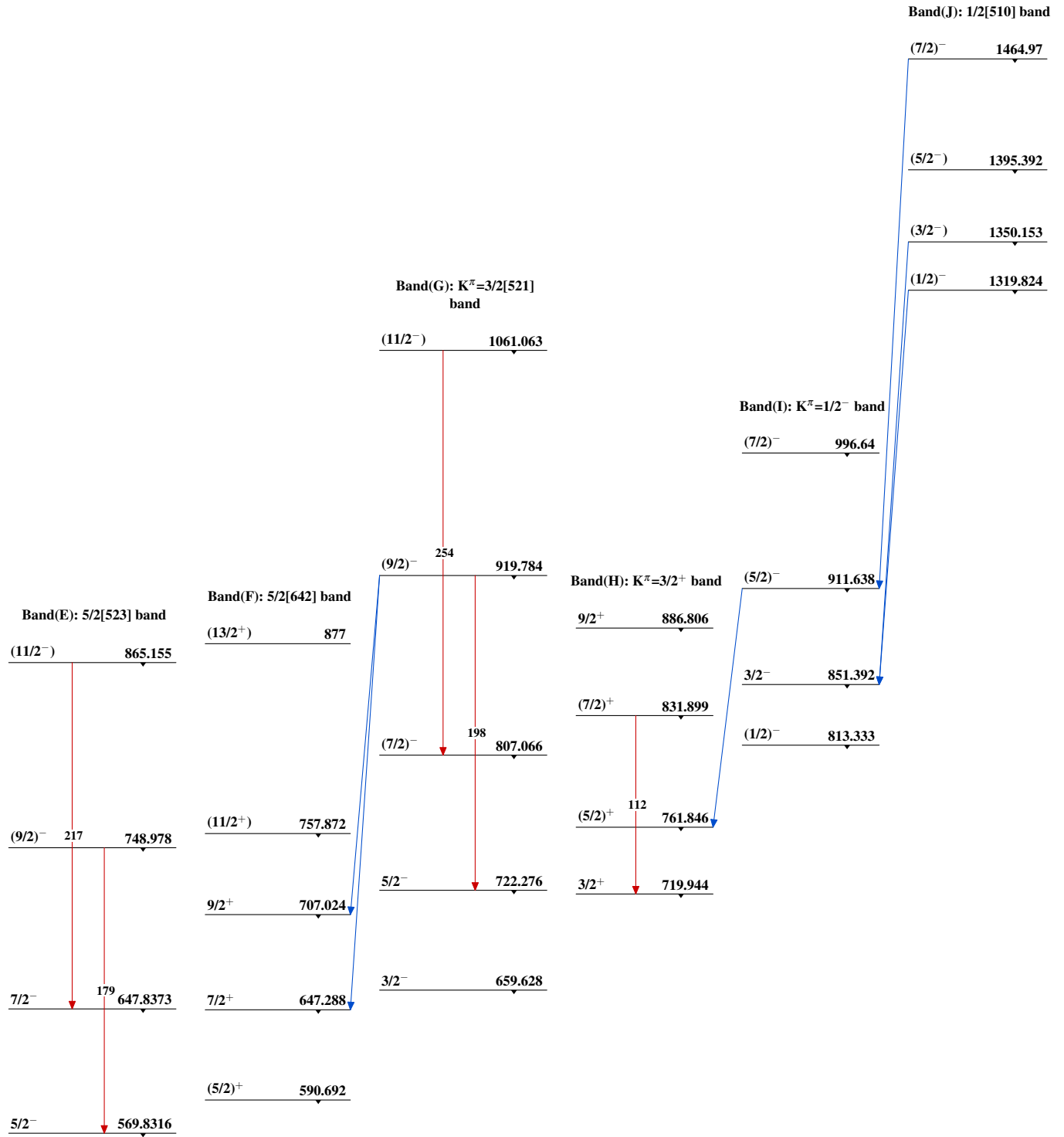
Level Scheme (continued)

Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided



Adopted Levels, Gammas



Adopted Levels, Gammas (continued) $^{169}_{70}\text{Yb}_{99}$

Adopted Levels, Gammas (continued)

Band(L): 7/2[503]? band

9/2⁻ 1554.881



7/2⁻ 1449.796



Band(M): β vibration band

(9/2)⁺ 1141.26



Band(K): 7/2[514] band

9/2⁻ 1078.343



7/2⁺ 1070.693



7/2⁻ 960.602



¹⁶⁹₇₀Yb₉₉

^{169}Lu $\varepsilon+\beta^+$ decay (34.06 h) [1978Ba73](#),[1978Bo39](#),[1980Ba07](#)

Parent: ^{169}Lu : $E=0.0$; $J^\pi=7/2^+$; $T_{1/2}=34.06$ h 5; $Q(\varepsilon)=2293$ 3; $\% \varepsilon + \% \beta^+$ decay=100.0

^{169}Lu - J^π , $T_{1/2}$: from ^{169}Lu Adopted Levels.

^{169}Lu - $Q(\varepsilon)$: from [2021Wa16](#).

Others: [1957Bo61](#), [1958Ke88](#), [1959Dz01](#), [1959Ha09](#), [1960Dz02](#), [1960Ha18](#), [1960Io01](#), [1960Io02](#), [1960Wi16](#), [1961Me05](#), [1961Pi02](#), [1962Dz05](#), [1963Tu01](#), [1964Dz02](#), [1964Dz06](#), [1968Lo10](#), [1969Ar23](#), [1970Ba09](#), [1970Bo06](#), [1970Dz11](#), [1971Ma74](#), [1972Bo69](#), [1972Dz02](#), [1973Bo38](#), [1977Ar17](#), [1977Bo31](#), [1980DuZP](#), [1980Bu24](#), [1991Dz04](#), [1982Da23](#).

[1978Ba73](#): measured E_γ , I_γ , $\gamma\gamma$ coin using Ge(Li) detectors (FWHM=0.5 keV at ≈ 100 keV, 0.9 keV at ≈ 200 keV, 2.1-2.7 keV at $E \approx 1$ MeV), and ce data using a Si(Li) detector.

[1980Ba07](#): measured ce- γ coin; Ge(Li) detector (FWHM=3.5 keV at $E_\gamma=1332$) and toroidal magnetic spectrometer.

[1977Bo31](#): measured β^+ and ce spectra using iron-free toroidal spectrometer, resolution=1.1%.

[1977Ar17](#): magnetic spectrometer, 0.17% resolution; measured ce spectra.

^{169}Lu sources for γ and ce studies were from spallation of tantalum by protons ($E(p)=660$ -680 MeV); chemical and mass separation.

The decay scheme is largely from [1978Bo39](#), incorporating photon data from [1977Ar17](#) and [1978Ba73](#) and β^+ data from [1977Bo31](#). Additions and refinements to the scheme from [1978Bo39](#), based on ce- γ coin, were introduced in [1980Ba07](#) (16 additional levels, 5 levels from [1978Bo39](#) eliminated); the evaluation by [1988DzZW](#) then proposed an additional 9 levels, along with the omission of 8 of the levels newly proposed by [1980Ba07](#) and an additional 5 of the levels proposed in [1978Bo39](#) (1541, 1566, 1707, 1708, 1954). Small changes have been made based on data of [1982Da23](#) (nuclear orientation) and several other studies; additional changes accommodate some of the recommendations from [1991DzZY](#) or [1992Dz03](#).

For discussion of band structure and other possible levels of ^{169}Yb that may be deduced from earlier decay data, see [1988DzZW](#), [1989Dz05](#), [1991Dz04](#), [1991DzZY](#), [1992Dz03](#), [1993Dz02](#) and [1995Dz02](#).

 ^{169}Yb Levels

E(level) [†]	J^π [‡]	$T_{1/2}$	Comments
0.0 [#]	7/2 ⁺	32.016 d 8	$T_{1/2}$: from Adopted Levels.
24.210 [@] 8	1/2 ⁻	46 s 2	$T_{1/2}$: from Adopted Levels.
70.880 [#] 5	9/2 ⁺		
86.927 [@] 7	3/2 ⁻		
99.250 [@] 6	5/2 ⁻		
161.645 [#] 6	11/2 ⁺		
191.216 ^{&} 5	5/2 ⁻	3.35 ns 15	$T_{1/2}$: from $\gamma\gamma(t)$ (1968Lo10).
243.827 [@] 7	7/2 ⁻		
264.272 [@] 8	9/2 ⁻		
269.628 [#] 19	13/2 ⁺		
278.594 ^{&} 6	7/2 ⁻		
389.523 ^{&} 7	9/2 ⁻		
487.031 [@] 14	(11/2 ⁻)		
512.039 [@] 17	(13/2 ⁻)		
523.066 ^{&} 7	11/2 ⁻		
569.837 ^a 10	5/2 ⁻		
590.67 ^b 3	(5/2 ⁺)		
647.34 ^b 3	7/2 ⁺		
647.847 ^a 11	7/2 ⁻		
659.52 ^c 12	3/2 ⁻		
707.03 ^b 5	9/2 ⁺		
720.00 ^d 8	3/2 ⁺		
722.21 ^c 5	5/2 ⁻		

Continued on next page (footnotes at end of table)

^{169}Lu $\varepsilon+\beta^+$ decay (34.06 h) [1978Ba73](#),[1978Bo39](#),[1980Ba07](#) (continued) ^{169}Yb Levels (continued)

E(level) [†]	J ^π [‡]	Comments
748.923 ^a 23	(9/2) ⁻	
761.822 ^d 18	(5/2) ⁺	
807.079 ^c 16	(7/2) ⁻	
832.085 ^d 20	(7/2) ⁺	
851.7? 5	3/2 ⁻	Tentative level proposed in 1988DzZW .
886.80 ^d 4	9/2 ⁺	
911.38 ^e 5	(5/2) ⁻	
919.80 ^c 5	(9/2) ⁻	
929.17 4	11/2 ⁻	
960.612 ^f 14	7/2 ⁻	
1061.2 3	(11/2) ⁻	Level proposed in 1988DzZW .
1070.77 ^g 3	7/2 ⁺	
1078.335 ^f 19	9/2 ⁻	
1141.44 ^g 7	(9/2) ⁺	
1167.74 8	(7/2,9/2) ⁻	Level not included in 1988DzZW .
1177.01 6	(7/2,9/2) ⁺	
1204.55 17		Level proposed in 1988DzZW and 1993Dz02 .
1283.282 20	(7/2,9/2) ⁻	
1343.57 4	(7/2) ⁻	
1406.35 4	9/2 ⁻	Level not included in 1988DzZW .
1420.31 13	(5/2 ⁻ , 7/2,9/2 ⁻)	Proposed as J=7/2 member of 1/2[521] β vibration band by 1980Ba07 . However, level is absent from 1988DzZW .
1427.12 10	(7/2,9/2) ⁻	
1444.75 5	7/2 ⁻ , 9/2 ⁻	Level not included in 1988DzZW .
1449.781 13	7/2 ⁻	
1463.412 16	7/2 ⁻	
1540.69 4	9/2 ⁻	Level not included in 1988DzZW .
1554.876 24	9/2 ⁻	
1565.65 5	(7/2) ⁻	Level not included in 1988DzZW .
1616.80 4	(1/2 ⁺ , 3/2, 5/2 ⁺)	
1656.22 9	5/2 ⁻ , 7/2 ⁻ , 9/2 ⁻	Level not included in 1988DzZW .
1658.10 3	5/2 ⁺	
1689.290 23	7/2 ⁻	
1694.48 6	5/2 ⁺	Level not included in 1988DzZW .
1707.71 8	(7/2,9/2) ⁺	Level not included in 1988DzZW .
1708.52 4	7/2 ⁻	Level not included in 1988DzZW .
1716.02 3	7/2 ⁺	
1781.696 22	7/2 ⁻	
1888.00 6	(7/2 ⁺ , 9/2 ⁺)	Level not included in 1988DzZW .
1908.63 3	5/2 ⁺	
1954.50 4	5/2 ⁻ , 7/2 ⁻	Level not included in 1988DzZW .
1972.35 8	9/2 ⁻	Level not included in 1988DzZW .
1973.97 3	7/2 ⁻	
2029.87 4	7/2 ⁻	
2065.04 11	7/2 ⁺	
2101.03 7	(5/2, 7/2) ⁻	
2135.4 4		
2287.23 5	7/2 ⁻	$\% \varepsilon + \% \beta^+ = 0.281$ 11 implied; however decay energy too low for K or L1 or L2 capture. Calculated $\log ft$ unrealistic.
2296.78? 15	5/2 ⁻ , 7/2 ⁻ , 9/2 ⁻	$\% \varepsilon + \% \beta^+ = 0.083$ 14 implied; however level energy $\geq Q$ value. Consequently, level is indicated as uncertain, as are the placements of all transitions deexciting it.

Continued on next page (footnotes at end of table)

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) [1978Ba73](#),[1978Bo39](#),[1980Ba07](#) (continued)

¹⁶⁹Yb Levels (continued)

[†] From least -squares fit to $E\gamma$, excluding all questionably or multiply-placed transitions as well as the 761 γ (from 832 level), 908.64 γ (from 1070 level), 1151.70 γ (from 1541 level) and 1676.46 γ (from 1954 level), each of which fits poorly. However, even with these exclusions, three $E\gamma$ are 4σ from their expected values and four deviate by 3σ . It implies some of these transitions may be misplaced in this decay scheme.

[‡] From Adopted Levels.

Band(A): 7/2[633] band.

@ Band(B): 1/2[521] band.

& Band(C): 5/2[512] band.

^a Band(D): 5/2[523] band.

^b Band(E): 5/2[642] band.

^c Band(F): 3/2[521] band + K-2 γ vibration built on 1/2[521].

^d Band(G): 3/2[651] band + K-2 γ vibration built on 7/2[633].

^e Band(H): 1/2[510] band + K-2 γ vibration built on 5/2[512].

^f Band(I): 7/2[514] band.

^g Band(J): β vibration band. Built on 7/2[633] g.s.; band assignment from [1988DzZW](#).

ε, β^+ radiations

$\varepsilon+\beta^+$ feedings to excited states are from intensity imbalance at each level; see comment on $I\gamma$ normalization for calculation of g.s. feeding. The allowed, $\Delta N=2$ feeding from a 7/2[404] parent to the 7/2[633] g.s. of ¹⁶⁹Yb is expected to be strongly inhibited. Feeding to members of the 1/2[521] band (K-forbidden) is expected to be weak also. For questionable placements and for multiply-placed transitions with undivided intensity, intensities of $1/2I\gamma \pm 1/2I\gamma$ have been assumed for each placement. There is apparent and unexpected feeding of 0.25% 11 to 161.7 level, 0.23% 9 to 269.7 level, 0.17% 8 to 486.9 level, and 0.19% 2 to 720.0 level. This might be attributable to an incomplete decay scheme (2.7% of γ intensity is unplaced).

β^+ spectrum ([1977Bo31](#)):

Other β^+ spectrum: [1981By04](#) (used total-absorption γ -ray spectroscopy to measure strength function).

$E\beta$	$I\beta$ (relative to $I_{ce}(K)=1$ for 191.2 γ)
-----	-----
1271 3	0.55 5
900 +100-60	0.028 11
670 50	0.028 6
310 +60-40	0.006 +4-3

The 1271 β^+ group feeds the ground state.

$E(\text{decay})$	$E(\text{level})$	$I\varepsilon^{\dagger}$	$\text{Log } ft$	$I(\varepsilon+\beta^+)^{\dagger}$
(157.6 32)	2135.4	0.0070 11	8.51 7	0.0070 11
(192.0 32)	2101.03	0.072 5	7.740 38	0.072 5
(228.0 32)	2065.04	0.0125 11	8.697 43	0.0125 11
(263.1 32)	2029.87	1.14 6	6.893 29	1.14 6
(319.0 32)	1973.97	1.02 9	7.144 41	1.02 9
(320.7 32)	1972.35	0.41 6	7.55 7	0.41 6
(338.5 32)	1954.50	0.57 4	7.458 34	0.57 4
(384.4 32)	1908.63	2.12 9	7.016 22	2.12 9
(405.0 32)	1888.00	0.35 3	7.850 39	0.35 3
(511.3 32)	1781.696	3.25 8	7.111 15	3.25 8
(577.0 32)	1716.02	1.69 7	7.511 20	1.69 7
(584.5 32)	1708.52	0.84 7	7.827 37	0.84 7

Continued on next page (footnotes at end of table)

^{169}Lu $\varepsilon+\beta^+$ decay (34.06 h) **1978Ba73,1978Bo39,1980Ba07** (continued) ε, β^+ radiations (continued)

E(decay)	E(level)	$I\beta^+{}^\dagger$	$I\varepsilon{}^\dagger$	Log ft	$I(\varepsilon+\beta^+)^\dagger$	Comments
(585.3 32)	1707.71		0.410 19	8.139 22	0.410 19	
(598.5 32)	1694.48		0.121 8	8.691 30	0.121 8	
(603.7 32)	1689.290		1.62 5	7.572 16	1.62 5	
(634.9 32)	1658.10		4.86 13	7.143 15	4.86 13	
(636.8 32)	1656.22		0.44 5	8.19 5	0.44 5	
(676.2 32)	1616.80		0.407 15	8.279 18	0.407 15	
(727.4 32)	1565.65		0.37 4	8.389 48	0.37 4	
(738.1 32)	1554.876		1.63 15	7.759 41	1.63 15	
(752.3 32)	1540.69		0.69 9	8.15 6	0.69 9	
(829.6 32)	1463.412		5.07 17	7.375 17	5.07 17	
(843.2 32)	1449.781		15.8 4	6.896 14	15.8 4	
(848.3 32)	1444.75		0.245 25	8.711 45	0.245 25	
(865.9 32)	1427.12		0.36 12	8.56 14	0.36 12	
(872.7 32)	1420.31		0.22 4	8.78 8	0.22 4	
(886.7 32)	1406.35		0.69 9	8.30 6	0.69 9	
(949.4 32)	1343.57		1.38 6	8.064 20	1.38 6	
(1009.7 32)	1283.282		2.15 11	7.928 23	2.15 11	
(1116.0 32)	1177.01	1.63×10^{-7} 36	0.283 21	8.900 33	0.283 21	
(1125.3 32)	1167.74	4.0×10^{-7} 8	0.41 4	8.747 43	0.41 4	
(1151.6 32)	1141.44	3.6×10^{-7} 6	0.111 11	9.335 44	0.111 11	
(1214.7 32)	1078.335	7.6×10^{-5} 7	3.14 10	7.932 15	3.14 10	
(1222.2 32)	1070.77	1.94×10^{-5} 22	0.67 5	8.609 33	0.67 5	
(1332.4 32)	960.612	0.00558 34	25.2 7	7.112 14	25.2 7	
(1363.8 32)	929.17	1.37×10^{-5} 29	0.34 7	9.82 ^{1u} 9	0.34 7	
(1381.6 32)	911.38	6.1×10^{-5} 8	0.145 17	9.38 5	0.145 17	
(1406.2 32)	886.80	2.77×10^{-4} 17	0.495 20	8.867 19	0.495 20	
(1441.3 [‡] 32)	851.7?	8.088×10^{-5}	0.1 1	≥ 9.2	0.1 1	
(1485.9 32)	807.079	7.5×10^{-4} 9	0.61 7	8.83 5	0.61 7	
(1531.2 32)	761.822	9.7×10^{-4} 20	0.54 11	8.91 9	0.54 11	
(1544.1 32)	748.923	0.00127 20	0.64 10	8.84 7	0.64 10	
(1586.0 32)	707.03	0.00215 44	0.80 16	8.77 9	0.80 16	
(1633.5 32)	659.52	1.7×10^{-4} 9	0.27 15	10.25 ^{1u} 24	0.27 15	
(1645.2 32)	647.847	0.00815 37	2.05 7	8.391 16	2.06 7	
(1645.7 32)	647.34	0.00210 28	0.53 7	8.98 6	0.53 7	
(1702.3 32)	590.67	0.00232 45	0.42 8	9.11 8	0.42 8	
(1723.2 32)	569.837	0.0061 5	0.98 8	8.752 36	0.99 8	
(1903.5 32)	389.523	0.0112 44	0.78 31	8.94 17	0.79 31	
(2014.4 32)	278.594	0.024 9	1.08 40	8.85 16	1.1 4	
(2028.7 [‡] 32)	264.272	<0.008570	<0.37143	>9.3	<0.38	
(2049.2 [‡] 32)	243.827	<0.01	<0.46	>9.2	<0.47	
(2101.8 32)	191.216	0.046 17	1.6 6	8.73 16	1.6 6	
(2293.0 33)	0.0	0.51 5	10 1	8.002 42	10.5 10	E(decay): other: 2293 3 from $E\beta^+=1271$ 3 (1977Bo31). $I(\varepsilon+\beta^+), I\varepsilon$: deduced from $I\beta(1271\beta)/I\varepsilon(K)(191.2\gamma)=0.55$ 5 (1977Bo31).

[†] Absolute intensity per 100 decays.[‡] Existence of this branch is questionable.

γ(¹⁶⁹Yb)

I_γ normalization: from Σ I_γ(1+α) (to g.s. plus 24.2 level) less I_γ(24.2)(1+α)=89.5% 10, based on (%ε+%β⁺ to g.s.)=10.5 10 [deduced value from the measured data of I(β⁺ to g.s.)/I(191 ce(K))=0.55 5 ([1977Bo31](#)) and I(ε)/I(β⁺)=18.6 from theory]. This normalization and the decay-scheme yields a ΣI(K x-ray) value of ≈527 compared with ΣI(K x-ray)(exp)=503 6 ([1978Ba73](#)).

α(K)exp data given in comments are from [1978Ba73](#), unless indicated to the contrary.

I(K x-ray) relative to I_γ(960.6)=100 ([1978Ba73](#))

E(K x-ray)	I(K x-ray)
-----	-----
51.354	146 3
52.389	254 5
59.4	82 2
61.0	20.7 5

<u>E_γ[†]</u>	<u>I_γ^{†d}</u>	<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.^a</u>	<u>δ^a</u>	<u>α^e</u>	<u>I_(γ+ce)^d</u>	Comments
12.31 2	0.078 & 17	99.250	5/2 ⁻	86.927	3/2 ⁻	M1+E2	0.028 +11-9	3.1×10 ² 5		%I _γ =0.017 4 E _γ : from 1973Bo38 . I _γ : deduced from Ice(L)=19.3 43 (1977Ar17) and α(L)(theory). Mult.,δ: from ce subshell ratios: L1:L2:L3:M1:M2:M3:N1:N2:O= 350 100:60 15:55 25:70 16:12 2:10 3:17 3:3 1:3.3 10 (1977Ar17). E _γ : from 1973Bo38 . I(γ+ce)(14.2γ) cannot exceed 0.9 9 and I(γ+ce)(34.8γ) cannot exceed 1.5 7 based on intensity balances at the 243.8 and 264.3 levels.
14.22 4		278.594	7/2 ⁻	264.272	9/2 ⁻				<1.8	%I _γ =0.0074 13 E _γ : from 1973Bo38 . I _γ : deduced from Ice(M1)=0.33 6 (1977Ar17) and α(M1)(theory). Mult.: from ce subshell ratios (1977Ar17); M1+E2 with δ<0.055 (nuclear orientation, 1982Da23). L1:M1:M2=36 6:8.0 13: ≤1.6 (1977Ar17). E _γ : from 1970Ba09 . I(γ+ce): from intensity balance at 24.2 level; ε+β ⁺ feeding to this level is not expected (ΔJ=3, Δπ=yes).
20.44 2	0.035 6	264.272	9/2 ⁻	243.827	7/2 ⁻	M1		59.0 8		
24.20 2		24.210	1/2 ⁻	0.0	7/2 ⁺	E3		2.58×10 ⁵ 4	60.0 22	

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) ¹⁹⁷⁸Ba73,¹⁹⁷⁸Bo39,¹⁹⁸⁰Ba07 (continued)

$\gamma(^{169}\text{Yb})$ (continued)										Comments
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ ^a	α ^e	$I_{(\gamma+ce)}$ ^d	
										Mult.: from ce subshell ratios: L1:L2:L3:M1:M2:M3:(M4+M5):N:O= $\leq 50:500$ 50:600 50:<8:140 15:160 15:29 3:71 7:6 2 (1977Ar17).
34.79 4		278.594	7/2 ⁻	243.827	7/2 ⁻	M1+E2	≈ 0.022 ^b	≈ 12.36	<2.2	E _{γ} : from 1973Bo38. I _($\gamma+ce$) : See comment with 14.2 γ . Mult.: from ce subshell ratios (1977Ar17). L1:L2=11.6 13: ≈ 1.2 (1977Ar17).
62.730 14	2.79 11	86.927	3/2 ⁻	24.210	1/2 ⁻	M1+E2	0.58 ^b 3	14.96 27		%I γ =0.592 23 $\alpha(\text{L})_{\text{exp}}=4.7$ 3 (1977Ar17); L1:L2:L3:M1:M2:M3:N= 75 7:130 15:130 10: ≈ 20 : ≈ 40 : ≈ 40 :19 2 (1977Ar17); L1:L2:L3=100:161 5:164 5 (1987BaZB).
70.880 6	7.27 13	70.880	9/2 ⁺	0.0	7/2 ⁺	M1+E2	-0.31 ^c +15-26	9.4 6		%I γ =1.543 35 A ₂ =+0.80 22 (1982Da23) $\alpha(\text{K})_{\text{exp}}=6.4$ 9 (1978Ba73), 7.2 11 (1977Ar17); K:L1:L2:L3:M1:M2:M3= 1220 150:170 20:80 15:50 10:37 7:19 3:11.5 20 (1977Ar17); L1:L2:L3=100:46.9 13:34.4 7 (1987BaZB).
75.036 6	1.30 3	99.250	5/2 ⁻	24.210	1/2 ⁻	E2		10.06 14		%I γ =0.276 8 Mult.: from ce subshell ratios (1973Bo38, 1977Ar17). $\alpha(\text{K})_{\text{exp}}=1.4$ 3 (1978Ba73); K:L1:L2:L3:M1:M2:M3:N:O= 50 9:5.0:83:85:1.33:26.6:26.6:13.3:3.3 (1973Bo38); K:L1:L2:L3= ≤ 50 :5.5 5:95 3:100 (1977Ar17).
87.377 4	10.50 19	278.594	7/2 ⁻	191.216	5/2 ⁻	M1+E2	-0.23 ^b 2	5.00 7		%I γ =2.23 6 δ : sign from $\delta=-0.14$ +7-24 from $\gamma\gamma(\theta)$ (1980Bu24). $\alpha(\text{K})_{\text{exp}}=3.5$ 5 (1978Ba73), 4.0 5 (1977Ar17); K:L1:L2:L3:M1:M2:M3= 1050 100:160 12:32 3:24 3:32 3:8.7 7:5.7 10 (1977Ar17); L1:L2:L3=100:21.3 9:16.4 5 (1987BaZB).
90.764 4	2.38 5	161.645	11/2 ⁺	70.880	9/2 ⁺	M1+E2	-0.28 ^b 2	4.48 6		%I γ =0.505 14 A ₂ =+0.79 53 (1982Da23) δ : sign from nuclear orientation ($\delta=-0.3$ +3-6, 1982Da23); $\delta<0$ supported by $\delta=-0.40$ 9 from ($\alpha, 2n\gamma$).

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) [1978Ba73,1978Bo39,1980Ba07](#) (continued)

$\gamma(^{169}\text{Yb})$ (continued)									Comments
E_γ [†]	I_γ ^{†d}	E_i (level)	J_i^π	E_f	J_f^π	Mult. ^a	δ^a	α^e	
91.965 3	2.56 5	191.216	5/2 ⁻	99.250	5/2 ⁻	M1(+E2)	-0.19 ^b 5	4.30 6	$\alpha(\text{K})_{\text{exp}}=3.0$ 3 (1978Ba73), 3.0 6 (1977Ar17); K:L1:L2:L3:M1:M2:N:O= 66 11:10:2.5:<0.83:2.5:0.66: 0.83:0.17 (1973Bo38); K:L1:L2:L3=190 15:27 2:8.1 10:4.5 7 (1977Ar17). $\%I_\gamma=0.543$ 14 $A_2=-0.24$ 36 (1982Da23) $\alpha(\text{K})_{\text{exp}}=3.63$ 8 (1977Ar17); K:L1:L2:L3:M1:M2:N= 133 20:16.6:3.3:<0.66:5.0:0.83:1.33 (1973Bo38); K:L1:L2=240 30:31 4:4.3 15 (1977Ar17). δ : sign from nuclear orientation ($\delta=-0.2$ +4-3, 1982Da23). $\%I_\gamma=0.433$ 17 $A_2=+1.04$ 90 (1982Da23) Mult.: from ce subshell ratios (1977Ar17). $\alpha(\text{K})_{\text{exp}}=2.0$ 4 (1978Ba73), 1.9 3 (1977Ar17); K:L1:L2:M= 140 10:18.3 14:1.7 3: $\approx$ 4.6 (1977Ar17); K:L1:L2:L3:M1:M2:N:O= 108 20:19.9:2.0:0.20:6.64:0.66: 1.66:0.50 (1973Bo38). $\%I_\gamma=0.075$ 4 δ : sign from δ in Adopted Gammas dataset. $\alpha(\text{K})_{\text{exp}}=1.6$ 3 (1978Ba73); K:L1:L2:L3:M1:M2:N= 150 23:23.2:8.3:2.3:6.6:1.7:1.7 (1973Bo38). $\%I_\gamma=1.59$ 5 $A_2=+0.60$ 11 (1982Da23) δ : sign from -0.17 +7-8 (1982Da23 – nuclear orientation). Other values: -0.28 +9-8 ($\gamma\gamma(\theta)$, 1980Bu24), -0.11 +16-25 (from ¹⁶⁷ Er($\alpha,2n\gamma$)). $\alpha(\text{K})_{\text{exp}}=1.55$ 25 (1978Ba73); K:L1:L2:L3:M1:M2:M3:N:O= 32 5:4.2:0.75:0.22:1.0:0.18:0.07:0.25:0.066 (1973Bo38). $\%I_\gamma=0.179$ 6 $A_2=+0.32$ 38 (1982Da23) δ : sign from -0.02 22 (nuclear orientation, 1982Da23). $\alpha(\text{K})_{\text{exp}}=1.3$ 2 (1978Ba73); K:L1:L2:L3:M1:M2:N= 300 50:36:6.6:1.3:8.3:1.7:2.5 (1973Bo38). $\%I_\gamma=0.512$ 16 $A_2=-0.53$ 12 (1982Da23) δ : others: 0.42 3 (ce subshell ratios, 1987BaZB), 0.7 5 ($\alpha(\text{K})$, 1978Ba73), 0.25 5 (ce subshell ratios, 1973Bo38). $\alpha(\text{K})_{\text{exp}}=0.80$ 15 (1978Ba73); K:L1:L2:L3:M1:M2:N= 515
104.293 9	2.04 7	191.216	5/2 ⁻	86.927	3/2 ⁻	M1(+E2)	-0.55 ^c +65-20	2.93 7	
108.004 25	0.353 18	269.628	13/2 ⁺	161.645	11/2 ⁺	M1+E2	-0.29 ^b 4	2.68 4	
110.924 4	7.48 18	389.523	9/2 ⁻	278.594	7/2 ⁻	M1+E2	-0.17 ^b +4-3	2.499 35	
133.540 5	0.843 22	523.066	11/2 ⁻	389.523	9/2 ⁻	M1+E2	-0.16 ^b 4	1.469 21	
144.576 7	2.41 6	243.827	7/2 ⁻	99.250	5/2 ⁻	M1+E2	+0.52 ^c +12-9	1.104 32	

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) **1978Ba73,1978Bo39,1980Ba07** (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ^a	α^e	Comments
156.901 4	6.01 11	243.827	7/2 ⁻	86.927	3/2 ⁻	E2		0.616 9	90:73:11.6:5:18.3:3.3:5.0 (1973Bo38); L1:L2:L3=100:27.0 22:16.7 22 (1987BaZB). %I γ =1.276 33 A ₂ =-0.503 53 (1982Da23) Mult.: from ce subshell ratios (1973Bo38). $\alpha(\text{K})_{\text{exp}}$ =0.28 5 (1978Ba73), 0.30 4 (1977Ar17); K:L1:L2:L3:M1:M2:M3:N:O= 432 83:50:99.6:66.4:11.6:2.5:16.6:13.3:3.3 (1973Bo38). %I γ =0.157 9 A ₂ =-0.43 19 (1982Da23) Mult.: from ce subshell ratios (1973Bo38). $\alpha(\text{K})_{\text{exp}}$ =0.38 10 (1978Ba73); K:L1:L2:L3:M1:M2:M3:N= 76 16:6.6:20:15:1.7:5:3.3:2.5 (1973Bo38). %I γ =1.79 5 A ₂ =-0.472 44 (1982Da23) Mult.: from ce subshell ratios (1973Bo38). $\alpha(\text{K})_{\text{exp}}$ =0.24 5 (1978Ba73), 0.28 4 (1977Ar17); K:L1:L2:L3:M1:M2:M3:N:O= 531 90:55:222:178:13.3:56.4:50:25.0:6.6 (1973Bo38). %I γ =0.116 6 A ₂ =-0.74 20 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =0.52 14 (1978Ba73); K:L1:L2:L3:M1:M2:M3= 75 17:10:26.6:21.6:2.5:6.6:5 (1973Bo38). δ =9 -6, from ce ratio data using the BriceMixing code, does not reproduce $\alpha(\text{K})_{\text{exp}}$ well. %I γ =18.7 5 A ₂ =+0.054 12 (1982Da23) Mult.: from $\alpha(\text{K})_{\text{exp}}$ =0.046 10 (1978Ba73) and K:L1:L2:L3:M1:M2:M3:N:O= 108 20:18.6:2.7:2.7:5:0.7:0.7:0.15:0.35 (1973Bo38). $\alpha(\text{K})_{\text{exp}}$ =0.59 9 (1977Ar17) is presumed to be erroneous. δ : -0.058 9 from nuclear orientation (1982Da23) but <0.042 from $\alpha(\text{K})_{\text{exp}}$ =0.046 10 (1978Ba73). B(M2)(W.u.) $\leq$ 1.0 (from RUL) implies $\delta\leq$ 0.033, so evaluator adopts δ =-0.017 16. %I γ =0.696 26 $\alpha(\text{K})_{\text{exp}}$ =0.13 3 (1978Ba73); K:L2:L3:M1:M2= 111 20:30:21.6:8.3:5 (1973Bo38).
161.659 15	0.74 4	161.645	11/2 ⁺	0.0	7/2 ⁺	E2		0.555 8	
165.020 7	8.41 16	264.272	9/2 ⁻	99.250	5/2 ⁻	E2		0.517 7	
166.509 19	0.546 25	1449.781	7/2 ⁻	1283.282	(7/2,9/2) ⁻	M1+E2	+0.5 ^c 3	0.73 6	
191.217 5	88 2	191.216	5/2 ⁻	0.0	7/2 ⁺	E1+M2	-0.017 ^c 16	0.0631 25	
198.26 12	3.28 11	389.523	9/2 ⁻	191.216	5/2 ⁻	E2		0.277 4	

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) **1978Ba73,1978Bo39,1980Ba07** (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ ^a	α ^e	Comments
198.771 @ 5	0.18 & 4	269.628	13/2 ⁺	70.880	9/2 ⁺	[E2]		0.274 4	%I γ =0.038 9 $\alpha(\text{K})_{\text{exp}}$ =0.032 15, deduced from I γ and I(ce(K))=0.0058 25 (1978Ba73); inconsistent with $\alpha(\text{K})_{\text{(theory)}}$ =0.168 for required E2 multipolarity.
207.727 25	1.84 6	278.594	7/2 ⁻	70.880	9/2 ⁺	E1(+M2)	-0.09 ^c +14-16	0.07 11	%I γ =0.391 15 A ₂ =+0.02 21 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =0.034 17.
222.70 [#] 6	0.14 [#] 7	487.031	(11/2 ⁻)	264.272	9/2 ⁻				%I γ =0.030 15 $\alpha(\text{K})_{\text{exp}}$ =0.07 5 is inconsistent with the expected multipolarity for a (11/2 ⁻) to 9/2 ⁻ transition.
225.86 3	0.30 15	748.923	(9/2 ⁻)	523.066	11/2 ⁻				%I γ =0.064 32 $\alpha(\text{K})_{\text{exp}}$ =0.06 5 is inconsistent with the expected multipolarity for a (9/2 ⁻) to 11/2 ⁻ transition.
227.892 18	0.92 17	389.523	9/2 ⁻	161.645	11/2 ⁺	[E1]		0.0396 6	%I γ =0.20 4
243.207 12	0.92 20	487.031	(11/2 ⁻)	243.827	7/2 ⁻	(E2)		0.1419 20	%I γ =0.20 4 $\alpha(\text{K})_{\text{exp}}$ =0.074 26.
244.474 @ 5	0.82 15	523.066	11/2 ⁻	278.594	7/2 ⁻	(E2)		0.1395 20	%I γ =0.174 32 $\alpha(\text{K})_{\text{exp}}$ =0.12 5.
247.2 3	0.24 8	1167.74	(7/2,9/2) ⁻	919.80	(9/2) ⁻	M1+E2	1.0 +26-8	0.20 6	%I γ =0.051 17 I γ : deduced from I γ =0.39 7 for 247.2 γ +247.8 γ , separate Ice components for doublet (1978Ba73), and known E2 multipolarity for 247.8 γ . Mult., δ : from $\alpha(\text{K})_{\text{exp}}$ =0.16 6.
247.766 [#] 15	0.15 3	512.039	(13/2) ⁻	264.272	9/2 ⁻	E2		0.1337 19	%I γ =0.032 6 I γ : see comment with 247.2 γ from 1168 level.
258.331 19	1.45 6	647.847	7/2 ⁻	389.523	9/2 ⁻	M1+E2	+1.4 +19-6	0.157 32	%I γ =0.308 14 A ₂ =+0.34 32 (1982Da23) Mult., δ : from $\alpha(\text{K})_{\text{exp}}$ =0.12 3 (1978Ba73). Sign of the δ from δ =+0.12 +25-21 in nuclear orientation (1982Da23).
272.66 ^g 16	0.12 ^{g&} 4	919.80	(9/2) ⁻	647.34	7/2 ⁺				%I γ =0.025 9 $\alpha(\text{K})_{\text{exp}}$ =0.017 9.
272.66 ^g 16	0.25 ^g 8	1343.57	(7/2) ⁻	1070.77	7/2 ⁺				%I γ =0.053 17 I γ : deduced from I γ (272.1 γ +272.7 γ)=0.37 6 and I γ (272.1 γ)=0.12 4. $\alpha(\text{K})_{\text{exp}}$ =0.017 9 for doublet.

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) ¹⁹⁷⁸Ba73,¹⁹⁷⁸Bo39,¹⁹⁸⁰Ba07 (continued) $\gamma(^{169}\text{Yb})$ (continued)

E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ^a	α^e	Comments
278.60 4	0.56 4	278.594	7/2 ⁻	0.0	7/2 ⁺	(E1)		0.02391 33	%I γ =0.119 9 $\alpha(\text{K})_{\text{exp}}$ =0.022 11.
291.234 19	1.90 7	569.837	5/2 ⁻	278.594	7/2 ⁻	M1+E2	-0.10 ^c 9	0.1696 33	%I γ =0.403 17 A ₂ =+0.27 12 (¹⁹⁸² Da23) δ : sign from $\delta=-0.17$ +6-8 from $\gamma\gamma(\theta)$ (¹⁹⁸⁰ Bu24). Other δ : +0.10 9 (¹⁹⁸² Da23, nuclear orientation).
318.70 7	0.384 18	389.523	9/2 ⁻	70.880	9/2 ⁺	(E1)		0.01719 24	$\alpha(\text{K})_{\text{exp}}$ =0.18 4. %I γ =0.082 4 $\alpha(\text{K})_{\text{exp}}$ =0.024 12.
^x 357.10 20	0.20 10								%I γ =0.042 21 $\alpha(\text{K})_{\text{exp}}$ =0.024 17.
359.38 7	0.71 4	748.923	(9/2) ⁻	389.523	9/2 ⁻	(M1+E2)	1.5 +15-6	0.060 13	%I γ =0.151 9 A ₂ =-0.33 23 (¹⁹⁸² Da23) δ : other value: -0.44 $\leq\delta\leq$ +2.04 (nuclear orientation, ¹⁹⁸² Da23).
369.251 15	3.58 9	647.847	7/2 ⁻	278.594	7/2 ⁻	M1(+E2)	-0.02 ^c 5	0.0904 13	$\alpha(\text{K})_{\text{exp}}$ =0.049 11. %I γ =0.760 23 A ₂ =-0.419 34 (¹⁹⁸² Da23)
378.632 11	9.01 23	569.837	5/2 ⁻	191.216	5/2 ⁻	M1+E2	-0.41 +19-25	0.078 8	$\alpha(\text{K})_{\text{exp}}$ =0.076 6. %I γ =1.91 6 A ₂ =-0.382 57 (¹⁹⁸² Da23) $\alpha(\text{K})_{\text{exp}}$ =0.065 5. δ : sign from nuclear orientation ($\delta=-0.04$ 6, ¹⁹⁸² Da23).
383.59 5	0.32 5	647.847	7/2 ⁻	264.272	9/2 ⁻	[M1,E2]		0.059 23	%I γ =0.068 11
389.57 5	0.63 3	389.523	9/2 ⁻	0.0	7/2 ⁺	(E1)		0.01066 15	%I γ =0.134 7 A ₂ =+0.24 38 (¹⁹⁸² Da23) Mult.: $\delta=+0.03$ 21 (nuclear orientation, ¹⁹⁸² Da23) suggests possible M2 admixture.
403.98 4	0.53 4	647.847	7/2 ⁻	243.827	7/2 ⁻	(M1)		0.07136 99	$\alpha(\text{K})_{\text{exp}}$ =0.013 2. %I γ =0.112 9 $\alpha(\text{K})_{\text{exp}}$ =0.056 6.
406.03 ^f 7	0.181 ^f 16	929.17	11/2 ⁻	523.066	11/2 ⁻				%I γ =0.0384 35 $\alpha(\text{K})_{\text{exp}}$ =0.051 7 for doublet.
406.03 ^f 7	0.181 ^f 16	1689.290	7/2 ⁻	1283.282	(7/2,9/2) ⁻				%I γ =0.0384 35 $\alpha(\text{K})_{\text{exp}}$ =0.0051 7 for doublet.
419.39 8	0.155 14	1973.97	7/2 ⁻	1554.876	9/2 ⁻				%I γ =0.0329 30
423.53 6	0.121 14	1070.77	7/2 ⁺	647.34	7/2 ⁺	M1		0.0630 9	%I γ =0.0257 30 $\alpha(\text{K})_{\text{exp}}$ =0.066 14.
^x 427.81 3	0.251 16					M1		0.0614 9	%I γ =0.0533 35

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) **1978Ba73,1978Bo39,1980Ba07** (continued)

$\gamma(^{169}\text{Yb})$ (continued)									Comments
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ ^a	α ^e	
432.27 7	0.118 13	1343.57	(7/2) ⁻	911.38	(5/2) ⁻	M1+E2	1.2 +45-7	0.040 13	$\alpha(\text{K})_{\text{exp}}=0.049$ 10. Placed by 1992Dz03 from 1071 level to an otherwise unknown 643 level deexcited only by two γ 's already placed elsewhere. %I γ =0.0250 28 $\alpha(\text{K})_{\text{exp}}=0.033$ 12. %I γ =0.062 9
^x 452.42 8	0.29 4								Placed by 1992Dz03 from 1071 level to an otherwise unknown 618 level deexcited by two γ 's already placed elsewhere. %I γ =0.647 32 A ₂ =+0.49 16 (1982Da23) δ : from 1980Bu24 ($\gamma\gamma(\theta)$). Other values: -0.09 9 (1982Da23 - nuclear orientation) , 0.5 4 from $\alpha(\text{K})_{\text{exp}}$ in 1978Ba73.
456.621 27	3.05 14	647.847	7/2 ⁻	191.216	5/2 ⁻	M1+E2	-0.24 +10-9	0.0502 15	$\alpha(\text{K})_{\text{exp}}=0.038$ 6. %I γ =0.042 11 $\alpha(\text{K})_{\text{exp}}=0.020$ 10. %I γ =0.098 11
466.93 21	0.20 5	1427.12	(7/2,9/2) ⁻	960.612	7/2 ⁻	(E2)		0.02128 30	I γ : deduced from total I γ =2.33 13 and requirement that I(470 γ from 570 level)/I(379 γ) and I(470 γ from 749 level)/I(360 γ) should be identical in ε decay and (n, γ) E=thermal.
470.47 ^g 3	0.46 ^g 5	569.837	5/2 ⁻	99.250	5/2 ⁻				$\alpha(\text{K})_{\text{exp}}=0.042$ 10 for doublet. %I γ =0.40 6 See comment on 470 γ from 570 level. %I γ =0.028 6 $\alpha(\text{K})_{\text{exp}}=0.036$ 18. %I γ =0.144 17 $\alpha(\text{K})_{\text{exp}}=0.050$ 8. %I γ =0.134 7 $\alpha(\text{K})_{\text{exp}}=0.038$ 7. %I γ =0.149 7 $\alpha(\text{K})_{\text{exp}}=0.032$ 7. %I γ =0.127 15 $\alpha(\text{K})_{\text{exp}}=0.045$ 7. %I γ =0.042 21 $\alpha(\text{K})_{\text{exp}}=0.043$ 25. %I γ =0.125 19 I γ : combined value for 502.8 γ +505.4 γ . %I γ =0.125 19
470.47 ^g 3	1.87 ^g 26	748.923	(9/2) ⁻	278.594	7/2 ⁻	M1		0.0479 7	
476.38 15	0.13 3	1283.282	(7/2,9/2) ⁻	807.079	(7/2) ⁻				
480.00 8	0.68 8	1070.77	7/2 ⁺	590.67	(5/2) ⁺	(M1)		0.0455 6	
482.84 4	0.63 3	569.837	5/2 ⁻	86.927	3/2 ⁻	M1		0.0448 6	
484.65 4	0.70 3	748.923	(9/2) ⁻	264.272	9/2 ⁻	(M1)		0.0444 6	
489.25 6	0.60 7	1449.781	7/2 ⁻	960.612	7/2 ⁻	M1		0.0433 6	
^x 492.25 26	0.20 10								
502.8 3	0.59 9	1463.412	7/2 ⁻	960.612	7/2 ⁻	[M1,E2]		0.029 11	
505.10 17	0.59 9	748.923	(9/2) ⁻	243.827	7/2 ⁻	M1		0.0399 6	

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) [1978Ba73](#),[1978Bo39](#),[1980Ba07](#) (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ ^a	α ^e	Comments
									$\alpha(\text{K})_{\text{exp}} \geq 0.028$ 9. For 505.4 γ +502.8 γ ; component from 1463 level, suggested by 1978Ba73, very weak. Relative branching from 749 level in $^{168}\text{Yb}(\text{n},\gamma)$ E=thermal imply more than $I_\gamma=0.59$ intensity here from this level if all I_γ for a 505.4 γ in that data set deexcites the 749 level and evaluator presumes that the 504 γ is a doublet in that reaction. I_γ : combined value for 502.8 γ +505.4 γ . $\%I_\gamma=0.0170$ 32 $\alpha(\text{K})_{\text{exp}}=0.0096$ 28 for doublet. E_γ : from Adopted Gammas. $\%I_\gamma=0.045$ 6 I_γ : deduced from total $I_\gamma(520\gamma)=0.293$ 25 and $I_\gamma=0.080$ 15 for 591-level placement. $\alpha(\text{K})_{\text{exp}}=0.0096$ 28 for doublet dominated by this transition. $\%I_\gamma=0.042$ 21 Alternative placement from 1177 level, as suggested by 1980Ba07 and 1993Dz02, not likely. Relative branching from 920 level in $^{168}\text{Yb}(\text{n},\gamma)$ E=thermal require more than $I_\gamma=0.20$ here. $\alpha(\text{K})_{\text{exp}}=0.043$ 25. $\%I_\gamma=0.085$ 13 $\%I_\gamma=0.066$ 9 $\alpha(\text{K})_{\text{exp}}=0.045$ 10. $\%I_\gamma=0.333$ 22 $A_2=-0.011$ 95 (1982Da23) $\alpha(\text{K})_{\text{exp}}=0.027$ 3. $\%I_\gamma=0.310$ 18 $A_2=-0.54$ 12 (1982Da23) $\alpha(\text{K})_{\text{exp}}=0.027$ 3. $\%I_\gamma=0.064$ 32 $\alpha(\text{K})_{\text{exp}}=0.024$ 14. $\%I_\gamma=0.089$ 7 I_γ : deduced from total $I_\gamma=0.533$ 16 and $I_\gamma=0.115$ 26 for 659.6-level placement. Mult., δ : M1+E2, $\delta=1.1$ 3 from $\alpha(\text{K})_{\text{exp}}=0.021$ 2 for doublet dominated by this transition;
519.788 ^{g@} 15	0.080 ^{g&} 15	590.67	(5/2) ⁺	70.880	9/2 ⁺	[E2]		0.01617 23	
520.02 ^g 6	0.21 ^g 3	1167.74	(7/2,9/2) ⁻	647.847	7/2 ⁻	(E2)		0.01615 23	
529.7 5	0.20 10	919.80	(9/2) ⁻	389.523	9/2 ⁻	(M1)		0.0353 5	
539.37 15 542.91 13	0.40 6 0.31 4	929.17 807.079	11/2 ⁻ (7/2) ⁻	389.523 264.272	9/2 ⁻ 9/2 ⁻	(M1)		0.0331 5	
545.43 7	1.57 10	707.03	9/2 ⁺	161.645	11/2 ⁺	M1+E2	-0.12 ^c 7	0.0325 6	
548.70 5	1.46 8	647.847	7/2 ⁻	99.250	5/2 ⁻	M1+E2	+0.53 ^c +13-10	0.0283 16	
^x 550.2 3	0.30 15								
560.73 ^g 7	0.42 ^{g&} 3	647.847	7/2 ⁻	86.927	3/2 ⁻	(E2)		0.01340 19	

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) **1978Ba73,1978Bo39,1980Ba07** (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ ^a	α ^e	Comments
560.73 ^g 7	0.115 ^{g&} 26	659.52	3/2 ⁻	99.250	5/2 ⁻	(M1)		0.0305 4	other component is known from (n, γ) to have $\alpha(\text{K})_{\text{exp}} > \alpha(\text{K})(\text{M1})$ so mult=E2(+M1) is likely for this transition. An M1 component would be inconsistent with level scheme. %I γ =0.024 6 Mult.: from Adopted Gammas. $\alpha(\text{K})_{\text{exp}}$ =0.021 2 for doublet (1978Ba73).
563.243 15	1.71 10	807.079	(7/2) ⁻	243.827	7/2 ⁻	(E2)		0.01326 19	%I γ =0.363 22 E γ : from Adopted Gammas. E γ =562.98 5 in 1978Ba73 .
569.79 4	0.62 3	569.837	5/2 ⁻	0.0	7/2 ⁺	[E1]		0.00457 6	$\alpha(\text{K})_{\text{exp}}$ =0.0140 15. %I γ =0.132 7
572.59 12	0.46 6	659.52	3/2 ⁻	86.927	3/2 ⁻	M1+E2	-0.7 ^c +4-6	0.024 5	$\alpha(\text{K})_{\text{exp}}$ =0.008 4. %I γ =0.098 13 A ₂ =+0.48 35 (1982Da23)
576.42 4	3.01 25	647.34	7/2 ⁺	70.880	9/2 ⁺	M1+E2	+0.09 ^c 4	0.0283 4	$\alpha(\text{K})_{\text{exp}}$ =0.023 6. %I γ =0.64 5 A ₂ =+0.292 54 (1982Da23)
587.44 6	0.27 5	1658.10	5/2 ⁺	1070.77	7/2 ⁺	M1		0.0271 4	$\alpha(\text{K})_{\text{exp}}$ =0.025 3. %I γ =0.057 11 $\alpha(\text{K})_{\text{exp}}$ =0.023 5.
590.664 28	3.00 16	590.67	(5/2) ⁺	0.0	7/2 ⁺	M1+E2	+0.34 ^c +8-7	0.0252 8	Placement from 1992Dz03 ; based on energy. %I γ =0.64 4 A ₂ =+0.572 79 (1982Da23)
613.9 3	0.15 8	1204.55		590.67	(5/2) ⁺				$\alpha(\text{K})_{\text{exp}}$ =0.024 3. %I γ =0.032 17 $\alpha(\text{K})_{\text{exp}}$ =0.015 11.
617.682 25	1.01 8	1449.781	7/2 ⁻	832.085	(7/2) ⁺	E1		0.00386 5	Placement from 1993Dz02 . %I γ =0.214 17 $\alpha(\text{K})_{\text{exp}}$ =0.0040 22.
622.96 5	0.71 6	722.21	5/2 ⁻	99.250	5/2 ⁻	M1(+E2)		0.017 6	%I γ =0.151 13 A ₂ =-0.58 26 (1982Da23)
^x 632.8 3	0.20 10								Mult.: $\alpha(\text{K})_{\text{exp}}$ consistent with pure M1; -0.10 $\leq\delta\leq$ +2.07 (nuclear orientation, 1982Da23) suggests E2 admixture. $\alpha(\text{K})_{\text{exp}}$ =0.022 3. %I γ =0.042 21 $\alpha(\text{K})_{\text{exp}}$ =0.012 8.
633.071 [@] 20	0.34 ^{&} 4	911.38	(5/2) ⁻	278.594	7/2 ⁻				1978Ba73 proposed placement from 720 level, but transition is not seen in ¹⁶⁸ Yb(n, γ) E=thermal despite intense population of the 720 level in that reaction. %I γ =0.072 9

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) [1978Ba73,1978Bo39,1980Ba07](#) (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ^a	α^e	Comments
635.410 ^f 15	<1.3 ^f	659.52	3/2 ⁻	24.210	1/2 ⁻	M1		0.02218 31	$\alpha(\text{K})_{\text{exp}}=0.012$ 8. I_γ : other: 0.20 10 from 1978Ba73 . E_γ : from Adopted Gammas. I_γ : deduced from $I_\gamma(635.4\gamma+636.1\gamma)=2.72$ 9 and $I_\gamma(636.1\gamma)=2.1$ 7. $\alpha(\text{K})_{\text{exp}}>0.03$ from $I(\text{ce}(\text{K}))$ (1978Ba73) and I_γ here.
635.410 ^f 15	<1.3 ^f	722.21	5/2 ⁻	86.927	3/2 ⁻	M1		0.02218 31	E_γ : from Adopted Gammas.
636.11 @ 7	2.1 & 7	707.03	9/2 ⁺	70.880	9/2 ⁺	E2(+M1)		0.016 6	% $I_\gamma=0.45$ 15 E_γ : from Adopted Gammas. Mult., δ : $\alpha(\text{K})_{\text{exp}}=0.008$ from $I(\text{ce}(\text{K}))$ (1978Ba73) and I_γ here, implies dominant E2 component.
642.65 8	0.24 4	1449.781	7/2 ⁻	807.079	(7/2) ⁻	(M1)		0.02156 30	% $I_\gamma=0.051$ 9 $\alpha(\text{K})_{\text{exp}}=0.036$ 11.
647.33 18	1.23 9	647.34	7/2 ⁺	0.0	7/2 ⁺	M1+E2	+0.5 ^c +6-4	0.019 4	% $I_\gamma=0.261$ 20 $A_2=-0.59$ 15 (1982Da23) $\alpha(\text{K})_{\text{exp}}=0.016$ 2.
649.72 12	0.24 3	748.923	(9/2) ⁻	99.250	5/2 ⁻				% $I_\gamma=0.051$ 6 $\alpha(\text{K})_{\text{exp}}\leq 0.012$.
655.61 13	0.69 8	919.80	(9/2) ⁻	264.272	9/2 ⁻	(M1)		0.02049 29	% $I_\gamma=0.146$ 17 $\alpha(\text{K})_{\text{exp}}=0.0164$ 23.
657.86 30	0.81 10	1406.35	9/2 ⁻	748.923	(9/2) ⁻				% $I_\gamma=0.172$ 21 $\alpha(\text{K})_{\text{exp}}\geq 0.016$ 9. I_γ : combined intensity for 657.9 γ +660.5 γ .
657.9 ^{#h} 3		929.17	11/2 ⁻	269.628	13/2 ⁺	(E1) [#]		0.00338 5	I_γ : 0.81 10 for 657.9 γ +660.5 γ doublet.
660.5 ^{f‡h} 5	0.81 ^f 10	851.7?	3/2 ⁻	191.216	5/2 ⁻	M1+E2	1.3 7	0.013 4	% $I_\gamma=0.172$ 21 I_γ : combined intensity for 657.9 γ +660.5 γ .
664.69 ^{f‡} 8	0.52 ^f 5	929.17	11/2 ⁻	264.272	9/2 ⁻	[E2(+M1)]		0.014 5	% $I_\gamma=0.110$ 11 $\alpha(\text{K})_{\text{exp}}=0.009$ 3 (1978Ba73) (mult.=E2(+M1)) for doubly-placed γ .
664.69 ^{f‡} 8	0.52 ^f 5	1427.12	(7/2,9/2) ⁻	761.822	(5/2) ⁺				% $I_\gamma=0.110$ 11 $\alpha(\text{K})_{\text{exp}}=0.009$ 3 (1978Ba73) (mult.=E2(+M1)) for doubly-placed γ .
667.59 7	0.31 5	911.38	(5/2) ⁻	243.827	7/2 ⁻	M1		0.01958 27	% $I_\gamma=0.066$ 11
670.39 3	0.90 9	832.085	(7/2) ⁺	161.645	11/2 ⁺	E2		0.00878 12	% $I_\gamma=0.191$ 19 $\alpha(\text{K})_{\text{exp}}=0.0079$ 27.
675.90 11	0.32 4	919.80	(9/2) ⁻	243.827	7/2 ⁻	M1		0.01898 27	% $I_\gamma=0.068$ 9 $\alpha(\text{K})_{\text{exp}}=0.022$ 8.
682.12 28	0.09 4	960.612	7/2 ⁻	278.594	7/2 ⁻				% $I_\gamma=0.019$ 8 $\alpha(\text{K})_{\text{exp}}=0.007$ 4.

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) ¹⁹⁷⁸Ba73,¹⁹⁷⁸Bo39,¹⁹⁸⁰Ba07 (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ^a	α^e	Comments
687.93 4	1.15 6	1449.781	7/2 ⁻	761.822	(5/2) ⁺	(E1(+M2))	+0.01 ^c 8	0.0031 4	%I γ =0.244 13 A ₂ =+0.31 14 (1982Da23) Mult.: from nuclear orientation, with $\Delta\pi$ =yes from decay scheme.
690.87 3	2.05 10	761.822	(5/2) ⁺	70.880	9/2 ⁺	(E2)		0.00820 11	%I γ =0.435 23 $\alpha(\text{K})\text{exp}$ =0.0078 7.
701.04 24	0.25 5	1449.781	7/2 ⁻	748.923	(9/2) ⁻				%I γ =0.053 11
703.33 10	0.52 6	1781.696	7/2 ⁻	1078.335	9/2 ⁻	M1		0.01717 24	%I γ =0.110 13 $\alpha(\text{K})\text{exp}$ =0.019 7.
707.94 6	1.48 9	807.079	(7/2) ⁻	99.250	5/2 ⁻	M1+E2	+0.30 ^c 13	0.0161 7	%I γ =0.314 20 A ₂ =-0.23 19 (1982Da23) $\alpha(\text{K})\text{exp}$ =0.016 4.
720.00 8	0.89 8	720.00	3/2 ⁺	0.0	7/2 ⁺	E2		0.00747 10	%I γ =0.189 17 $\alpha(\text{K})\text{exp}$ =0.0077 10.
725.07 7	1.40 7	886.80	9/2 ⁺	161.645	11/2 ⁺	M1+E2	1.06 +27-21	0.0114 10	%I γ =0.297 16 Mult., δ : from $\alpha(\text{K})\text{exp}$ =0.0095 8.
728.73 6	1.04 6	1689.290	7/2 ⁻	960.612	7/2 ⁻	(M1)		0.01570 22	%I γ =0.221 13 $\alpha(\text{K})\text{exp}$ =0.0155 16.
760.95@ 4	0.9 5	832.085	(7/2) ⁺	70.880	9/2 ⁺	M1+E2	0.76 +29-25	0.0114 12	%I γ =0.19 11 E γ : from Adopted Gammas. E γ =761.35 3 in 1978Ba73 .
761.864@ 25	2.2& 4	761.822	(5/2) ⁺	0.0	7/2 ⁺	M1+E2	0.76 +28-25	0.0113 12	I γ : deduced from I γ (761.0 γ +761.9 γ)=3.11 26 and I γ (761.9 γ)=2.2 4. Mult., δ : from $\alpha(\text{K})\text{exp}$ =0.0095 10 for doublet.
767.55 4	1.46 12	929.17	11/2 ⁻	161.645	11/2 ⁺	E1+M2	-0.17 ^c +12-10	0.0034 14	%I γ =0.47 8 E γ : from Adopted Gammas. E γ =761.35 3 in 1978Ba73 .
782.6 [‡] 3	0.20 10	1061.2	(11/2 ⁻)	278.594	7/2 ⁻				Mult., δ : from $\alpha(\text{K})\text{exp}$ =0.0095 10 for doublet. %I γ =0.310 26 A ₂ =-0.347 76 (1982Da23) $\alpha(\text{K})\text{exp}$ =0.0029 4.
^x 792.5 5	0.10 5								%I γ =0.042 21 $\alpha(\text{K})\text{exp}$ =0.032 20.
796.93 7	0.34 7	1444.75	7/2 ⁻ ,9/2 ⁻	647.847	7/2 ⁻	E2		0.00597 8	%I γ =0.021 11 $\alpha(\text{K})\text{exp}$ =0.039 27.
802.34 4	1.13 9	1449.781	7/2 ⁻	647.34	7/2 ⁺				%I γ =0.072 15 $\alpha(\text{K})\text{exp}$ =0.0049 13.
815.95 4	0.91 4	886.80	9/2 ⁺	70.880	9/2 ⁺	M1+E2	-0.80 ^c +17-24	0.0094 8	%I γ =0.240 20 $\alpha(\text{K})\text{exp}$ ≤0.004. %I γ =0.193 9

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) [1978Ba73,1978Bo39,1980Ba07](#) (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ^a	α^e	Comments
									$A_2=+0.13$ 10 (1982Da23) $\alpha(\text{K})_{\text{exp}}=0.0084$ 9. %I γ =0.191 9 %I γ =0.287 12
817.6 [#] 4 821.18 4	0.90 [#] 4 1.35 5	1888.00 1781.696	(7/2 ⁺ ,9/2 ⁺) 7/2 ⁻	1070.77 960.612	7/2 ⁺ 7/2 ⁻	M1(+E2)	+0.13 ^c +31-13	0.0116 9	$A_2=-0.523$ 89 (1982Da23) $\alpha(\text{K})_{\text{exp}}=0.0118$ 10. %I γ =0.032 9 $\alpha(\text{K})_{\text{exp}}=0.015$ 5. %I γ =0.062 9 $\alpha(\text{K})_{\text{exp}}=0.0085$ 12.
824.70 17	0.15 4	911.38	(5/2) ⁻	86.927	3/2 ⁻	(M1)		0.01153 16	%I γ =0.032 9 $\alpha(\text{K})_{\text{exp}}=0.015$ 5.
832.01 9	0.29 4	832.085	(7/2) ⁺	0.0	7/2 ⁺	(M1)		0.01128 16	%I γ =0.062 9 $\alpha(\text{K})_{\text{exp}}=0.0085$ 12.
847.9 ^{zh} 7	0.10 5	2296.78?	5/2 ⁻ ,7/2 ⁻ ,9/2 ⁻	1449.781	7/2 ⁻	M1		0.01076 15	%I γ =0.021 11 $\alpha(\text{K})_{\text{exp}}=0.009$ 6.
857.15 [#] 24	0.15 8	1427.12	(7/2,9/2) ⁻	569.837	5/2 ⁻				%I γ =0.032 17 $\alpha(\text{K})_{\text{exp}}=0.012$ 8. The uncertainty allows the transition as either M1 or E2.
862.4 ^f 5	0.15 ^f 8	1781.696	7/2 ⁻	919.80	(9/2) ⁻				%I γ =0.032 17 $\alpha(\text{K})_{\text{exp}}=0.008$ 6 for doublet.
862.4 ^f 5	0.15 ^f 8	2029.87	7/2 ⁻	1167.74	(7/2,9/2) ⁻				%I γ =0.032 17 $\alpha(\text{K})_{\text{exp}}=0.008$ 6 for doublet.
875.9 ^f	0.15 ^f 8	1707.71	(7/2,9/2) ⁺	832.085	(7/2) ⁺				%I γ =0.032 17 $\alpha(\text{K})_{\text{exp}}=0.012$ 8 for doublet.
875.9 ^f	0.15 ^f 8	1954.50	5/2 ⁻ ,7/2 ⁻	1078.335	9/2 ⁻				%I γ =0.032 17 $\alpha(\text{K})_{\text{exp}}=0.012$ 8 for doublet.
879.93 4	1.46 8	1449.781	7/2 ⁻	569.837	5/2 ⁻	M1+E2	-0.9 ^c 4	0.0076 12	%I γ =0.310 18 $A_2=+1.44$ 45 (1982Da23) $\alpha(\text{K})_{\text{exp}}=0.0086$ 9. %I γ =0.074 15
883.81 9	0.35 7	1954.50	5/2 ⁻ ,7/2 ⁻	1070.77	7/2 ⁺				Alternative placement from 1716 level, as suggested by 1978Ba73, not likely. Additional intensity to 832 level would make intensity balance there negative.
889.753 21	22.9 6	960.612	7/2 ⁻	70.880	9/2 ⁺	E1		1.86×10 ⁻³ 3	%I γ =4.86 15 $A_2=+0.179$ 43 (1982Da23) Mult.: E1 for 889.8 γ and 960.6 γ established by low $\alpha(\text{K})_{\text{exp}}$ from preliminary normalization. Adopted normalization of 1978Ba73 assumes pure E1 for both.

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) [1978Ba73,1978Bo39,1980Ba07](#) (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{‡d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ^a	α^e	Comments
									1982Da23 report $\delta=+0.018$ 29 for 889.8 γ (nuclear orientation). %I γ =0.13 4 $\alpha(\text{K})\text{exp}=0.006$ 3. %I γ =0.036 15 $\alpha(\text{K})\text{exp}=0.007$ 4. %I γ =0.110 15 $\alpha(\text{K})\text{exp}\leq 0.003$. %I γ =0.787 27 A ₂ =+0.149 41 (1982Da23) $\alpha(\text{K})\text{exp}=0.0014$ 3. %I γ =0.047 11 $\alpha(\text{K})\text{exp}=0.0043$ 20. %I γ =0.021 11 $\alpha(\text{K})\text{exp}\leq 0.028$. %I γ =0.064 32 $\alpha(\text{K})\text{exp}=0.0035$ 21 for doublet. %I γ =0.11 5 $\alpha(\text{K})\text{exp}=0.0042$ 23. %I γ =0.11 5 $\alpha(\text{K})\text{exp}=0.0042$ 23 for doublet. %I γ =21.2 5 A ₂ =-0.477 31 (1982Da23) Mult.: see comment with 889.8 γ .
895.82 11	0.61 21	1973.97	7/2 ⁻	1078.335	9/2 ⁻				1982Da23 report $\delta=+0.06$ +5-4 for 960.6 γ (nuclear orientation). %I γ =0.110 11 $\alpha(\text{K})\text{exp}=0.0023$ 7. %I γ =0.159 17 $\alpha(\text{K})\text{exp}=0.0023$ 13. %I γ =0.049 15 $\alpha(\text{K})\text{exp}=0.0068$ 25. %I γ =0.382 24 A ₂ =+1.00 12 (1982Da23) Mult., δ : from $\alpha(\text{K})\text{exp}=0.0037$ 5 (1978Ba73). Sign from +1.3 6 (1982Da23 - nuclear orientation).
903.42 23	0.17 7	1167.74	(7/2,9/2) ⁻	264.272	9/2 ⁻				%I γ =1.64 5 A ₂ =-0.391 31 (1982Da23) $\alpha(\text{K})\text{exp}=0.00137$ 10. %I γ =0.072 13 $\alpha(\text{K})\text{exp}=0.011$ 4.
908.64 7	0.52 7	1070.77	7/2 ⁺	161.645	11/2 ⁺				
916.710 29	3.71 11	1078.335	9/2 ⁻	161.645	11/2 ⁺	E1(+M2)	-0.010 ^c 27	0.00176 4	
^x 920.41 21	0.22 5					(E2)		0.00440 6	
926.6 5	0.10 5	1449.781	7/2 ⁻	523.066	11/2 ⁻				
934.5 5	0.30 15	1656.22	5/2 ⁻ ,7/2 ⁻ ,9/2 ⁻	722.21	5/2 ⁻				
939.7 ^f 5	0.50 ^f 25	1427.12	(7/2,9/2) ⁻	487.031	(11/2 ⁻)				
939.7 ^f 5	0.50 ^f 25	1463.412	7/2 ⁻	523.066	11/2 ⁻				
960.622 20	100 2	960.612	7/2 ⁻	0.0	7/2 ⁺	E1		1.61×10 ⁻³ 2	
979.79 [‡] 7	0.52 5	1141.44	(9/2) ⁺	161.645	11/2 ⁺	E2(+M1)		0.0057 18	
^x 984.09 14	0.75 8								
993.96 13	0.23 7	1954.50	5/2 ⁻ ,7/2 ⁻	960.612	7/2 ⁻	(M1)		0.00727 10	
999.96 7	1.80 11	1070.77	7/2 ⁺	70.880	9/2 ⁺	M1+E2	+1.9 5	0.0045 4	
1007.465 32	7.71 19	1078.335	9/2 ⁻	70.880	9/2 ⁺	E1+M2	-0.08 ^c 5	0.00158 17	
1013.08 10	0.34 6	1973.97	7/2 ⁻	960.612	7/2 ⁻	(M1)		0.00694 10	

¹⁶⁹Lu ε+β⁺ decay (34.06 h) **1978Ba73,1978Bo39,1980Ba07 (continued)**

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ^a	α^e	Comments
1015.4 [#] 4 1017.58 5	1.11 8	1177.01 1540.69	(7/2,9/2) ⁺ 9/2 ⁻	161.645 523.066	11/2 ⁺ 11/2 ⁻	M1		0.00686 10	Seen only in ce spectrum (1976Ba61). %I _γ =0.236 17 A ₂ =+0.88 16 (1982Da23) Mult.: M1+E2 with 0.41≤δ≤3.05 (nuclear orientation, 1982Da23). α(K)exp=0.0055 9. %I _γ =0.076 11 α(K)exp=0.0039 21. %I _γ =0.119 7
^x 1025.72 7	0.36 5								A ₂ =-0.22 25 (1982Da23) α(K)exp=0.0063 9. %I _γ =0.042 21 α(K)exp=0.023 13. %I _γ =0.138 11 A ₂ =-0.60 19 (1982Da23) α(K)exp=0.0047 7. %I _γ =0.074 26 α(K)exp=0.0036 20. %I _γ =1.73 7 A ₂ =+0.207 33 (1982Da23) α(K)exp=0.0052 5. %I _γ =0.425 35 α(K)exp=0.0063 8. %I _γ =0.289 18 Alternative placement from 1716.1 level, as suggested by 1978Ba73 and 1993Dz02, not likely. 1980Ba07 assign all intensity to this 1168-level placement on basis of cey coin data. α(K)exp=0.0029 15. %I _γ =0.363 18 A ₂ =+0.171 66 (1982Da23) Mult.: from α(K)exp=0.0367 26 (1978Ba73) and nuclear orientation (1982Da23). 1982Da23 report two solutions for δ(M1,E2) (-0.74 +11-13, +10 +50-5). α: estimated from α(K)exp (1978Ba73) and K/L for E0 transitions (2020Do01 - K/L=7.1 for 1197γ of ¹⁶⁸ Yb was used). %I _γ =1.02 7
1031.91 6	0.56 3	1554.876	9/2 ⁻	523.066	11/2 ⁻	M1+E2	-0.28 ^c +19-29	0.0064 6	
1037.49 [#] 13	0.20 10	1427.12	(7/2,9/2) ⁻	389.523	9/2 ⁻				
1043.20 8	0.65 5	1972.35	9/2 ⁻	929.17	11/2 ⁻	M1+E2	-1.1 ^c 7	0.0048 13	
1055.8 4	0.35 12	1888.00	(7/2 ⁺ ,9/2 ⁺)	832.085	(7/2) ⁺				
1060.28 4	8.16 27	1449.781	7/2 ⁻	389.523	9/2 ⁻	M1+E2	+0.036 ^c 22	0.00620 9	
1065.09 5	2.00 16	1343.57	(7/2) ⁻	278.594	7/2 ⁻	M1		0.00614 9	
1068.54 8	1.36 8	1167.74	(7/2,9/2) ⁻	99.250	5/2 ⁻				
1070.81 7	1.71 8	1070.77	7/2 ⁺	0.0	7/2 ⁺	E0+M1+E2		0.042 3	
1073.79 3	4.8 3	1463.412	7/2 ⁻	389.523	9/2 ⁻	M1+E2	+0.18 ^c 7	0.00593 11	

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) **1978Ba73,1978Bo39,1980Ba07** (continued)

$\gamma(^{169}\text{Yb})$ (continued)									Comments
E_γ [†]	I_γ ^{‡d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ ^a	α ^e	
1078.28 4	4.58 18	1078.335	9/2 ⁻	0.0	7/2 ⁺	E1(+M2)	-0.16 +6-8	0.0016 4	A ₂ =+0.409 94 (1982Da23) $\alpha(\text{K})_{\text{exp}}=0.0046$ 5. %I γ =0.97 4 A ₂ =+0.327 57 (1982Da23) δ : from $\alpha(\text{K})_{\text{exp}}=0.00139$ 20 (1978Ba73). sign from $\delta=-0.01$ 3 (1982Da23 – nuclear orientation). %I γ =0.091 15 $\alpha(\text{K})_{\text{exp}}<0.002$. %I γ =0.057 6 $\alpha(\text{K})_{\text{exp}}<0.003$. %I γ =0.138 13 A ₂ =-0.14 18 for spin 7/2 or -0.13 16 for spin 9/2 (1982Da23). Mult., δ : $\delta=-0.21$ +13-17 (if J(1177.0 level)=7/2) or $\delta=-0.41$ 22 (if J=9/2) (nuclear orientation, 1982Da23) suggests E2 admixture. However, $\alpha(\text{K})_{\text{exp}}$ value implies pure M1.
1088.23 8	0.43 7	1658.10	5/2 ⁺	569.837	5/2 ⁻				$\alpha(\text{K})_{\text{exp}}=0.0053$ 7. %I γ =0.168 9 A ₂ =-0.11 34 (1982Da23) $\alpha(\text{K})_{\text{exp}}=0.0049$ 8. %I γ =0.028 9 $\alpha(\text{K})_{\text{exp}}=0.010$ 5. %I γ =0.140 17 $\alpha(\text{K})_{\text{exp}}<0.0016$. Seen only in ce spectrum (1976Ba61). %I γ =0.170 15 $\alpha(\text{K})_{\text{exp}}=0.0016$ 6. %I γ =0.083 5 $\alpha(\text{K})_{\text{exp}}=0.0043$ 11. %I γ =0.037 5 $\alpha(\text{K})_{\text{exp}}=0.0054$ 20. %I γ =0.066 13 $\alpha(\text{K})_{\text{exp}}=0.0039$ 16. %I γ =0.049 25 %I γ =0.187 24 A ₂ =+0.18 34 (1982Da23) $\alpha(\text{K})_{\text{exp}}=0.0045$ 15. %I γ =0.047 9
1099.89 11	0.27 3	1343.57	(7/2) ⁻	243.827	7/2 ⁻				
1106.11 6	0.65 6	1177.01	(7/2,9/2) ⁺	70.880	9/2 ⁺	M1(+E2)		0.0043 13	
1109.99 7	0.79 4	2029.87	7/2 ⁻	919.80	(9/2) ⁻	M1+E2	-0.19 ^c +24-37	0.0055 5	
1117.61 [‡] 20	0.13 4	1204.55		86.927	3/2 ⁻				
1122.21 7	0.66 8	1954.50	5/2 ⁻ ,7/2 ⁻	832.085	(7/2) ⁺				
1127.1 [#] 6		1888.00	(7/2 ⁺ ,9/2 ⁺)	761.822	(5/2) ⁺				
^x 1133.44 5	0.80 7								
^x 1139.28 5	0.389 21					M1		0.00521 7	
1141.96 10	0.176 23	1406.35	9/2 ⁻	264.272	9/2 ⁻	M1		0.00518 7	
1146.92 13	0.31 6	1908.63	5/2 ⁺	761.822	(5/2) ⁺	(M1)		0.00513 7	
1148.0 [#] 6	0.23 [#] 12	1427.12	(7/2,9/2) ⁻	278.594	7/2 ⁻				
1151.70 7	0.88 11	1540.69	9/2 ⁻	389.523	9/2 ⁻	M1+E2	≥ 0.36 ^c	0.0038 10	
1156.03 16	0.22 4	1420.31	(5/2 ⁻ ,7/2,9/2 ⁻)	264.272	9/2 ⁻				

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) ¹⁹⁷⁸Ba73,¹⁹⁷⁸Bo39,¹⁹⁸⁰Ba07 (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ ^a	α ^e	Comments
1162.49 ^f 7	0.77 ^f 5	1406.35	9/2 ⁻	243.827	7/2 ⁻	M1		0.00496 7	%I γ =0.163 11 $\alpha(\text{K})_{\text{exp}}$ =0.0050 6 for doublet.
1162.49 ^f 7	0.77 ^f 5	1427.12	(7/2,9/2) ⁻	264.272	9/2 ⁻	M1		0.00496 7	%I γ =0.163 11 $\alpha(\text{K})_{\text{exp}}$ =0.0050 6 for doublet.
1165.21 11	0.73 5	1554.876	9/2 ⁻	389.523	9/2 ⁻	M1		0.00493 7	%I γ =0.155 11 $\alpha(\text{K})_{\text{exp}}$ =0.0039 13.
1171.20 4	3.43 11	1449.781	7/2 ⁻	278.594	7/2 ⁻	M1+E2	+0.22 ^c +74-15	0.0048 9	%I γ =0.728 27 A_2 =-0.562 77 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =0.0048 4.
1176.48 [#] 22	0.68 7	1420.31	(5/2 ⁻ ,7/2,9/2 ⁻)	243.827	7/2 ⁻				%I γ =0.144 15 I γ : combined value for 1176.5 γ +1177.7 γ . $\alpha(\text{K})_{\text{exp}}$ =0.0010 2 for doublet.
1177.7 [#] 4	0.68 7	1177.01	(7/2,9/2) ⁺	0.0	7/2 ⁺				%I γ =0.144 15 I γ : see comment with 1176.5 γ from 1420 level.
1180.45 6	0.81 9	1444.75	7/2 ⁻ ,9/2 ⁻	264.272	9/2 ⁻	M1(+E2)		0.0037 11	%I γ =0.172 19 A_2 =-0.489 91 (1982Da23) A_2 =-0.489 91 for spin 7/2 or -0.428 80 for spin 9/2 (1982Da23). Mult.: δ =-0.7 +2-10 (if J(1444.7 level)=7/2) or δ =+0.88 24 or -0.02 +16-11 (if J=9/2) (nuclear orientation, 1982Da23) suggests E2 admixture. $\alpha(\text{K})_{\text{exp}}$ implies no E2 admixture. $\alpha(\text{K})_{\text{exp}}$ =0.0049 12.
1184.875 24	9.5 4	1463.412	7/2 ⁻	278.594	7/2 ⁻	M1+E2	-0.15 ^c 7	0.00469 8	%I γ =2.02 9 A_2 =-0.312 64 (1982Da23) δ : other value: -0.10 +0-13 ($\gamma\gamma(\theta)$, 1980Bu24). $\alpha(\text{K})_{\text{exp}}$ =0.0042 3.
1199.10 6	0.96 8	1463.412	7/2 ⁻	264.272	9/2 ⁻	M1+E2	+0.22 ^c +25-19	0.00451 28	%I γ =0.204 17 A_2 =+0.47 28 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =0.0040 6.
1201.0 [#] 9		1444.75	7/2 ⁻ ,9/2 ⁻	243.827	7/2 ⁻				Seen only in ce spectrum (1976Ba61).
1206.00 4	2.15 14	1449.781	7/2 ⁻	243.827	7/2 ⁻	M1+E2	≥ 0.83 ^c	0.0031 6	%I γ =0.456 31 A_2 =+0.34 13 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =0.0043 5.
1212.52 8	2.04 16	1283.282	(7/2,9/2) ⁻	70.880	9/2 ⁺	E1(+M2)	-0.02 ^c 7	0.00109 8	%I γ =0.433 35 A_2 =+0.13 10 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =8.2 $\times 10^{-4}$ 7.
1215.28 11	0.45 4	1406.35	9/2 ⁻	191.216	5/2 ⁻				%I γ =0.096 9 $\alpha(\text{K})_{\text{exp}}$ ≤ 0.0035 .
1219.61 4	1.28 17	1463.412	7/2 ⁻	243.827	7/2 ⁻	M1+E2	-1.0 ^c +3-9	0.0035 5	%I γ =0.27 4

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) [1978Ba73,1978Bo39,1980Ba07](#) (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ ^a	α ^e	Comments
									$A_2=+0.28$ 13 (1982Da23) $\alpha(\text{K})\text{exp}=0.0064$ 11. %I γ =0.102 26
1223.07 ^f 8	0.48 ^f 12	1972.35	9/2 ⁻	748.923	(9/2) ⁻				%I γ =0.102 26
1223.07 ^f 8	0.48 ^f 12	2029.87	7/2 ⁻	807.079	(7/2) ⁻				%I γ =0.102 26
1244.24 12	0.32 4	1343.57	(7/2) ⁻	99.250	5/2 ⁻	M1		0.00422 6	%I γ =0.068 9 $\alpha(\text{K})\text{exp}=0.0045$ 11.
1251.74 25	0.28 9	1973.97	7/2 ⁻	722.21	5/2 ⁻	(E2)		2.38×10^{-3} 3	%I γ =0.059 19 $\alpha(\text{K})\text{exp}=0.0026$ 10.
1258.59 6	1.52 4	1449.781	7/2 ⁻	191.216	5/2 ⁻	M1		0.00411 6	%I γ =0.323 10 $\alpha(\text{K})\text{exp}=0.0031$ 6.
1260.86 6	1.36 8	1908.63	5/2 ⁺	647.847	7/2 ⁻				%I γ =0.289 18
1266.68 [#] 25	0.57 10	1656.22	5/2 ⁻ , 7/2 ⁻ , 9/2 ⁻	389.523	9/2 ⁻	E2		2.33×10^{-3} 3	%I γ =0.121 21 $A_2=+0.40$ 35 (1982Da23) Mult.: $-0.65\leq\delta\leq+3.30$ (nuclear orientation, 1982Da23) suggests little, if any, M1 admixture.
1272.46 6	2.91 14	1343.57	(7/2) ⁻	70.880	9/2 ⁺				$\alpha(\text{K})\text{exp}=0.0017$ 5. %I γ =0.618 32 $\alpha(\text{K})\text{exp}=0.0016$ 5.
1276.62 ^f 23	0.75 ^f 7	1540.69	9/2 ⁻	264.272	9/2 ⁻	M1		0.00397 6	%I γ =0.159 15 $\alpha(\text{K})\text{exp}=0.0038$ 11 for doublet.
1276.62 ^f 23	0.75 ^f 7	1554.876	9/2 ⁻	278.594	7/2 ⁻	M1		0.00397 6	%I γ =0.159 15 $\alpha(\text{K})\text{exp}=0.0038$ 11 for doublet.
1283.28 4	9.0 4	1283.282	(7/2, 9/2) ⁻	0.0	7/2 ⁺	E1(+M2)	-0.01 ^c +6-5	1.01×10^{-3} 3	%I γ =1.91 9 $A_2=-0.447$ 41 (1982Da23) $\alpha(\text{K})\text{exp}=7.3\times 10^{-4}$ 7.
1290.59 3	4.89 26	1554.876	9/2 ⁻	264.272	9/2 ⁻	M1+E2	0.8 +5-4	0.0032 4	%I γ =1.04 6 $A_2=-0.195$ 48 (1982Da23) δ : from $\alpha(\text{K})\text{exp}=0.0027$ 3 (1978Ba73). Other: -0.33 6 or +1.61 20 (1982Da23 - nuclear orientation).
1296.90 5	0.71 4	1540.69	9/2 ⁻	243.827	7/2 ⁻	M1+E2	0.9 +8-5	0.0031 5	$\alpha(\text{K})\text{exp}=0.0027$ 3. %I γ =0.151 9 δ : from $\alpha(\text{K})\text{exp}=0.0026$ 4.
1301.33 5	0.66 4	1565.65	(7/2) ⁻	264.272	9/2 ⁻	(M1)		0.00380 5	%I γ =0.140 9 $\alpha(\text{K})\text{exp}=0.0028$ 4.
1307.20 5	0.48 8	1406.35	9/2 ⁻	99.250	5/2 ⁻	E2		2.20×10^{-3} 3	%I γ =0.102 17 $\alpha(\text{K})\text{exp}=0.0016$ 4.
1311.13 7	0.28 5	1554.876	9/2 ⁻	243.827	7/2 ⁻	M1		0.00373 5	%I γ =0.059 11 $\alpha(\text{K})\text{exp}=0.0036$ 8.

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) **1978Ba73,1978Bo39,1980Ba07** (continued)

$\gamma(^{169}\text{Yb})$ (continued)

E_γ ^{$\dagger$}	I_γ ^{$\dagger d$}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^{a}	δ^a	α^e	Comments
1318.53 ^{f} 12	0.55 ^{f} 5	1708.52	7/2 ⁻	389.523	9/2 ⁻	(M1)		0.00368 5	%I γ =0.117 11 $\alpha(\text{K})\text{exp}$ =0.0029 9 for doublet.
1318.53 ^{f} 12	0.55 ^{f} 5	1908.63	5/2 ⁺	590.67	(5/2) ⁺	(M1)		0.00368 5	%I γ =0.117 11 $\alpha(\text{K})\text{exp}$ =0.0029 9 for doublet.
1321.53 ^{f} 16	0.33 ^{f} 3	1420.31	(5/2 ⁻ , 7/2, 9/2 ⁻)	99.250	5/2 ⁻				%I γ =0.070 6
1321.53 ^{f} 16	0.33 ^{f} 3	1565.65	(7/2 ⁻)	243.827	7/2 ⁻				%I γ =0.070 6
1326.85 ^{g} 3	2.54 ^{g}	1716.02	7/2 ⁺	389.523	9/2 ⁻	E1		9.81×10 ⁻⁴ 14	%I γ =0.539 10 I γ : cey coincidence data (1980Ba07) used to estimate I γ for each placement; I $\gamma(\text{exp})$ =3.02 8 for doublet.
									$\alpha(\text{K})\text{exp}$ =8.9×10 ⁻⁴ 33.
1326.85 ^{g} 3	0.48 ^{g}	1973.97	7/2 ⁻	647.34	7/2 ⁺	E1		9.81×10 ⁻⁴ 14	%I γ =0.1019 18
1338.82 4	6.93 21	1908.63	5/2 ⁺	569.837	5/2 ⁻	E1+M2	-0.04 ^{c} 3	9.85×10 ⁻⁴ 28	%I γ =1.47 5 A ₂ =-0.383 36 (1982Da23) $\alpha(\text{K})\text{exp}$ =8.5×10 ⁻⁴ 20.
1343.56 13	0.63 5	1343.57	(7/2) ⁻	0.0	7/2 ⁺				%I γ =0.134 11
1350.65 9	0.828 21	1449.781	7/2 ⁻	99.250	5/2 ⁻	M1+E2	-0.19 ^{c} +15-21	0.00344 15	%I γ =0.176 5 A ₂ =+0.66 26 (1982Da23) $\alpha(\text{K})\text{exp}$ =0.0037 6.
^x 1355.11 5	0.57 3					M1+E2	0.8 +6-4	0.0029 4	%I γ =0.121 7 δ : from $\alpha(\text{K})\text{exp}$ =0.0024 3.
1363.83 9	0.30 4	1554.876	9/2 ⁻	191.216	5/2 ⁻	E2		2.04×10 ⁻³ 3	%I γ =0.064 9 $\alpha(\text{K})\text{exp}$ =0.0018 6.
1367.56 ^{$\ddagger$} 7	0.64 4	2287.23	7/2 ⁻	919.80	(9/2) ⁻				%I γ =0.136 9
1374.53 8	0.90 4	1565.65	(7/2 ⁻)	191.216	5/2 ⁻	(M1)		0.00335 5	%I γ =0.191 9 $\alpha(\text{K})\text{exp}$ =0.0042 12.
1379.04 ^{g} 4	9.0 ^{g}	1449.781	7/2 ⁻	70.880	9/2 ⁺	E1		9.54×10 ⁻⁴ 13	%I γ =1.910 34 $\alpha(\text{K})\text{exp}$ =6.8×10 ⁻⁴ 11 for doublet. I γ : cey coincidence data (1980Ba07) used to estimate I γ for each placement; I γ =13.6 3 for doublet.
1379.04 ^{g} 4	4.6 ^{g}	1658.10	5/2 ⁺	278.594	7/2 ⁻	E1		9.54×10 ⁻⁴ 13	%I γ =0.976 17 $\alpha(\text{K})\text{exp}$ =0.0068 11 for doublet. See comment on 1379 γ from 1450 level.
1392.27 ^{g} 4	0.45 ^{g}	1656.22	5/2 ⁻ , 7/2 ⁻ , 9/2 ⁻	264.272	9/2 ⁻	E2		1.97×10 ⁻³ 3	%I γ =0.0955 17 I γ : cey coincidence data (1980Ba07) used to estimate I γ for each placement; I $\gamma(\text{exp})$ =5.56 12 for doublet. $\alpha(\text{K})\text{exp}$ =0.0017 3 for doublet.

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) **1978Ba73,1978Bo39,1980Ba07** (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ^a	α^e	Comments
1392.27 ^g 4	5.11 ^g	1781.696	7/2 ⁻	389.523	9/2 ⁻	E2		1.97×10 ⁻³ 3	%I γ =1.085 19 $\alpha(\text{K})_{\text{exp}}$ =0.0017 3 for doublet.
1406.23 5	0.96 4	1406.35	9/2 ⁻	0.0	7/2 ⁺	E1+M2	+0.38 ^c +2I-35	0.0018 8	%I γ =0.204 9 A ₂ =+0.15 24 (1982Da23) δ : from $\alpha(\text{K})_{\text{exp}}$ =0.0014 7 (1978Ba73). Sign from +0.08 13 nuclear orientation (1982Da23).
1412.39 10	0.49 5	1656.22	5/2 ⁻ , 7/2 ⁻ , 9/2 ⁻	243.827	7/2 ⁻	M1(+E2)	-0.08 ^c 18	0.00315 8	%I γ =0.104 11 A ₂ =+0.44 29 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =0.004 1.
^x 1419.68 13	0.18 4								%I γ =0.038 9
^x 1425.54 [‡] 22	0.27 6					M1		0.00309 4	%I γ =0.057 13 $\alpha(\text{K})_{\text{exp}}$ =0.0042 15. Placed by 1988DzZW from 1617 level, but absence of this γ in (n, γ) E=thermal (where many transitions from this level are observed) makes that placement unlikely. A γ of similar energy deexcites a 1555 level in (n, γ) E=thermal.
1429.87 9	1.33 8	1708.52	7/2 ⁻	278.594	7/2 ⁻	M1(+E2)	+0.02 ^c +18-13	0.00307 6	%I γ =0.282 18 A ₂ =-0.45 10 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =0.0035 6.
1437.43 4	2.67 9	1716.02	7/2 ⁺	278.594	7/2 ⁻	E1(+M2)	-0.07 ^c +9-8	0.00096 10	%I γ =0.567 22 A ₂ =-0.382 69 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =4.9×10 ⁻⁴ 16.
1449.74 4	42.4 9	1449.781	7/2 ⁻	0.0	7/2 ⁺	E1(+M2)	0.00 ^c 4	9.32×10 ⁻⁴ 16	%I γ =9.00 23 A ₂ =-0.435 30 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =5.3×10 ⁻⁴ 15.
1463.39 4	6.45 15	1463.412	7/2 ⁻	0.0	7/2 ⁺	E1(+M2)	+0.02 ^c +11-9	0.00093 9	%I γ =1.37 4 A ₂ =-0.449 74 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =8.1×10 ⁻⁴ 14.
1466.84 4	14.2 4	1658.10	5/2 ⁺	191.216	5/2 ⁻	E1(+M2)	-0.03 ^c 4	9.34×10 ⁻⁴ 26	%I γ =3.01 10 A ₂ =-0.395 40 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =8.5×10 ⁻⁴ 12.
1483.97 ^{‡h} 9	0.86 6	1554.876	9/2 ⁻	70.880	9/2 ⁺	[E1]		9.25×10 ⁻⁴ 13	%I γ =0.183 13 Mult.: $\alpha(\text{K})_{\text{exp}}$ =0.0015 4 (1978Ba73) favors mult=E2, inconsistent with this placement. Consequently, the evaluator shows the placement as uncertain.

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) **1978Ba73,1978Bo39,1980Ba07 (continued)**

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ ^a	α ^e	Comments
1487.21 24	0.155 20	1973.97	7/2 ⁻	487.031	(11/2 ⁻)				%I γ =0.033 4
1497.92 4	1.20 5	1689.290	7/2 ⁻	191.216	5/2 ⁻	M1+E2	+0.24 ^c 6	0.00273 5	%I γ =0.255 12 A ₂ =-0.12 11 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =0.0017 5. %I γ =0.195 11 A ₂ =-0.461 62 (1982Da23) Multipolarity cannot be determined with available data ($\alpha(\text{K})_{\text{exp}}$ =0.0020 6; δ =+0.03 +10-8 or +1.03 18 from nuclear orientation (1982Da23)).
1502.89 6	0.92 5	1781.696	7/2 ⁻	278.594	7/2 ⁻				
1517.31 4	2.33 13	1708.52	7/2 ⁻	191.216	5/2 ⁻	M1+E2	-5.9 ^c +7-9	1.75×10 ⁻³ 3	%I γ =0.495 29 A ₂ =+0.244 44 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =0.0013 3.
1524.77 5	2.19 11	1716.02	7/2 ⁺	191.216	5/2 ⁻	E1(+M2)	+0.03 ^c 4	9.26×10 ⁻⁴ 24	%I γ =0.465 25 A ₂ =+0.263 83 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =5.4×10 ⁻⁴ 14.
1529.87 [‡] 4	1.92 6	1616.80	(1/2 ⁺ , 3/2, 5/2 ⁺)	86.927	3/2 ⁻				%I γ =0.408 15
1540.63 15	0.17 4	1540.69	9/2 ⁻	0.0	7/2 ⁺				%I γ =0.036 9
1547.69 ^{‡h} 18	0.23 3	2296.78?	5/2 ⁻ , 7/2 ⁻ , 9/2 ⁻	748.923	(9/2 ⁻)				%I γ =0.049 6
1554.4 ^f 5	0.46 ^f 11	1554.876	9/2 ⁻	0.0	7/2 ⁺				%I γ =0.098 23
1554.4 ^f 5	0.46 ^f 11	1716.02	7/2 ⁺	161.645	11/2 ⁺				%I γ =0.098 23
1556.7 4	0.24 4	1656.22	5/2 ⁻ , 7/2 ⁻ , 9/2 ⁻	99.250	5/2 ⁻				%I γ =0.051 9
^x 1568.66 18	0.11 3								%I γ =0.023 6 $\alpha(\text{K})_{\text{exp}}$ =0.0043 25.
^x 1575.76 7	0.37 3								%I γ =0.079 7 $\alpha(\text{K})_{\text{exp}}$ =0.0024 9.
^x 1584.70 9	0.60 5								%I γ =0.127 11 $\alpha(\text{K})_{\text{exp}}$ =0.0012 5.
1590.35 5	2.05 8	1781.696	7/2 ⁻	191.216	5/2 ⁻	M1+E2	+0.117 ^c 23	2.45×10 ⁻³ 4	%I γ =0.435 19 A ₂ =-0.104 43 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =0.0020 5.
1595.89 23	0.097 23	1694.48	5/2 ⁺	99.250	5/2 ⁻				%I γ =0.021 5 $\alpha(\text{K})_{\text{exp}}$ =0.0028 17.
1607.51 6	0.289 23	1694.48	5/2 ⁺	86.927	3/2 ⁻	E1(+M2)	+0.04 ^c 18	0.00093 20	%I γ =0.061 5 A ₂ =+0.31 33 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =5.4×10 ⁻⁴ 20.
1618.48 4	3.04 7	1689.290	7/2 ⁻	70.880	9/2 ⁺	E1(+M2)	+0.04 ^c 6	0.00093 4	%I γ =0.645 19 A ₂ =+0.209 90 (1982Da23) $\alpha(\text{K})_{\text{exp}}$ =6.0×10 ⁻⁴ 16.
^x 1626.12 14	0.098 20								%I γ =0.021 4

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) [1978Ba73,1978Bo39,1980Ba07](#) (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ^a	α^e	Comments
1630.02 ¹³	0.28 ⁵	1908.63	5/2 ⁺	278.594	7/2 ⁻				%I γ =0.059 ¹¹
1636.82 ⁸	0.94 ⁴	1707.71	(7/2,9/2) ⁺	70.880	9/2 ⁺	M1+E2		0.0019 ⁴	%I γ =0.200 ⁹ A ₂ =+0.437 88 for spin 7/2 or +0.382 77 for spin 9/2 (1982Da23). Mult.: restricted to M1+E2 by $\alpha(\text{K})_{\text{exp}}$ and two δ values (both large) +10 +18-4 (if J(1707.8 level)=7/2 or -2.8 +15-158 (if J=9/2)) (nuclear orientation, 1982Da23). $\alpha(\text{K})_{\text{exp}}=9\times 10^{-4}$ 5.
1645.14 ⁸	0.339 ²¹	1716.02	7/2 ⁺	70.880	9/2 ⁺	M1+E2	+0.34 ^c +21-15	0.00223 ¹⁰	%I γ =0.072 ⁵ A ₂ =+0.62 ¹⁹ (1982Da23) $\alpha(\text{K})_{\text{exp}}=0.0025$ 11.
1658.08 ⁵	3.39 ⁸	1658.10	5/2 ⁺	0.0	7/2 ⁺	M1+E2	+0.28 ^c 11	0.00222 ⁵	%I γ =0.720 ²¹ A ₂ =+0.51 ¹² (1982Da23) $\alpha(\text{K})_{\text{exp}}=0.0020$ 4.
^x 1671.60 ¹⁰	0.234 ²²								%I γ =0.050 ⁵ $\alpha(\text{K})_{\text{exp}}=0.0024$ 12.
1676.46 ⁸	0.378 ¹⁸	1954.50	5/2 ⁻ , 7/2 ⁻	278.594	7/2 ⁻	M1		2.23×10 ⁻³ ³	%I γ =0.080 ⁴ $\alpha(\text{K})_{\text{exp}}=0.0024$ 7.
1682.49 ⁵	1.25 ¹³	1781.696	7/2 ⁻	99.250	5/2 ⁻	M1+E2	+0.53 ^c +8-6	0.00206 ⁵	%I γ =0.265 ²⁸ A ₂ =-0.439 75 (1982Da23) $\alpha(\text{K})_{\text{exp}}=0.0024$ 7.
1689.35 ⁵	2.23 ¹¹	1689.290	7/2 ⁻	0.0	7/2 ⁺	E1(+M2)	-0.03 ^c 7	0.00093 ⁴	%I γ =0.473 ²⁵ A ₂ =-0.415 55 (1982Da23) $\alpha(\text{K})_{\text{exp}}=6.3\times 10^{-4}$ 20.
1694.38 ¹⁴	0.186 ¹³	1694.48	5/2 ⁺	0.0	7/2 ⁺	(M1)		2.19×10 ⁻³ ³	%I γ =0.0395 ²⁸ $\alpha(\text{K})_{\text{exp}}=0.0038$ 9.
^x 1702 ¹	0.10 ⁵								%I γ =0.021 ¹¹
1707.97 ⁸ ⁹	0.91 ⁸ ¹	1707.71	(7/2,9/2) ⁺	0.0	7/2 ⁺	(M1+E2)		0.00181 ³⁵	%I γ =0.193 ⁴ I γ : cey coincidence data (1980Ba07) used to estimate I γ for each placement; I $\gamma(\text{exp})$ =1.86 26 for doublet. $\alpha(\text{K})_{\text{exp}}=0.0012$ 4 for doublet.
1707.97 ⁸ ⁹	0.95 ⁸	1972.35	9/2 ⁻	264.272	9/2 ⁻	(M1+E2)		0.00181 ³⁵	%I γ =0.202 ⁴
1710.17 ¹⁰	1.2 ³	1973.97	7/2 ⁻	264.272	9/2 ⁻				%I γ =0.25 ⁶
1717.41 ⁶	0.48 ⁴	1908.63	5/2 ⁺	191.216	5/2 ⁻				%I γ =0.102 ⁹
1726.30 ⁹	0.26 ³	1888.00	(7/2 ⁺ , 9/2 ⁺)	161.645	11/2 ⁺				%I γ =0.055 ⁶
1730.8 ⁶	0.09 ⁵	1973.97	7/2 ⁻	243.827	7/2 ⁻				%I γ =0.019 ¹¹ $\alpha(\text{K})_{\text{exp}}=0.005$ 3.

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) ¹⁹⁷⁸Ba73,¹⁹⁷⁸Bo39,¹⁹⁸⁰Ba07 (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	E_i (level)	J_i^π	E_f	J_f^π	Mult. ^a	δ^a	α^e	Comments
^x 1737.03 26	0.180 23								%I γ =0.038 5 α (K)exp<0.005.
^x 1746.78 14	0.27 4					M1		2.08×10 ⁻³ 3	%I γ =0.057 9 α (K)exp=0.0038 16 (¹⁹⁷⁸ Ba73). Placed by ¹⁹⁸⁸ DzZW from 1909 level, but adopted $J^\pi=5/2^+$ for that level would imply an M3 transition.
1751.2 4	0.058 14	2029.87	7/2 ⁻	278.594	7/2 ⁻				%I γ =0.0123 30
1763.35 5	0.79 4	1954.50	5/2 ⁻ , 7/2 ⁻	191.216	5/2 ⁻	M1(+E2)		0.00173 32	%I γ =0.168 9 A ₂ =+0.32 13 for spin 7/2 or +0.30 12 for spin 5/2 (¹⁹⁸² Da23). Mult.: $\delta=-0.8+2-4$ (if J(1954.6 level)=5/2) or $\delta=0.00$ 7 (if J=7/2) (nuclear orientation, ¹⁹⁸² Da23) suggests E2 admixture.
1781.75 5	4.01 11	1781.696	7/2 ⁻	0.0	7/2 ⁺	E1+M2	+0.08 ^c +6-5	0.00097 4	α (K)exp=0.0021 6. %I γ =0.851 28 A ₂ =-0.490 35 (¹⁹⁸² Da23)
^x 1790.55 10	0.262 11								α (K)exp=6.2×10 ⁻⁴ 13. %I γ =0.0556 25
1810.64 13	0.104 18	1972.35	9/2 ⁻	161.645	11/2 ⁺				α (K)exp=0.0011 6.
1817.12 7	0.145 10	1888.00	(7/2 ⁺ , 9/2 ⁺)	70.880	9/2 ⁺				%I γ =0.022 4 %I γ =0.0308 22 α (K)exp=0.0029 15.
1822.42 [‡] 11	0.150 10	2101.03	(5/2, 7/2) ⁻	278.594	7/2 ⁻				%I γ =0.0318 22 α (K)exp=0.00063 22; consistent with E1 or E2.
^x 1833.41 11	0.133 10								%I γ =0.0282 22
1838.30 8	0.150 9	2029.87	7/2 ⁻	191.216	5/2 ⁻				%I γ =0.0318 20
^x 1850.87 10	0.102 20								%I γ =0.022 4
^x 1862.44 9	0.626 24								%I γ =0.133 6 α (K)exp=0.0010 5.
^x 1867.06 12	0.086 7								%I γ =0.0183 15 α (K)exp=0.0013 5.
1897.60 [‡] 10	0.137 8	2287.23	7/2 ⁻	389.523	9/2 ⁻	M1		1.83×10 ⁻³ 3	%I γ =0.0291 18 α (K)exp=0.0048 12.
1903.04 5	0.308 16	1973.97	7/2 ⁻	70.880	9/2 ⁺	(E1(+M2))	+0.08 ^c 15	0.00100 12	%I γ =0.065 4 A ₂ =+0.27 21 (¹⁹⁸² Da23) Placement from ¹⁹⁸² Da23. Mult.: from nuclear orientation, with $\Delta\pi$ =yes from decay scheme.

¹⁶⁹Lu $\varepsilon+\beta^+$ decay (34.06 h) **1978Ba73,1978Bo39,1980Ba07** (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^{†d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ^a	α^e	Comments
1908.46 6	0.354 20	1908.63	5/2 ⁺	0.0	7/2 ⁺	(M1,E2)		0.00156 26	%I γ =0.075 4 A ₂ =+0.13 24 (1982Da23) δ : 1982Da23 (nuclear orientation) report δ =0.00 18 or $\delta \geq 3.0$. $\alpha(\text{K})_{\text{exp}}$ =0.0014 5. %I γ =0.0089 21 %I γ =0.0221 20 %I γ =0.0106 17 %I γ =0.0391 26
^x 1916.1 4	0.042 10								%I γ =0.250 10
^x 1920.81 17	0.104 9								A ₂ =+0.199 64 (1982Da23)
^x 1947.33 22	0.050 8								Mult.: from nuclear orientation, with $\Delta\pi$ =yes from decay scheme.
1954.48 9	0.184 12	1954.50	5/2 ⁻ , 7/2 ⁻	0.0	7/2 ⁺				$\alpha(\text{K})_{\text{exp}}$ =0.0010 3.
1959.24 9	1.18 4	2029.87	7/2 ⁻	70.880	9/2 ⁺	(E1(+M2))	+0.03 ^c 4	1.00×10 ⁻³ 2	%I γ =0.0310 22 %I γ =0.257 10 A ₂ =-0.426 65 (1982Da23) Mult.: from nuclear orientation, with $\Delta\pi$ =yes from decay scheme.
^x 1969.80 20	0.146 10								$\alpha(\text{K})_{\text{exp}}$ =7×10 ⁻⁴ 4.
1973.68 6	1.21 4	1973.97	7/2 ⁻	0.0	7/2 ⁺	(E1+M2)	-0.13 ^c +9-8	0.00104 6	%I γ =0.0906 34 $\alpha(\text{K})_{\text{exp}}$ =0.00073 21.
^x 1985.08 12	0.427 14								%I γ =0.0287 34 $\alpha(\text{K})_{\text{exp}}$ =0.0012 7.
2014.06 [‡] 9	0.135 16	2101.03	(5/2,7/2) ⁻	86.927	3/2 ⁻	M1,E2		0.00148 22	%I γ =0.013 4 %I γ =0.105 5 $\alpha(\text{K})_{\text{exp}}$ =0.0016 8.
2018.40 ^{‡h} 27	0.062 19	2296.78?	5/2 ⁻ , 7/2 ⁻ , 9/2 ⁻	278.594	7/2 ⁻				%I γ =0.613 20 A ₂ =-0.457 33 (1982Da23) Mult.: from nuclear orientation, with $\Delta\pi$ =yes from decay scheme.
^x 2025.46 11	0.493 23								$\alpha(\text{K})_{\text{exp}}$ =2.4×10 ⁻⁴ 13.
2030.00 6	2.89 8	2029.87	7/2 ⁻	0.0	7/2 ⁺	(E1(+M2))	+0.03 ^c 5	1.03×10 ⁻³ 2	%I γ =0.071 5 $\alpha(\text{K})_{\text{exp}}$ =0.0029 15. %I γ =0.261 10 $\alpha(\text{K})_{\text{exp}}$ =0.0021 11.
^x 2048.99 8	0.335 22								%I γ =0.0125 11 $\alpha(\text{K})_{\text{exp}}$ =0.0062 16.
^x 2056.17 5	1.23 4								Placement from 1991DzZY .
2065.03 11	0.059 5	2065.04	7/2 ⁺	0.0	7/2 ⁺	M1+E2+E0		0.0073	α : estimated from $\alpha(\text{K})_{\text{exp}}$ (1978Ba73)

¹⁶⁹Lu ε+β⁺ decay (34.06 h) [1978Ba73](#),[1978Bo39](#),[1980Ba07](#) (continued)

γ(¹⁶⁹Yb) (continued)

E_γ [†]	I_γ ^{‡d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	α^e	Comments
^x 2070.85 11	0.130 5							and K/L for E0 transitions (2020Do01 – K/L=5.7 for 1543γ of ¹⁶⁸ Yb). %I _γ =0.0276 12 α(K)exp=0.0014 6.
^x 2088.69 14	0.043 3							%I _γ =0.0091 7
2095.90 [‡] 7	0.549 19	2287.23	7/2 ⁻	191.216	5/2 ⁻	M1	1.63×10 ⁻³ 2	%I _γ =0.117 5 α(K)exp=0.0018 6.
2101.09 [‡] 13	0.053 4	2101.03	(5/2,7/2) ⁻	0.0	7/2 ⁺			%I _γ =0.0112 9 α(K)exp<0.003.
^x 2112.0 4	0.036 11							%I _γ =0.0076 23
^x 2114.33 26	0.070 4							%I _γ =0.0149 9
^x 2122.47 10	0.84 4							%I _γ =0.178 9 α(K)exp=0.00112 20.
2135.4 4	0.033 5	2135.4		0.0	7/2 ⁺			%I _γ =0.0070 11 Placement from 1991DzZY .
^x 2139.39 17	0.31 4							%I _γ =0.066 9 α(K)exp=0.00078 22.
^x 2141.88 20	0.063 8							%I _γ =0.0134 17
^x 2148.27 17	0.106 6							%I _γ =0.0225 13
^x 2158.05 25	0.116 25							%I _γ =0.025 5 α(K)exp=0.0027 9.
^x 2161.18 10	0.30 3							%I _γ =0.064 6 α(K)exp=0.0009 5.
^x 2191.49 20	0.068 4							%I _γ =0.0144 9

[†] From [1978Ba73](#), except where otherwise noted.

[‡] Placement from [1988DzZW](#).

From [1980Ba07](#) and/or [1976Ba61](#).

@ From Adopted Gammas.

& Deduced from relative photon branching ratios in (n,γ) E=thermal and I_γ for transitions common to both decay and (n,γ).

^a From Adopted Gammas. Note that most of the multiplicities and mixing ratios of the adopted dataset are taken from this dataset, which are mainly based on α(K)exp and/or α(L)exp ([1978Ba73](#)). In [1978Ba73](#), the measured photon and ce intensities were scaled by assuming the most intense 889.8γ and 960.6γ are E1 and normalized with the theory values, which yielded α(K)(960γ)=0.00141 6 ([1978Ba73](#)) cf. α(K)=0.001372 19 (BrIcc v2.3e). For δ BrIccMixing v2.3b was used.

^b From all the subshell ce data using the BrIccMixing code v2.3b.

^c From nuclear orientation ([1982Da23](#)).

^d For absolute intensity per 100 decays, multiply by 0.212 4.

^e Total theoretical internal conversion coefficients, calculated using the BrIcc code ([2008Ki07](#)) with “Frozen Orbitals” approximation based on γ-ray energies, assigned multiplicities, and mixing ratios, unless otherwise specified.

^f Multiply placed with undivided intensity.

^{169}Lu $\varepsilon+\beta^+$ decay (34.06 h) [1978Ba73](#),[1978Bo39](#),[1980Ba07](#) (continued)

$\gamma(^{169}\text{Yb})$ (continued)

^g Multiply placed with intensity suitably divided.
^h Placement of transition in the level scheme is uncertain.
^x γ ray not placed in level scheme.

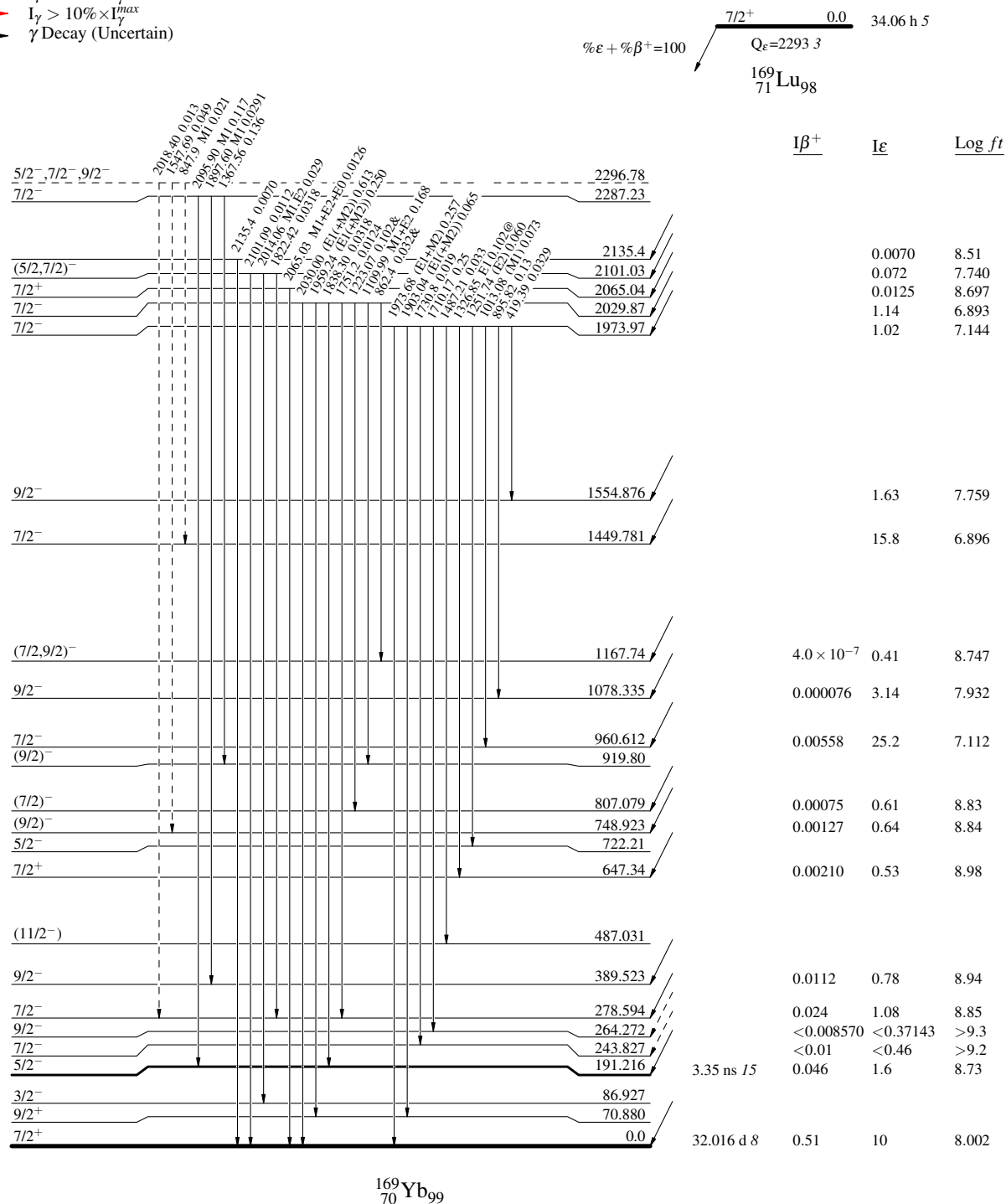
¹⁶⁹Lu ε+β⁺ decay (34.06 h) 1978Ba73,1978Bo39,1980Ba07

Decay Scheme

Intensities: I_(γ+ce) per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided

Legend

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}
- - - γ Decay (Uncertain)



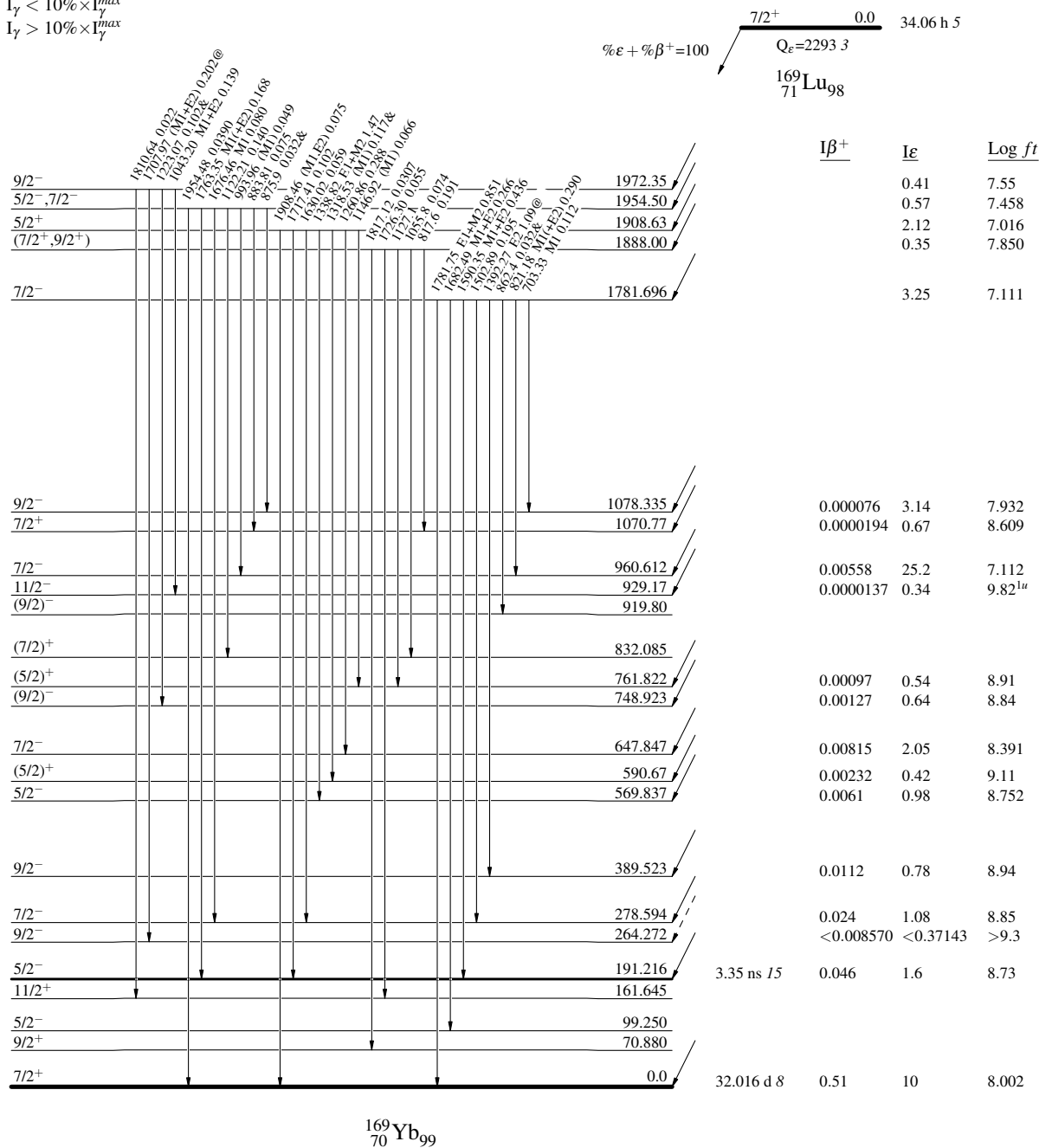
¹⁶⁹Lu $\varepsilon + \beta^+$ decay (34.06 h) 1978Ba73,1978Bo39,1980Ba07

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided

Legend

- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$

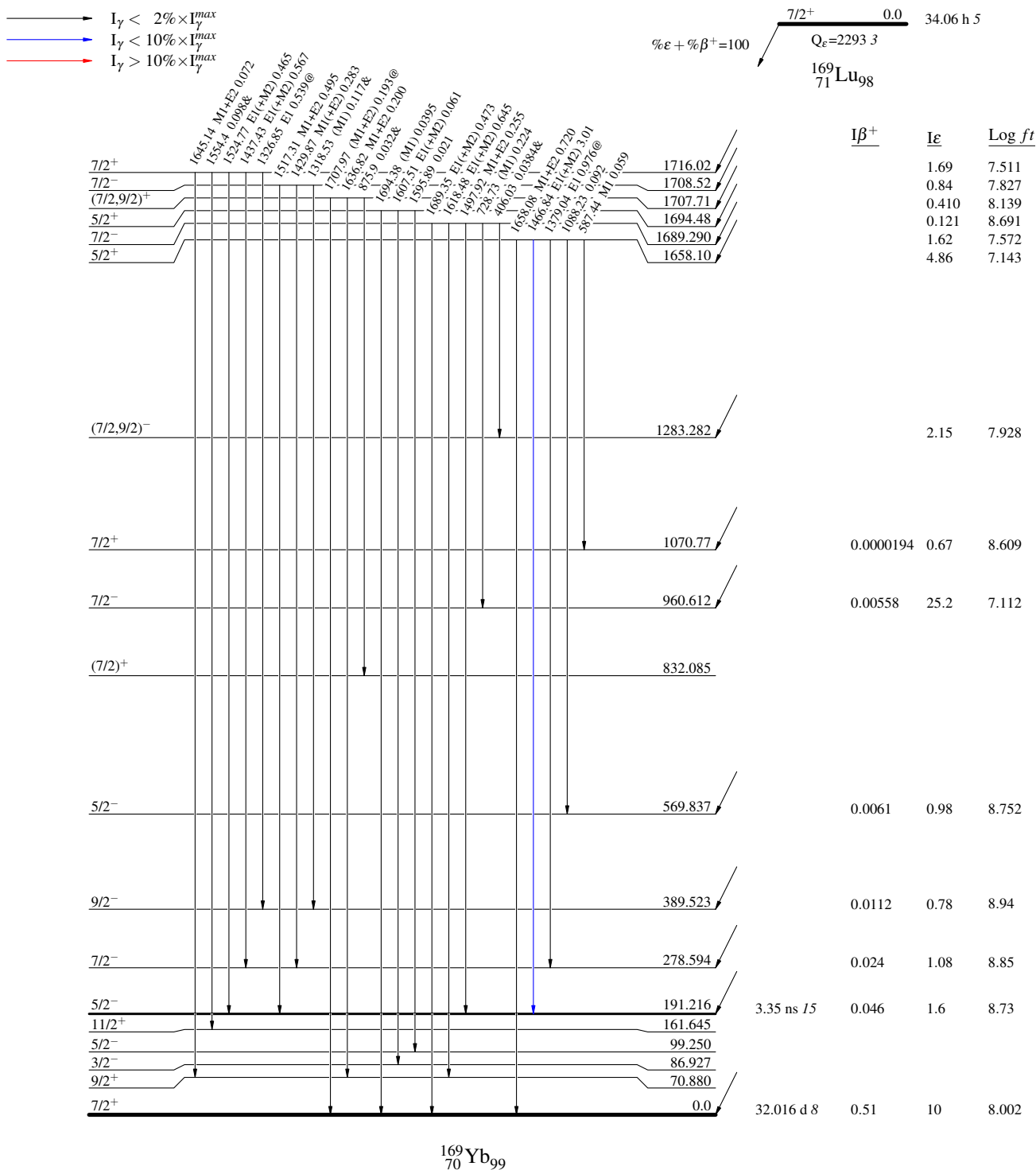


¹⁶⁹Lu ε+β⁺ decay (34.06 h) 1978Ba73,1978Bo39,1980Ba07

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided

Legend

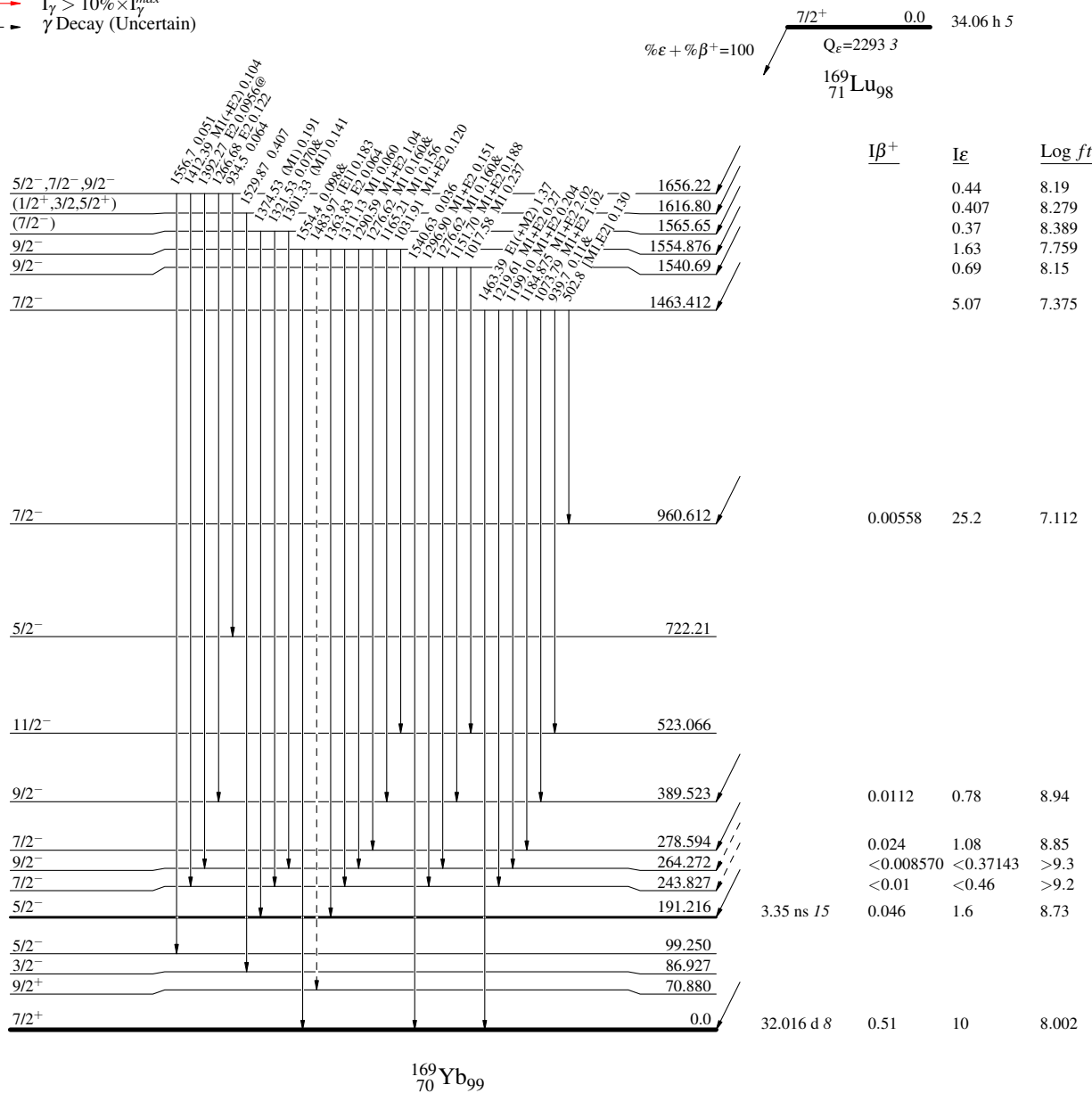


^{169}Lu $\varepsilon + \beta^+$ decay (34.06 h) 1978Ba73,1978Bo39,1980Ba07

Decay Scheme (continued)

Legend
 $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\text{max}}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\text{max}}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\text{max}}$
 $\cdots$ γ Decay (Uncertain)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided



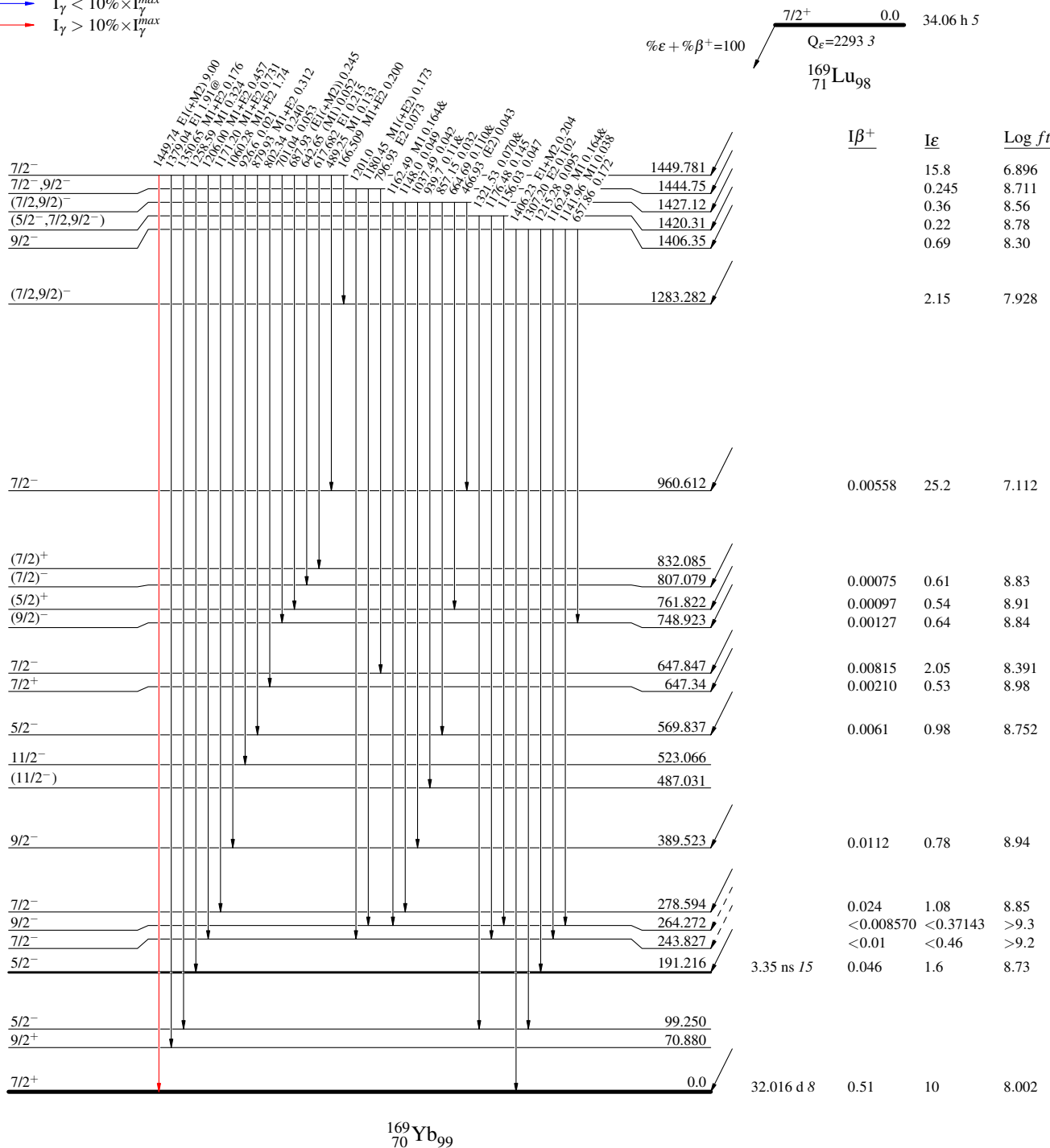
^{169}Lu $\varepsilon + \beta^+$ decay (34.06 h) 1978Ba73,1978Bo39,1980Ba07

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided

Legend

- $I_{\gamma} < 2\% \times I_{\gamma}^{\max}$
- $I_{\gamma} < 10\% \times I_{\gamma}^{\max}$
- $I_{\gamma} > 10\% \times I_{\gamma}^{\max}$



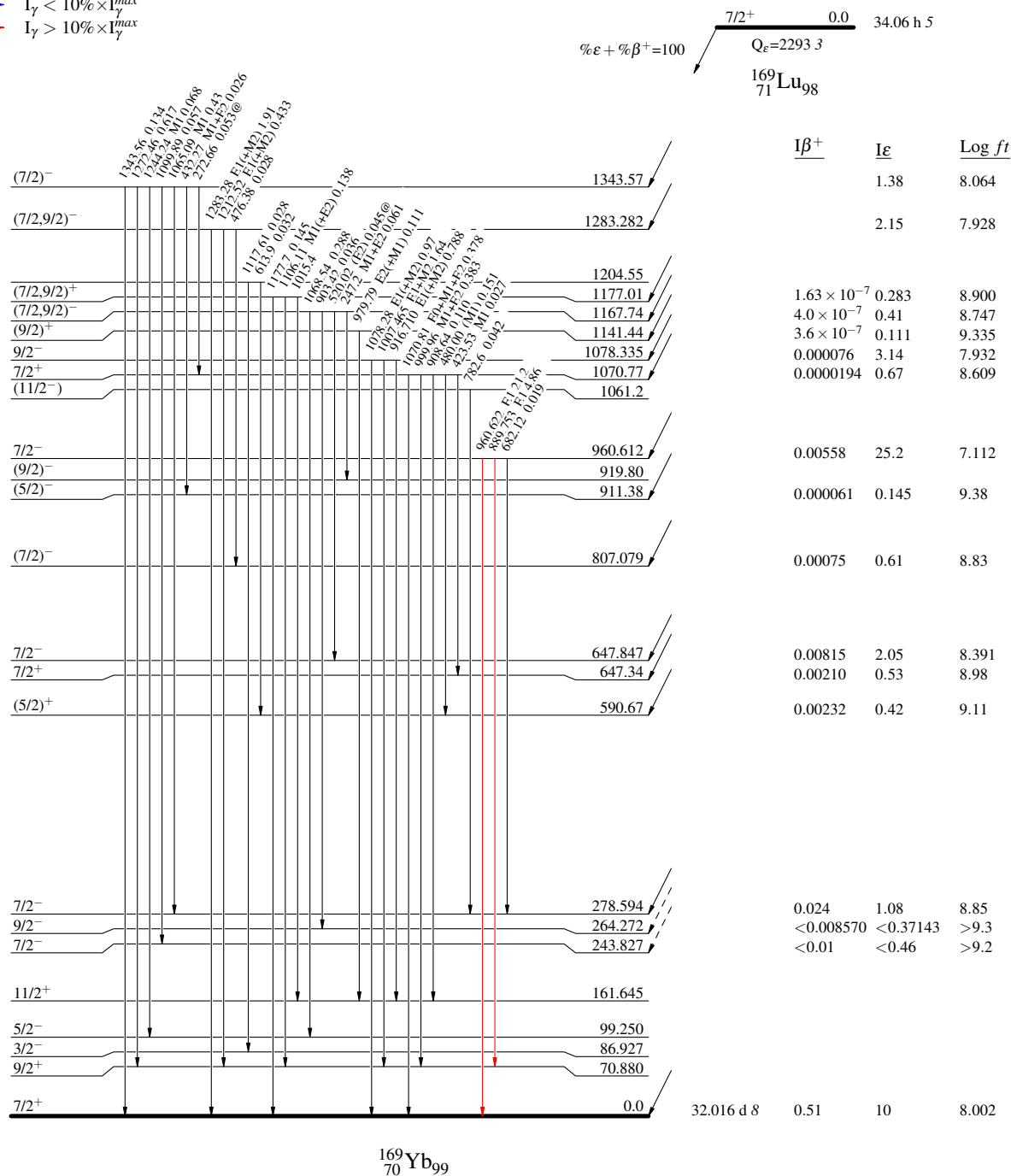
¹⁶⁹Lu $\epsilon + \beta^+$ decay (34.06 h) 1978Ba73,1978Bo39,1980Ba07

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided

Legend

- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$



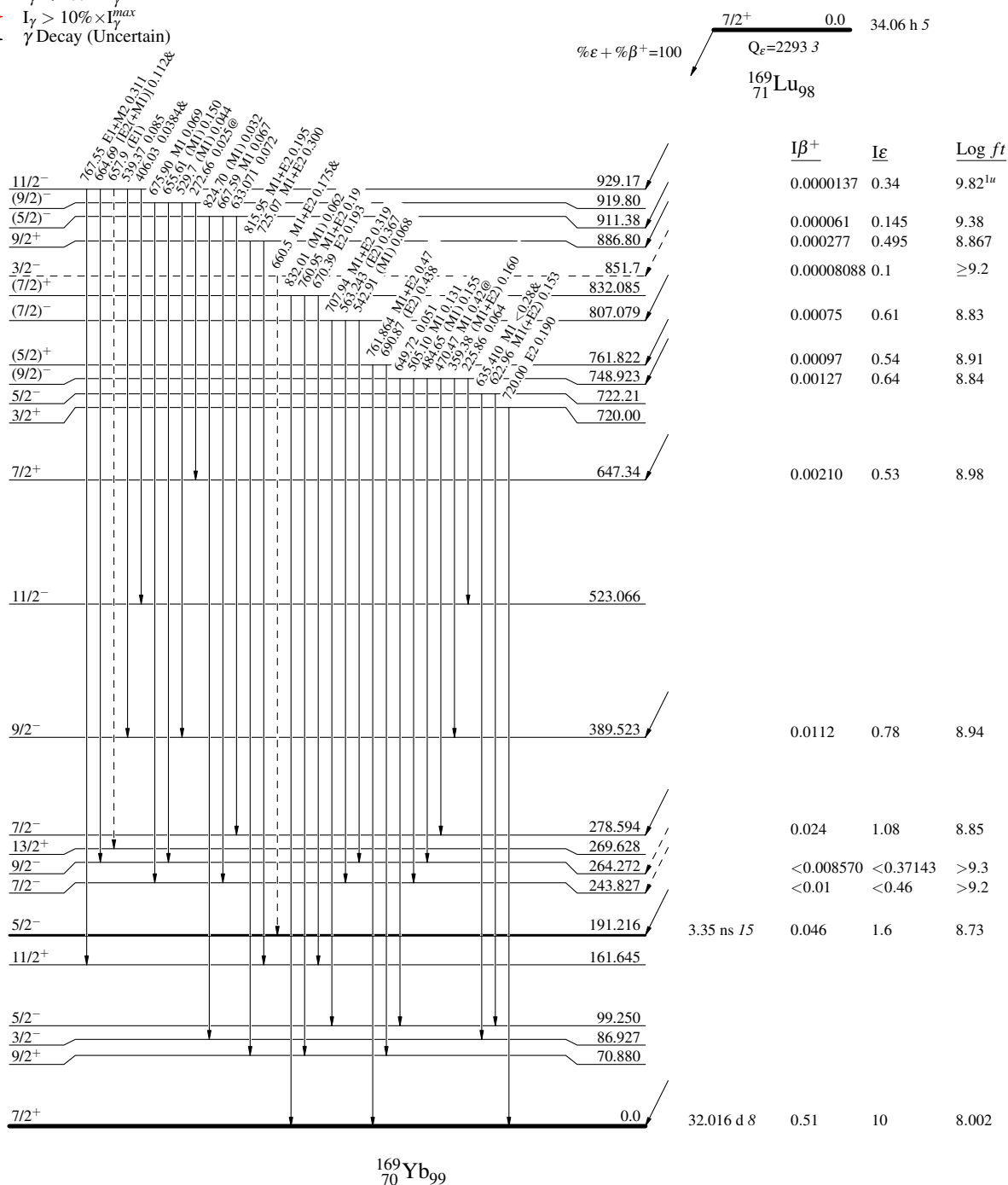
¹⁶⁹Lu $\epsilon + \beta^+$ decay (34.06 h) 1978Ba73,1978Bo39,1980Ba07

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided

Legend

- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$
- - - γ Decay (Uncertain)



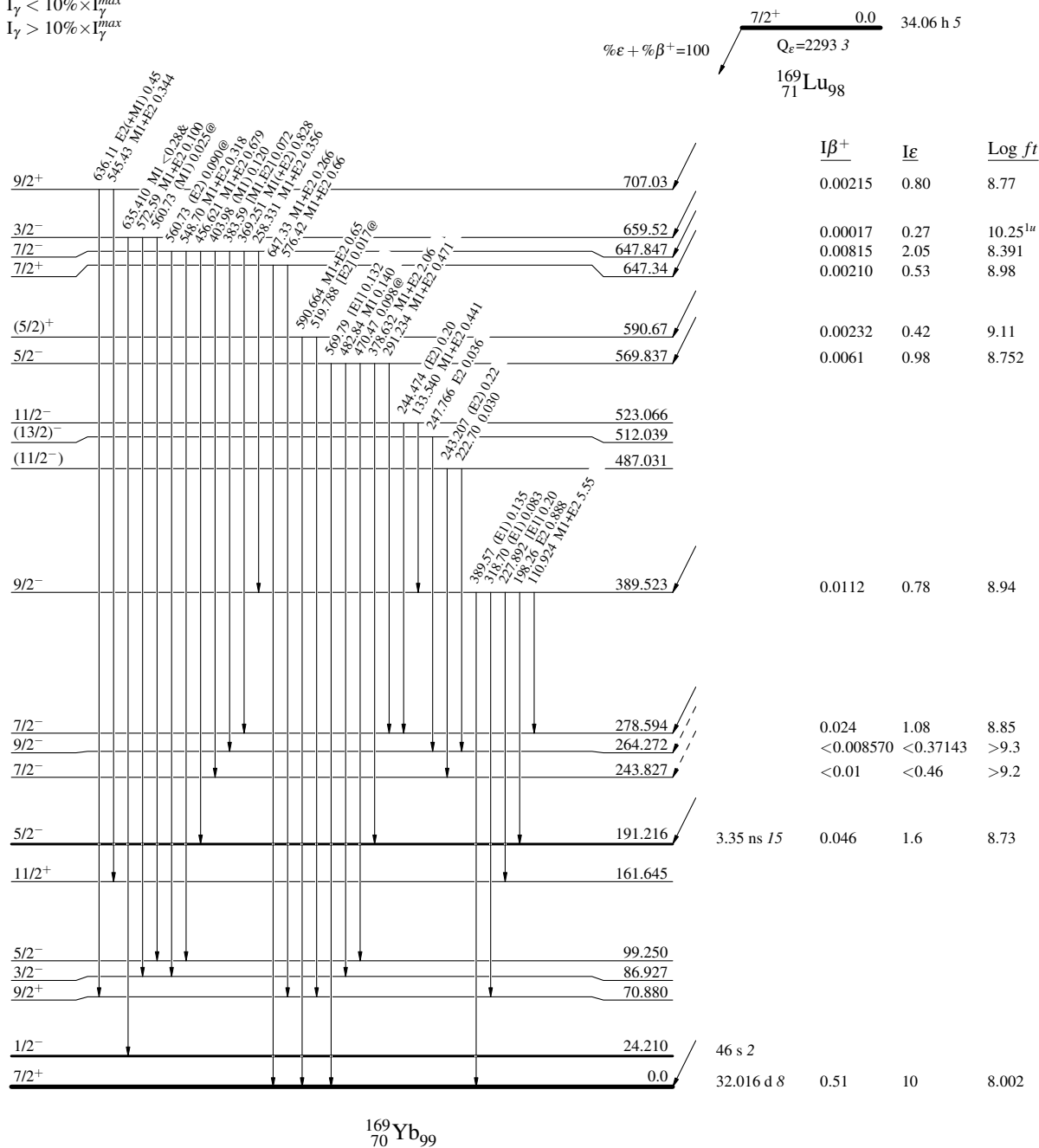
^{169}Lu $\varepsilon + \beta^+$ decay (34.06 h) 1978Ba73,1978Bo39,1980Ba07

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided

Legend

- $I_{\gamma} < 2\% \times I_{\gamma}^{\max}$
- $I_{\gamma} < 10\% \times I_{\gamma}^{\max}$
- $I_{\gamma} > 10\% \times I_{\gamma}^{\max}$



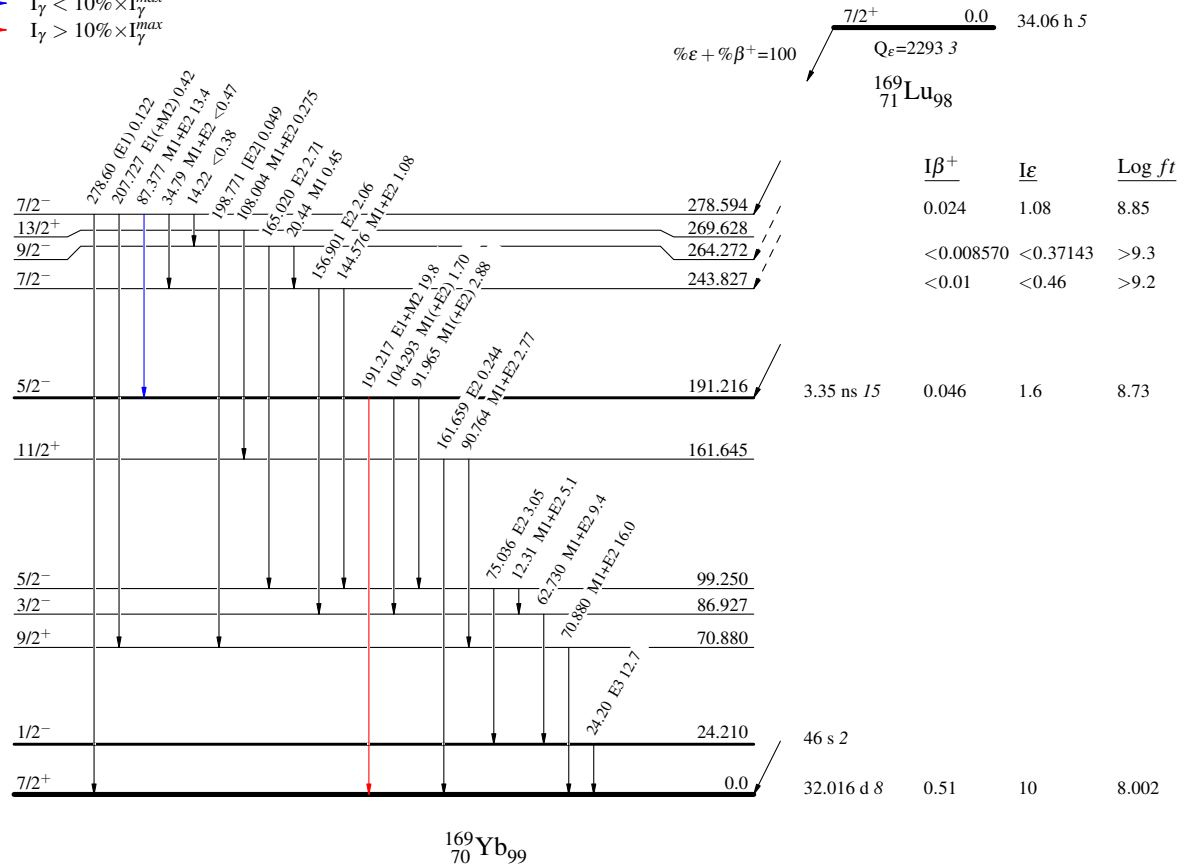
^{169}Lu $\varepsilon + \beta^+$ decay (34.06 h) $^{1978}\text{Ba}73,^{1978}\text{Bo}39,^{1980}\text{Ba}07$

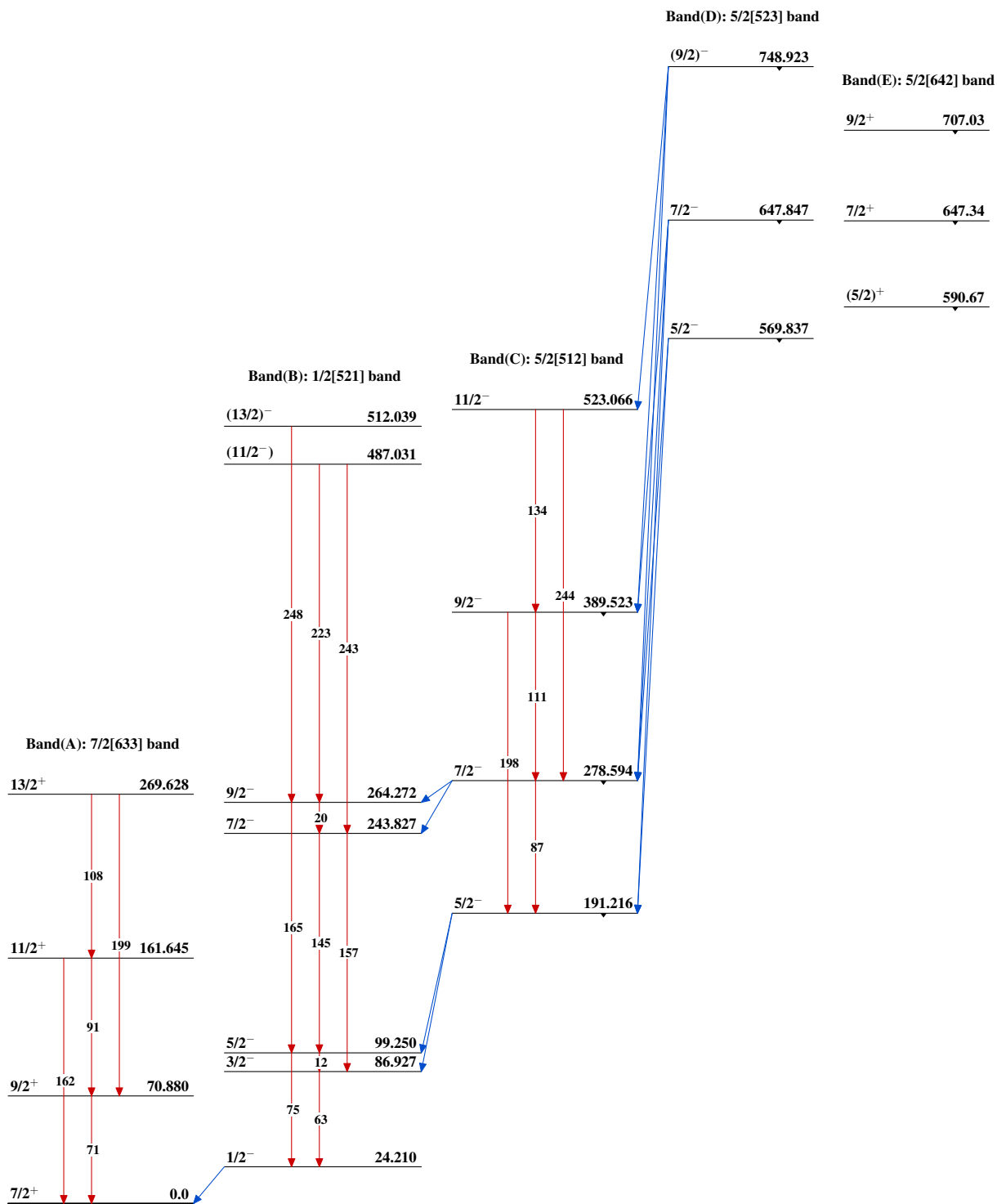
Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided

Legend

- $I_{\gamma} < 2\% \times I_{\gamma}^{\max}$
- $I_{\gamma} < 10\% \times I_{\gamma}^{\max}$
- $I_{\gamma} > 10\% \times I_{\gamma}^{\max}$



^{169}Lu ε decay (34.06 h) 1978Ba73,1978Bo39,1980Ba07

¹⁶⁹Lu ε decay (34.06 h) 1978Ba73,1978Bo39,1980Ba07 (continued)

		Band(J): β vibration band	
		(9/2) ⁺	1141.44
		↓	
		Band(I): 7/2[514] band	
		9/2 ⁻	1078.335
		↓	
		7/2 ⁺	1070.77
		↓	
		Band(F): 3/2[521] band + K-2 γ vibration built on 1/2[521]	
		(9/2) ⁻	919.80
		↓	
		Band(H): 1/2[510] band + K-2 γ vibration built on 5/2[512]	
		(5/2) ⁻	911.38
		↓	
		Band(G): 3/2[651] band + K-2 γ vibration built on 7/2[633]	
		9/2 ⁺	886.80
		↓	
		(7/2) ⁺	832.085
		↓	
		(7/2) ⁻	807.079
		↓	
		(5/2) ⁺	761.822
		↓	
		5/2 ⁻	722.21
		↓	
		3/2 ⁺	720.00
		↓	
		3/2 ⁻	659.52
		↓	

^{169}Yb IT decay (46 s)

Parent: ^{169}Yb : $E=24.2003$ 16; $J^\pi=1/2^-$; $T_{1/2}=46$ s 2; %IT decay=100.0

Isomer identified with L x ray coincidence data in $^{168}\text{Yb}(n,\gamma)$: $E=\text{slow}$ ([1949De16](#)), $E=\text{thermal}$ ([1960Ho10](#)).

 ^{169}Yb Levels

<u>$E(\text{level})^\dagger$</u>	<u>$J^\pi^\dagger$</u>	<u>$T_{1/2}$</u>	<u>Comments</u>
0.0	$7/2^+$	32.016 d 8	$T_{1/2}$: from Adopted Levels.
24.2003 16	$1/2^-$	46 s 2	%IT=100 $T_{1/2}$: from 1960Ho10 . Other value: 50 s (1949De16).

† From Adopted Levels.

 $\gamma(^{169}\text{Yb})$

I_γ normalization: from $I(\gamma+ce)(24\gamma)=100\%$.

<u>$E_\gamma^\dagger$</u>	<u>$I_\gamma^{\ddagger\#}$</u>	<u>$E_i(\text{level})$</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.†</u>	<u>$\alpha^@$</u>	<u>$I_{(\gamma+ce)}^\#$</u>	<u>Comments</u>
24.20 2	3.88×10^{-4} 6	24.2003	$1/2^-$	0.0	$7/2^+$	E3	2.58×10^5 4	100	See ^{169}Lu ε decay (34.06 h) for ce subshell data.

† From Adopted Gammas.

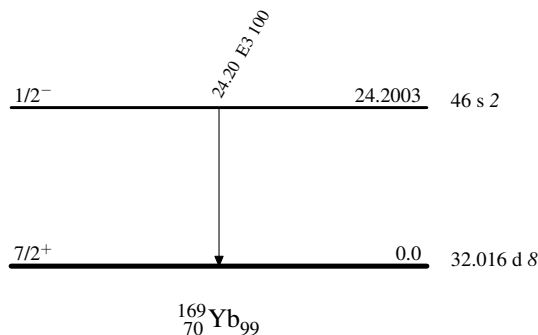
‡ Deduced from $I(\gamma+ce)$ and α .

$^\#$ Absolute intensity per 100 decays.

$^@$ Total theoretical internal conversion coefficients, calculated using the BrIcc code ([2008Ki07](#)) with "Frozen Orbitals" approximation based on γ -ray energies, assigned multiplicities, and mixing ratios, unless otherwise specified.

 ^{169}Yb IT decay (46 s)Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
%IT=100.0



¹²⁴Sn(⁴⁸Ca,3n γ) **1985Ba47**

No significant changes compared to that in the previous evaluation (**2008Ba31**) by C.M. Baglin.

1985Ba47: E(⁴⁸Ca)=201 MeV; $\theta=30^\circ, 90^\circ, 150^\circ$; measured E γ , I γ (6 Ge(Li), Compton-suppressed germanium, 50 bismuth germanate crystal detectors), $\gamma\gamma$ coin, γ -ray yields, I $\gamma(30^\circ)$ /I $\gamma(90^\circ)$; used cranking-model and gauge-space analyses to interpret level structure.

¹⁶⁹Yb Levels

E(level) [†]	J π [‡]	E(level) [†]	J π [‡]	E(level) [†]	J π [‡]	E(level) [†]	J π [‡]
0.0 ^{&}	7/2 ⁺ [#]	834.1 ^a 18	17/2 ⁻	2669.2 ^a 21	33/2 ⁻	5257.7 ^a 22	49/2 ⁻
24.2 ^a 10	1/2 ⁻ [#]	902.8 [@] 6	21/2 ⁺	2929 ^{&} 3	35/2 ⁺	5272.4 [@] 16	(49/2 ⁺)
70.1 [@] 6	9/2 ⁺ [#]	1157.1 ^{&} 6	23/2 ⁺	3075.1 [@] 12	37/2 ⁺	6046.1 [@] 17	(53/2 ⁺)
99.2 ^a 15	5/2 ⁻ [#]	1218.8 ^a 19	21/2 ⁻	3239.8 ^a 21	37/2 ⁻	6049.5 ^a 22	53/2 ⁻
161.0 ^{&} 3	11/2 ⁺ [#]	1336.1 [@] 7	25/2 ⁺	3588 ^{&} 4	(39/2 ⁺)	6875 [@] 3	(57/2 ⁺)
264.2 ^a 18	9/2 ⁻ [#]	1656.7 ^a 20	25/2 ⁻	3782.1 [@] 14	41/2 ⁺	6904.8 ^a 23	57/2 ⁻
269.1 [@] 6	13/2 ⁺ [#]	1666.2 ^{&} 8	27/2 ⁺	3857.3 ^a 21	41/2 ⁻	7771 [@] 4	(61/2 ⁺)
404.4 ^{&} 4	15/2 ⁺ [#]	1844.5 [@] 9	29/2 ⁺	4330 ^{&} 4	(43/2 ⁺)	7824.5 ^a 23	(61/2 ⁻)
512.3 ^a 18	13/2 ⁻	2141.4 ^a 20	29/2 ⁻	4524.3 [@] 15	45/2 ⁺	8807.8 ^a 23	(65/2 ⁻)
546.7 [@] 6	17/2 ⁺	2258.2 ^{&} 22	31/2 ⁺	4528.1 ^a 22	45/2 ⁻	9855.3 ^a 24	(69/2 ⁻)
735.8 ^{&} 5	19/2 ⁺	2426.0 [@] 11	33/2 ⁺	5116 ^{&} 4	(47/2 ⁺)	10962 ^a 3	(73/2 ⁻)

[†] From least-squares fit to E γ , arbitrarily allowing 1 keV uncertainty in all data shown without an uncertainty.

[‡] Authors' values, based on coincidence data, rotational band structure, and inferred γ -ray multiplicities (I $\gamma(30^\circ)$ /I $\gamma(90^\circ)$ yield ratios determined), except where noted. See ¹⁶⁹Yb Adopted Levels for evaluator's assignments; these differ only as a result of the introduction of parentheses for some of the adopted values.

From Adopted Levels.

@ Band(A): 7/2[633], $\alpha=+1/2$ band.

& Band(a): 7/2[633], $\alpha=-1/2$ band.

^a Band(B): 1/2[521].

 $\gamma(^{169}\text{Yb})$

E γ [†]	I γ [#]	E $_i$ (level)	J $_i^\pi$	E $_f$	J $_f^\pi$	Mult. ^{&}	Comments
24.2 [‡]		24.2	1/2 ⁻	0.0	7/2 ⁺		
70.9 [‡]		70.1	9/2 ⁺	0.0	7/2 ⁺		
75.0 [‡]		99.2	5/2 ⁻	24.2	1/2 ⁻		
90.8 [‡]		161.0	11/2 ⁺	70.1	9/2 ⁺		
108.0 [‡]		269.1	13/2 ⁺	161.0	11/2 ⁺		
135.3 [‡]		404.4	15/2 ⁺	269.1	13/2 ⁺		
141.9 [‡]		546.7	17/2 ⁺	404.4	15/2 ⁺		
160.9 3	19	161.0	11/2 ⁺	0.0	7/2 ⁺	Q	I $\gamma(30^\circ)$ /I $\gamma(90^\circ)$ =1.06 8.
165.0 [‡]		264.2	9/2 ⁻	99.2	5/2 ⁻		
166.8 [‡]		902.8	21/2 ⁺	735.8	19/2 ⁺		
177.9 [‡]		1336.1	25/2 ⁺	1157.1	23/2 ⁺		
189.1 [‡]		735.8	19/2 ⁺	546.7	17/2 ⁺		
199.4 6	@	269.1	13/2 ⁺	70.1	9/2 ⁺		
243.4 3	69	404.4	15/2 ⁺	161.0	11/2 ⁺	Q	I $\gamma(30^\circ)$ /I $\gamma(90^\circ)$ =0.97 3.
248.1 3	100	512.3	13/2 ⁻	264.2	9/2 ⁻	[Q]	I $\gamma(30^\circ)$ /I $\gamma(90^\circ)$ normalized to 1.00 2.

Continued on next page (footnotes at end of table)

$^{124}\text{Sn}(^{48}\text{Ca}, 3n\gamma)$ **1985Ba47** (continued) $\gamma(^{169}\text{Yb})$ (continued)

E_γ [†]	I_γ [#]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^{&}	Comments
253.3 [‡]		1157.1	23/2 ⁺	902.8	21/2 ⁺		
277.6 3	82	546.7	17/2 ⁺	269.1	13/2 ⁺	Q	$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.05$ 3.
321.8 3	110	834.1	17/2 ⁻	512.3	13/2 ⁻	Q	$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.04$ 3.
331.3 3	85	735.8	19/2 ⁺	404.4	15/2 ⁺	Q	$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.05$ 3.
356.2 3	113	902.8	21/2 ⁺	546.7	17/2 ⁺	Q	$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.10$ 3.
384.7 6	@	1218.8	21/2 ⁻	834.1	17/2 ⁻		
421.3 3	71	1157.1	23/2 ⁺	735.8	19/2 ⁺	Q	$I_\gamma(30^\circ)/I_\gamma(90^\circ)=0.97$ 5.
433.3 3	125	1336.1	25/2 ⁺	902.8	21/2 ⁺	Q	$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.08$ 3.
437.9 6	@	1656.7	25/2 ⁻	1218.8	21/2 ⁻		
484.7 3	95	2141.4	29/2 ⁻	1656.7	25/2 ⁻	Q	$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.04$ 3.
508.4 6	@	1844.5	29/2 ⁺	1336.1	25/2 ⁺		
509.1 6	@	1666.2	27/2 ⁺	1157.1	23/2 ⁺		
527.8 3	80	2669.2	33/2 ⁻	2141.4	29/2 ⁻	Q	$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.02$ 5.
570.6 3	143	3239.8	37/2 ⁻	2669.2	33/2 ⁻	Q	$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.09$ 3.
581.5 6	@	2426.0	33/2 ⁺	1844.5	29/2 ⁺		
592 2	@	2258.2	31/2 ⁺	1666.2	27/2 ⁺		
617.5 3	84	3857.3	41/2 ⁻	3239.8	37/2 ⁻		$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.34$ 9.
649.1 6	@	3075.1	37/2 ⁺	2426.0	33/2 ⁺		
659 1	42	3588	(39/2 ⁺)	2929	35/2 ⁺		$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.38$ 10.
670.8 6	≤170	4528.1	45/2 ⁻	3857.3	41/2 ⁻		$I_\gamma=170$ for 670.8γ and 671γ combined. $I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.44$ 8 for doublet. I_γ : see comment with 670.8γ.
671 2	≤170	2929	35/2 ⁺	2258.2	31/2 ⁺		$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.44$ 8 for doublet. I_γ : masked by transition in ^{167}Yb or ^{168}Yb .
707.0 6	150	3782.1	41/2 ⁺	3075.1	37/2 ⁺		$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.19$ 5.
729.6 3	152	5257.7	49/2 ⁻	4528.1	45/2 ⁻		$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.14$ 10.
742 2	≤97	4330	(43/2 ⁺)	3588	(39/2 ⁺)		$I_\gamma=97$ for 742γ and 742.2γ combined. $I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.35$ 11 for doublet. see comments with 742γ.
742.2 6	≤97	4524.3	45/2 ⁺	3782.1	41/2 ⁺		
748.1 6	@	5272.4	(49/2 ⁺)	4524.3	45/2 ⁺		
773.7 3	41	6046.1	(53/2 ⁺)	5272.4	(49/2 ⁺)		$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.07$ 11.
786 1	91	5116	(47/2 ⁺)	4330	(43/2 ⁺)		$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.24$ 11.
791.8 3	31	6049.5	53/2 ⁻	5257.7	49/2 ⁻	Q	$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.10$ 6.
829 2	@	6875	(57/2 ⁺)	6046.1	(53/2 ⁺)		
855.3 3	26	6904.8	57/2 ⁻	6049.5	53/2 ⁻		$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.2$ 3.
896 2	@	7771	(61/2 ⁺)	6875	(57/2 ⁺)		
919.7 3	14	7824.5	(61/2 ⁻)	6904.8	57/2 ⁻		$I_\gamma(30^\circ)/I_\gamma(90^\circ)=2.17$ 16.
983.3 3	10	8807.8	(65/2 ⁻)	7824.5	(61/2 ⁻)		$I_\gamma(30^\circ)/I_\gamma(90^\circ)=1.29$ 25.
1047.5 6	@	9855.3	(69/2 ⁻)	8807.8	(65/2 ⁻)		
1107 2	@	10962	(73/2 ⁻)	9855.3	(69/2 ⁻)		

[†] Uncertainties not reported, but estimated by evaluator from implied precision of authors' level energies.

[‡] Adopted value (rounded). Transition shown in level drawing in fig. 3 of **1985Ba47** but not included in table 3.

[#] Arbitrary units relative to $I_\gamma=100$ for 248.1γ; values are averages from 30° and 90° projected spectra.

@ Measurement was not possible (background interference and/or low intensity).

& From ratios of $I_\gamma(30^\circ \text{ or } 150^\circ)$ to $I_\gamma(90^\circ)$, normalized so ratio=1.00 2 for the 248.1-keV stretched Q transition.

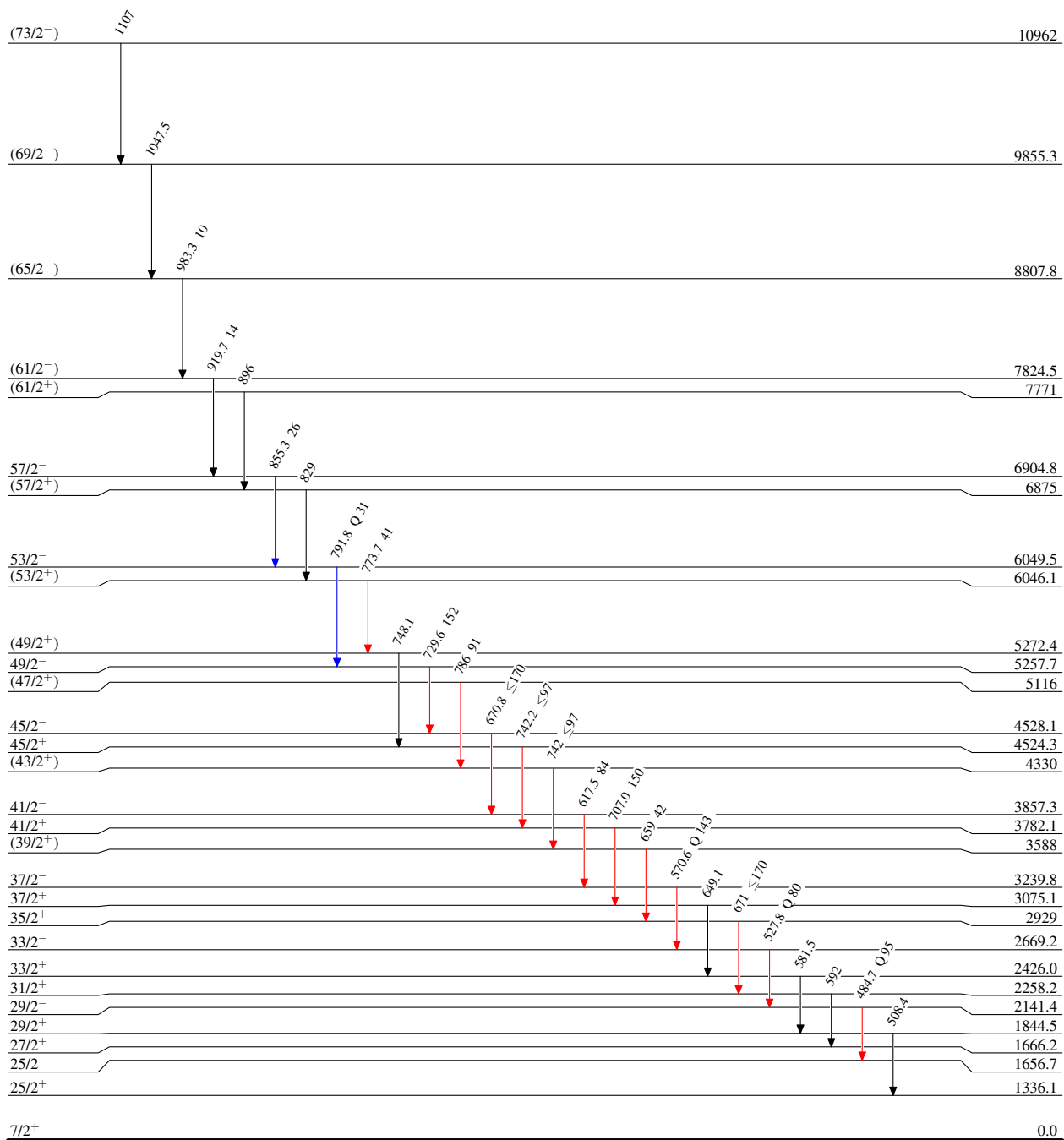
$^{124}\text{Sn}(^{48}\text{Ca}, 3n\gamma) \quad 1985\text{Ba47}$

Level Scheme

Intensities: relative I_γ for $E(^{48}\text{Ca})=201$ MeV (average from 30° and 90°
projected spectra)
90° projected spectra)

Legend

-  $I_\gamma < 2\% \times I_\gamma^{\text{max}}$
 $I_\gamma < 10\% \times I_\gamma^{\text{max}}$
 $I_\gamma > 10\% \times I_\gamma^{\text{max}}$



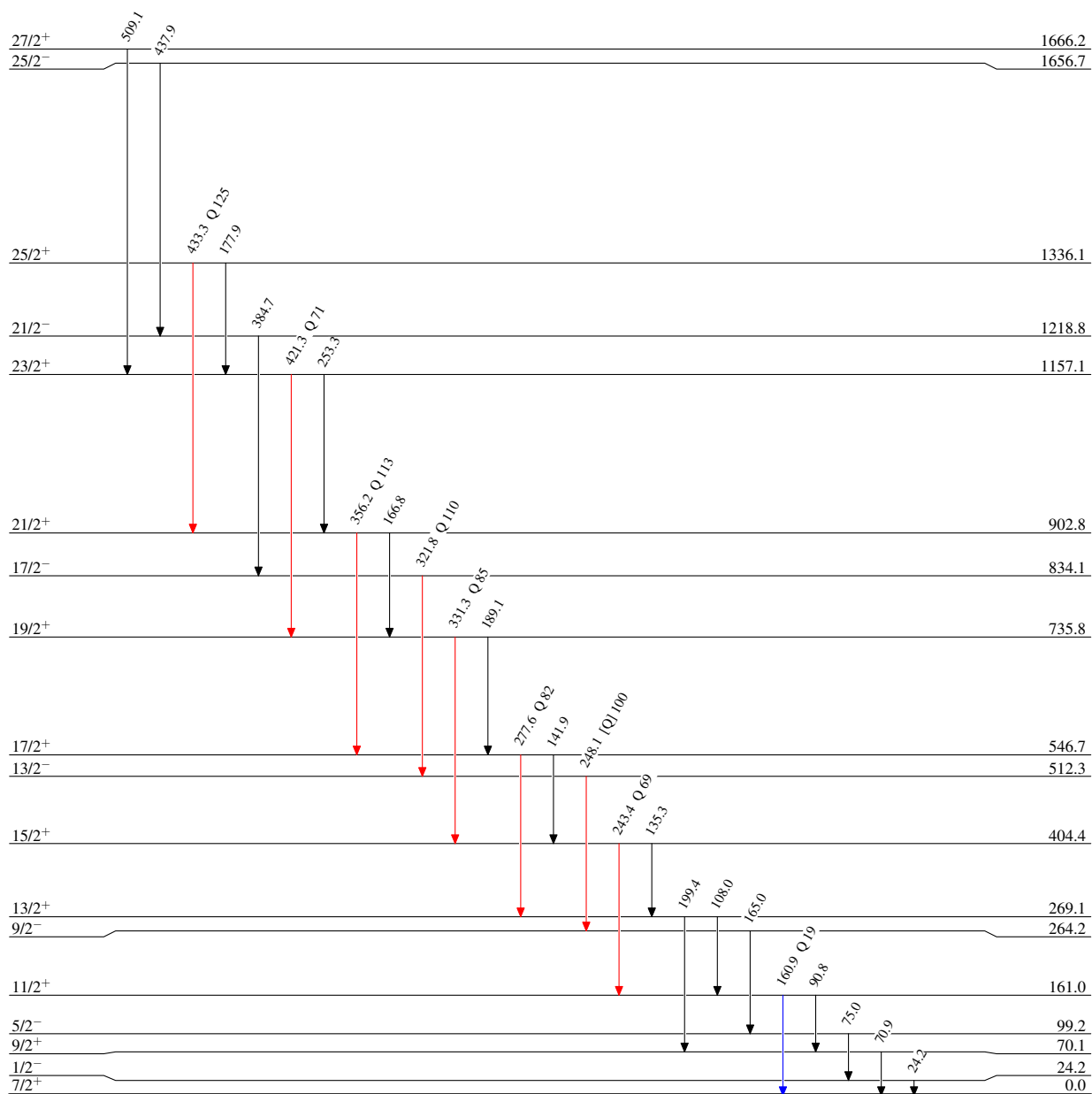
$^{124}\text{Sn}(^{48}\text{Ca},3n\gamma) \quad ^{1985}\text{Ba}47$

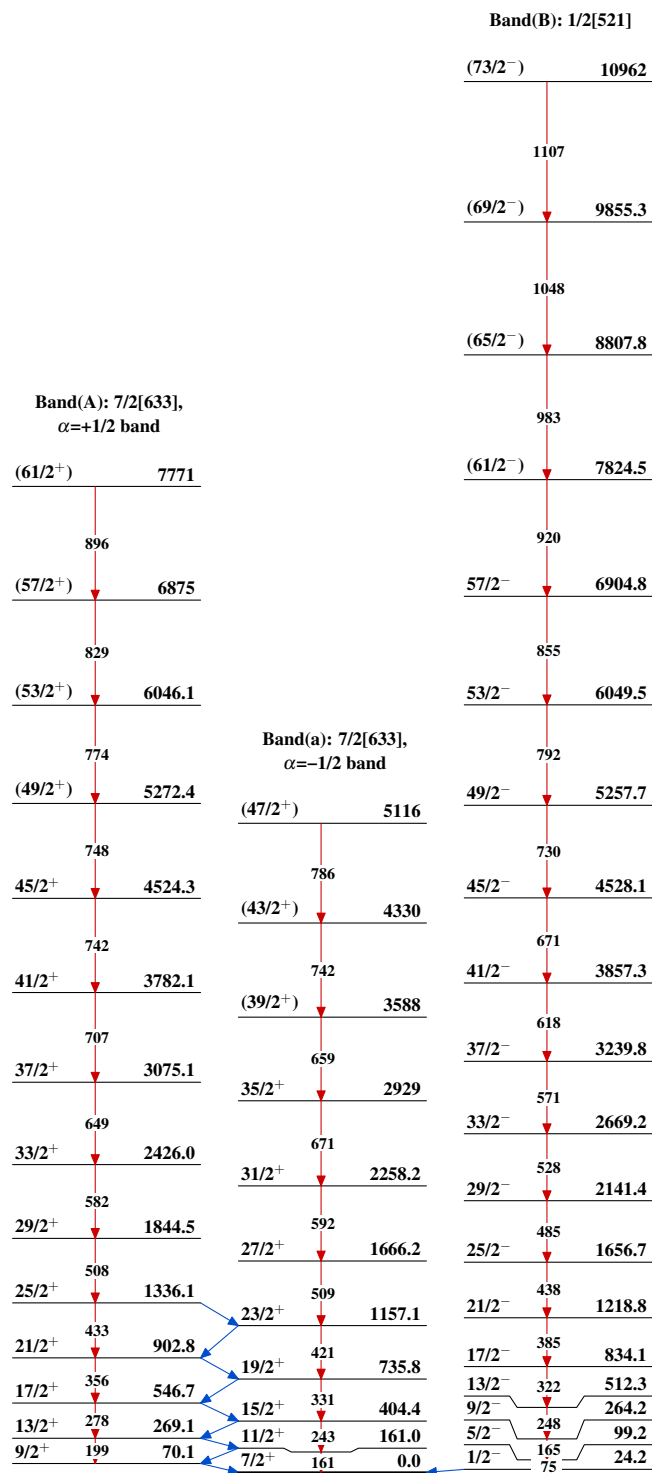
Level Scheme (continued)

Intensities: relative I_γ for $E(^{48}\text{Ca})=201$ MeV (average from 30° and 90° projected spectra)
 90° projected spectra)

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$

 $^{169}_{70}\text{Yb}_{99}$

$^{124}\text{Sn}(^{48}\text{Ca}, 3n\gamma) \quad ^{1985}\text{Ba}47$  $^{169}_{70}\text{Yb}_{99}$

¹⁶⁷Er($\alpha, 2n\gamma$) **1970Se15**

No significant changes compared to that in the previous evaluation (2008Ba31) by C.M. Baglin.

1970Se15: E(α)=26 MeV; $\theta=90^\circ, 110^\circ, 130^\circ, 150^\circ$; metallic erbium targets enriched to 87.2% in ¹⁶⁷Er; measured E γ , I γ (Ge(Li),

FWHM=1.5 keV at 100 keV), excit (E α =20-43 MeV), γ -ray angular distributions; used decay of γ spectrum between beam pulses to look for delayed transitions (10-100 ns range); used Nilsson model (with Coriolis coupling) to interpret level structure.

¹⁶⁹Yb Levels

E(level) [†]	J π [‡]	E(level) [†]	J π [‡]	E(level) [†]	J π [‡]	E(level) [†]	J π [‡]
0.0 [#]	7/2 ⁺	269.4 [#] 5	13/2 ⁺	735.5 [#] 6	19/2 ⁺	1249.9? ^{&} 8	19/2 ⁻
24.20 [@] 2	1/2 ⁻	278.9 ^{&} 6	7/2 ⁻	807.3 [@] 9	15/2 ⁻	1334.0 [#] 7	25/2 ⁺
70.8 [#] 4	9/2 ⁺	389.2 ^{&} 6	9/2 ⁻	833.5 [@] 10	17/2 ⁻	1650.2 [@] 11	23/2 ⁻
86.8 [@] 8	3/2 ⁻	404.6 [#] 5	15/2 ⁺	850.9 ^{&} 8	15/2 ⁻	1654.6 [@] 12	25/2 ⁻
99.3 [@] 5	5/2 ⁻	486.6 [@] 7	11/2 ⁻	902.1 [#] 7	21/2 ⁺	1664.4? [#] 9	(27/2 ⁺)
161.5 [#] 4	11/2 ⁺	511.8 [@] 8	13/2 ⁻	1042.1 ^{&} 8	17/2 ⁻	1842.7? [#] 9	(29/2 ⁺)
191.0 ^{&} 5	5/2 ⁻	522.3 ^{&} 7	11/2 ⁻	1155.7 [#] 7	23/2 ⁺		
243.6 [@] 7	7/2 ⁻	546.5 [#] 6	17/2 ⁺	1198.4 [@] 10	19/2 ⁻		
264.1 [@] 7	9/2 ⁻	676.6 ^{&} 7	13/2 ⁻	1217.4 [@] 11	21/2 ⁻		

[†] From least-squares fit to E γ .

[‡] Authors' values, based on coincidence data, rotational structure, and γ -ray multiplicities. Values in Adopted Levels agree, apart from the possible introduction of parentheses for some of the adopted values.

[#] Band(A): 7/2[633] band. Band is strongly perturbed, but authors could describe it well within the non-adiabatic unified model by reducing the single-particle Coriolis matrix elements for orbitals near the Fermi surface.

[@] Band(B): 1/2[521] band.

[&] Band(C): 5/2[512] band.

$\gamma(^{169}\text{Yb})$

E γ [†]	I γ [@]	E _i (level)	J π _i	E _f	J π _f	Mult. ^a	δ ^a	Comments
(24.20 [‡] 2)		24.20	1/2 ⁻	0.0	7/2 ⁺			
(62.719 [‡] 1)		86.8	3/2 ⁻	24.20	1/2 ⁻			
70.9 5	18.5 19	70.8	9/2 ⁺	0.0	7/2 ⁺	D+Q		A ₂ =-1.0 5
^x 72.7 5	1.5 3					D(+Q)		A ₂ =-0.4 4
75.1 5	3.5 7	99.3	5/2 ⁻	24.20	1/2 ⁻			A ₂ =-0.5 7
87.6 ^e 5	<15.4	278.9	7/2 ⁻	191.0	5/2 ⁻			A ₂ =+0.11 18
								I γ : includes component from ¹⁶⁸ Yb.
90.7 5	25.5 26	161.5	11/2 ⁺	70.8	9/2 ⁺	D+Q	-0.40 ^b 9	A ₂ =-0.49 3; A ₄ =+0.03 4
^x 93.1 5	1.2 3							A ₂ =+0.07 20
^x 106.1 5	4.0 8							A ₂ =+0.09 25
108.0 5	18.0 18	269.4	13/2 ⁺	161.5	11/2 ⁺	D+Q	-0.32 ^b 12	A ₂ =-0.51 10; A ₄ =-0.15 13
^x 108.9 5	6.0 12							
110.3 5	7.0 14	389.2	9/2 ⁻	278.9	7/2 ⁻	D(+Q)	-0.11 +16-25	A ₂ =-0.34 24
								δ : other: ± 0.15 from branching ratio.
^x 111.4 5	3.5 7					D(+Q)		A ₂ =-0.35 23
133.3 5	3.7 8	522.3	11/2 ⁻	389.2	9/2 ⁻	D+Q	-0.20 +10-12	A ₂ =-0.45 13; A ₄ =+0.08 17
								δ : other: ± 0.22 from branching ratio.
135.3 5	20.0 20	404.6	15/2 ⁺	269.4	13/2 ⁺	D+Q	-0.32 ^b 8	A ₂ =-0.58 4; A ₄ =+0.05 5
141.9 5	14.1 14	546.5	17/2 ⁺	404.6	15/2 ⁺	D+Q	-0.23 ^b 9	A ₂ =-0.53 10; A ₄ =+0.27 12
144.3 5	5.0 10	243.6	7/2 ⁻	99.3	5/2 ⁻	D+Q	>+0.5	A ₂ =+0.26 10; A ₄ =+0.09 15
								δ : positive, with $0.5 \leq \delta \leq 5.0$. Other: ± 0.47 from branching ratio.

Continued on next page (footnotes at end of table)

$^{167}\text{Er}(\alpha, 2n\gamma)$ **1970Se15** (continued) $\gamma(^{169}\text{Yb})$ (continued)

E_γ [†]	I_γ [@]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	δ^a	Comments
154.2 5	2.9 6	676.6	13/2 ⁻	522.3	11/2 ⁻	D+Q	-0.29 +9-7	$A_2=-0.56$ 4; $A_4=0.00$ 5 δ : other: ± 0.28 from branching ratio.
156.8 5	12.1 12	243.6	7/2 ⁻	86.8	3/2 ⁻			$A_2=+0.14$ 9
^x 158.7 5	2.2 5					D+Q		$A_2=0.00$ 7
161.4 5	8.7 18	161.5	11/2 ⁺	0.0	7/2 ⁺	Q		$A_2=+0.38$ 5; $A_4=-0.08$ 8
164.8 5	26.9 27	264.1	9/2 ⁻	99.3	5/2 ⁻	Q		$A_2=+0.29$ 3; $A_4=-0.01$ 5
166.8 5	6.0 12	902.1	21/2 ⁺	735.5	19/2 ⁺	D+Q	-0.14 ^b 8	$A_2=-0.48$ 10; $A_4=-0.05$ 5
174.5 5	2.4 5	850.9	15/2 ⁻	676.6	13/2 ⁻	D+Q	-0.6 +5-3	$A_2=-0.6$ 5 δ : other: ± 0.27 from branching ratio.
177.9 ^e 5	<2.3	1334.0	25/2 ⁺	1155.7	23/2 ⁺			I_γ : includes component from $^{167}\text{Er}(\alpha, \alpha')$.
^x 180.9 5	2.5 5							$A_2=-0.3$ 6
189.1 5	12.3 13	735.5	19/2 ⁺	546.5	17/2 ⁺	D+Q	-0.32 ^b 8	$A_2=-0.67$ 3; $A_4=-0.04$ 3
191.0 ^d 5	28.5 ^d 29	191.0	5/2 ⁻	0.0	7/2 ⁺			$A_2=-0.01$ 6
191.0 ^e 5		1042.1	17/2 ⁻	850.9	15/2 ⁻			1970Se15 indicate this placement as questionable; evaluator assigns all intensity to 191.0 level placement.
198.5 ^{de} 5	25 ^{d&} 3	269.4	13/2 ⁺	70.8	9/2 ⁺			$A_2=+0.25$ 2, $A_4=-0.15$ 3 for doublet. I_γ : 1970Se15 attribute remaining portion ($I_\gamma=55$) of total I_γ ($=81.5$) to ^{168}Yb . Mult.: angular distribution data are consistent with Q, but no assignment is made because of complexity of peak.
198.5 ^{de} 5	1.5 ^{d&} 3	389.2	9/2 ⁻	191.0	5/2 ⁻			$A_2=+0.25$ 2, $A_4=-0.15$ 3 for doublet.
207.4 ^e 5	2.2 5	1249.9?	19/2 ⁻	1042.1	17/2 ⁻			$A_2=-0.02$ 25
222.4 5	3.5 7	486.6	11/2 ⁻	264.1	9/2 ⁻			$A_2=+0.14$ 13 δ : +0.15 to +0.40 or +4.0 to $+\infty$. $A_2=+0.2$ 9
^x 227.8 5	2.3 5							Mult.: $\gamma(\theta)$ data are consistent with Q, but no assignment is made because of complexity of peak. $A_2=+0.29$ 3, $A_4=-0.04$ 5 for triplet.
243.0 ^d 5	40 ^{d&} 4	404.6	15/2 ⁺	161.5	11/2 ⁺			See comment on 243.0 γ from 405 level.
243.0 ^{de} 5	20 ^{d&} 2	486.6	11/2 ⁻	243.6	7/2 ⁻			See comment on 243.0 γ from 405 level.
247.7 5	2.9 ^{d&} 6	522.3	11/2 ⁻	278.9	7/2 ⁻			$A_2=+0.30$ 2; $A_4=-0.01$ 4
253.3 5	37 4	511.8	13/2 ⁻	264.1	9/2 ⁻	Q		$A_2=-0.74$ 3; $A_4=+0.16$ 3
277.1 5	4.7 10	1155.7	23/2 ⁺	902.1	21/2 ⁺	D+Q	-0.33 ^b 9	$A_2=+0.34$ 1; $A_4=-0.05$ 1
277.1 5	49 5	546.5	17/2 ⁺	269.4	13/2 ⁺	Q		$A_2=+0.27$ 16
287.6 5	5.5 11	676.6	13/2 ⁻	389.2	9/2 ⁻	(Q)		$A_2=+0.30$ 1, $A_4=-0.06$ 1 for 320.7 γ +321.7 γ .
320.7 5	15 2	807.3	15/2 ⁻	486.6	11/2 ⁻			$A_2=+0.30$ 1, $A_4=-0.06$ 1 for 320.7 γ +321.7 γ .
321.7 5	27 3	833.5	17/2 ⁻	511.8	13/2 ⁻	(Q)		$A_2=+0.12$ 4
328.4 5	7.2 15	850.9	15/2 ⁻	522.3	11/2 ⁻	(Q)		$A_2=+0.31$ 1; $A_4=-0.11$ 2
330.9 5	39 4	735.5	19/2 ⁺	404.6	15/2 ⁺	Q		$A_2=+0.35$ 1; $A_4=-0.11$ 2
355.6 5	37 4	902.1	21/2 ⁺	546.5	17/2 ⁺	Q		$A_2=+0.3$ 3; $A_4=-0.1$ 5
365.5 5	4.3 9	1042.1	17/2 ⁻	676.6	13/2 ⁻	(Q)		I_γ : estimated from level intensity balances; 1970Se15 attribute remaining portion ($I_\gamma=30$) of total I_γ ($=44.8$) to ^{168}Yb .
383.9 5	15 2	1217.4	21/2 ⁻	833.5	17/2 ⁻			$A_2=+0.32$ 2, $A_4=-0.20$ 4 for contaminated line.
391.1 5	8.8 18	1198.4	19/2 ⁻	807.3	15/2 ⁻	Q		$A_2=+0.21$ 4; $A_4=-0.01$ 6
399.4 ^e 5	3.5 7	1249.9?	19/2 ⁻	850.9	15/2 ⁻			$A_2=-0.13$ 14 for a complex line.

Continued on next page (footnotes at end of table)

$^{167}\text{Er}(\alpha, 2n\gamma)$ **1970Se15** (continued) $\gamma(^{169}\text{Yb})$ (continued)

E_γ [†]	I_γ [@]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^a	Comments
^x 400.4 5	4.6 9						
^x 416.4 5	1.9 4						
420.2 5	19.5 20	1155.7	23/2 ⁺	735.5	19/2 ⁺	Q	$A_2=+0.29$ 4; $A_4=-0.15$ 6
432.3 5	16.2 16	1334.0	25/2 ⁺	902.1	21/2 ⁺	Q	$A_2=+0.27$ 1; $A_4=-0.16$ 2
437.2 5	7.8 16	1654.6	25/2 ⁻	1217.4	21/2 ⁻	Q	$A_2=+0.29$ 1; $A_4=-0.18$ 11
451.8 5	5.6 12	1650.2	23/2 ⁻	1198.4	19/2 ⁻	Q	$A_2=+0.38$ 2; $A_4=-0.14$ 4
^x 463.8 5	2.5 5						
^x 483.3 5	4.8 10					Q	$A_2=+0.36$ 13
508.7 ^{c#e} 5	30 ^c 3	1664.4?	(27/2 ⁺)	1155.7	23/2 ⁺		
508.7 ^{c#e} 5	30 ^c 3	1842.7?	(29/2 ⁺)	1334.0	25/2 ⁺		
^x 584.2 5	2.8 6						
^x 590.3 5	7.4 15						

[†] From **1970Se15**, except where otherwise noted.

[‡] Adopted values (rounded).

1970Se15 suggest possible placements of a 508.7 γ in the 7/2[633] band, from a 27/2⁺ level at 1664 keV and/or a 29/2⁺ level at 1843 keV; both options are consistent with Adopted Levels, Gammas, so the 508.7 γ is presumed to be a doublet here, consistent with its I_γ .

@ Arbitrary units for $E(\alpha)=26$ MeV, $\theta=130^\circ$. $\Delta I_\gamma=10\%$ for strong transitions (taken by evaluator to be those with $I_\gamma \geq 10$); $\Delta I_\gamma=20\%$ assumed for others.

& Deduced from combined I_γ for both placements and analysis of level intensity balances.

^a From γ -ray angular distributions. Stretched Q assignments were based on large positive A_2 , and intraband D(+Q) assignments, on negative A_2 and placement relative to cascading Q γ 's, except as noted. Additionally, in Adopted Gammas, $\Delta\pi=(\text{no})$ is assigned for intraband transitions.

^b Estimated by evaluator from plot of measured and calculated mixing ratios as a function of spin in fig. 8 of **1970Se15**.

^c Multiply placed with undivided intensity.

^d Multiply placed with intensity suitably divided.

^e Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

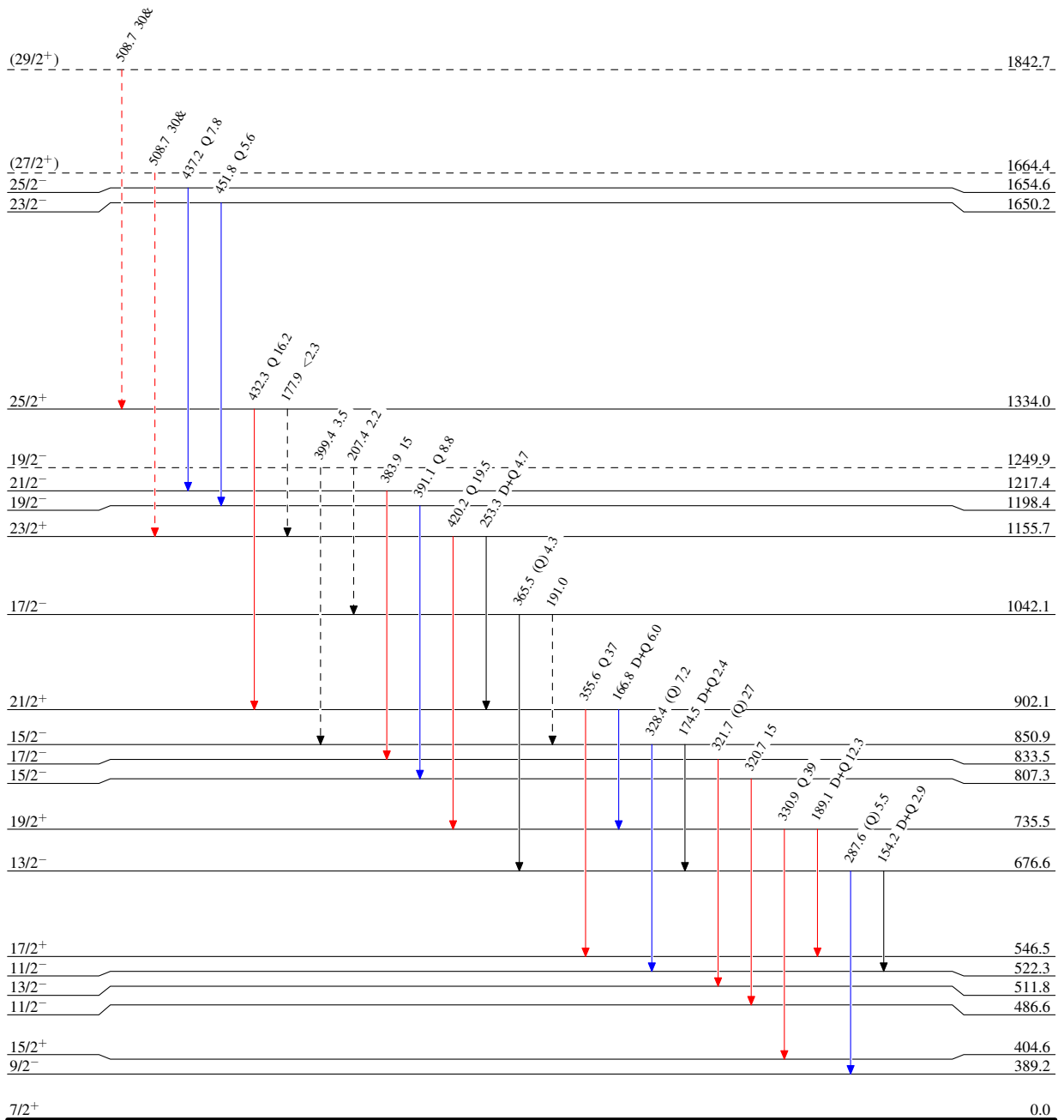
$^{167}\text{Er}(\alpha, 2n\gamma)$ 1970Se15

Level Scheme

Intensities: relative I_γ for $E(\alpha)=26$ MeV, $\theta=130^\circ$
& Multiply placed: undivided intensity given

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ γ Decay (Uncertain)

 $^{169}_{70}\text{Yb}_{99}$

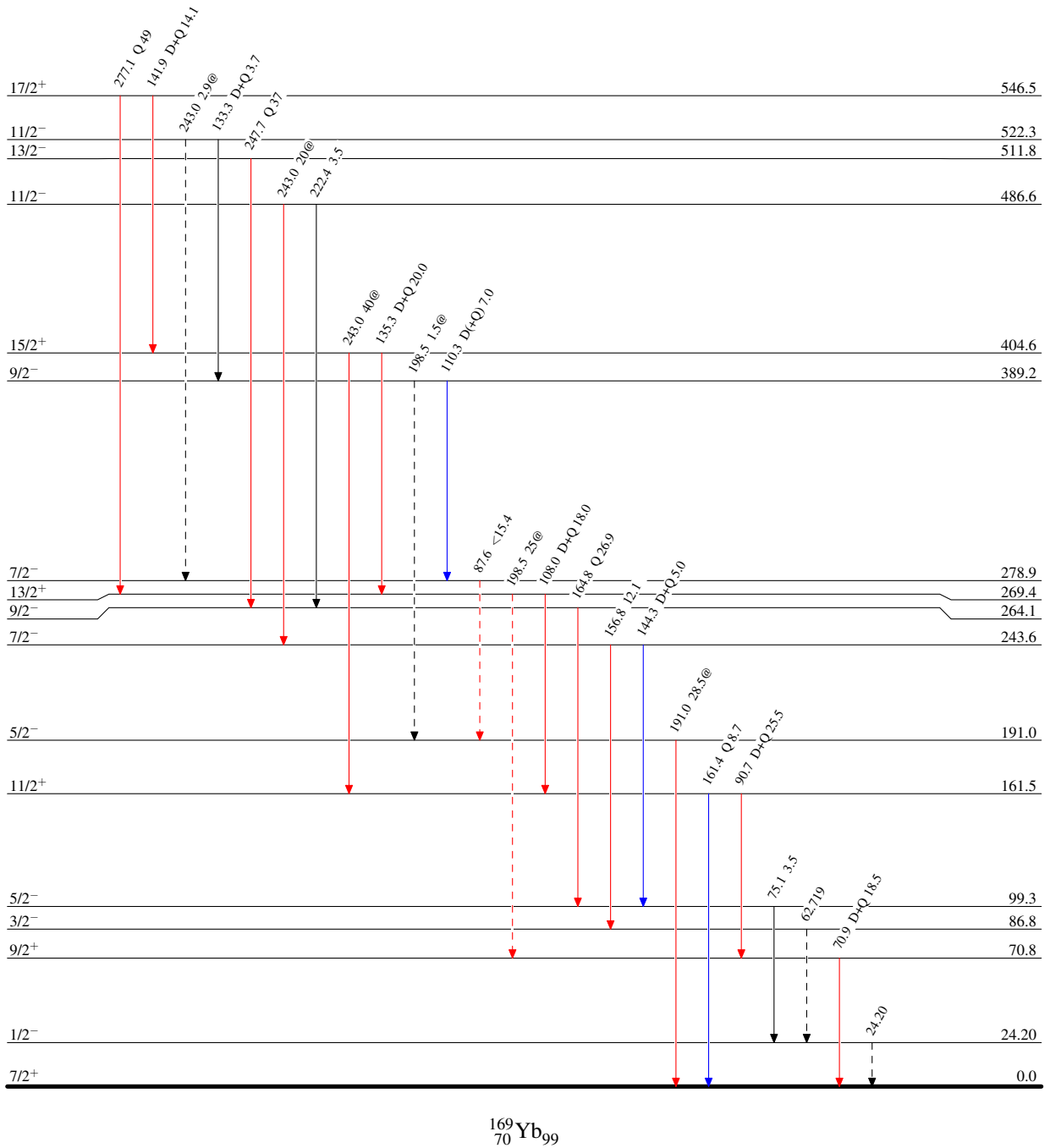
$^{167}\text{Er}(\alpha, 2n\gamma)$ 1970Se15

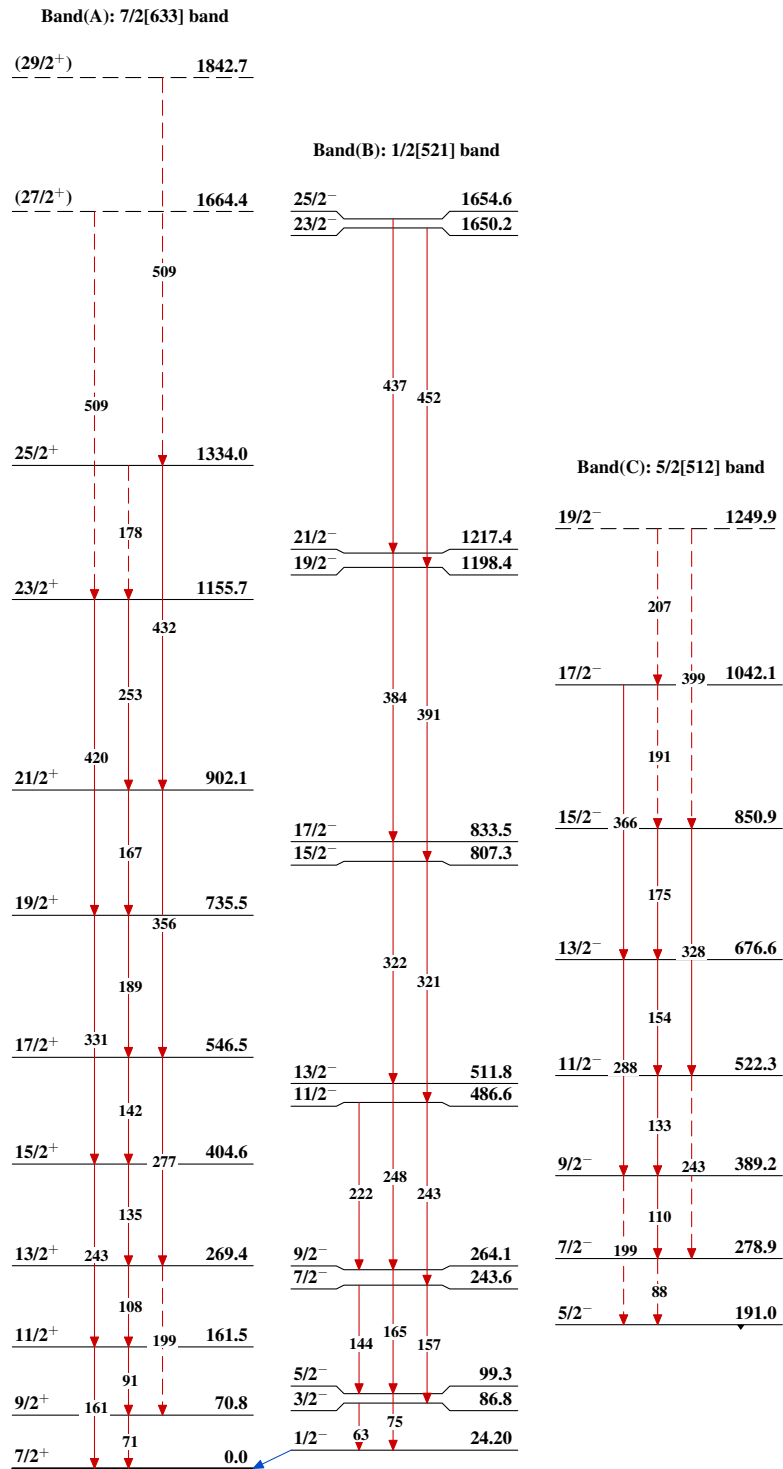
Level Scheme (continued)

Intensities: relative I_γ for $E(\alpha)=26$ MeV, $\theta=130^\circ$
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\cdots\cdots\cdots$ γ Decay (Uncertain)



$^{167}\text{Er}(\alpha, 2n\gamma)$ 1970Se15 $^{169}_{70}\text{Yb}_{99}$

$^{168}\text{Yb}(n,\gamma)$ E=thermal [1969Bo16,1972Wi12,1973GrZV](#)

Others: [2007ChZX](#) (supersedes [2003ChZS](#)), [1963Gi06](#), [1967Pr08](#), [1968Mi08](#) (also [1967Mi12](#)), [1968Sh12](#), [1973PrZl](#).

The level scheme combines data for primary transitions from [1973GrZV](#) (measured E_γ , I_γ), and for secondary transitions from

[1972Wi12](#) (measured E_γ , I_γ (crystal spectrometer)) and [1969Bo16](#) (measured $E(\text{ce})$, Ice (mag spect), E_γ , I_γ (Ge(Li)), $\gamma\gamma$ coin).

Reference citations are given with data from other sources. The evaluation of these data in [1988DzZW](#) has also been considered.

Many transitions remain unplaced, a number are multiply-placed, a number of levels fed by primary transitions do not yet have any deexciting gammas assigned, and intensity balance at excited levels is not good. Some transitions are almost certainly misplaced.

 ^{169}Yb Levels

E(level) [†]	J^π [‡]	Comments
0.0 [#]	7/2 ⁺	
24.1996 [@] 12	1/2 ⁻	
70.8817 [#] 8	9/2 ⁺	
86.9185 [@] 12	3/2 ⁻	
99.2401 [@] 12	5/2 ⁻	
161.6508 [#] 10	11/2 ⁺	
191.2136 ^{&} 11	5/2 ⁻	
243.8162 [@] 13	7/2 ⁻	
264.2533 [@] 19	9/2 ⁻	
269.6556 [#] 24	13/2 ⁺	
278.5973 ^{&} 12	7/2 ⁻	
389.5266 ^{&} 13	9/2 ⁻	
486.944 [@] 3	(11/2 ⁻)	
512.029 [@] 15	(13/2 ⁻)	E(level): level proposed in 1988DzZW .
523.070 ^{&} 4	11/2 ⁻	
569.831 ^a 3	5/2 ⁻	
590.695 ^b 7	(5/2 ⁺)	
647.281 ^b 10	7/2 ⁺	
647.837 ^a 3	7/2 ⁻	
659.618 ^c 7	3/2 ⁻	
677.105 ^{&} 6	13/2 ⁻	
706.981 ^b 9	9/2 ⁺	
719.936 ^c 6	3/2 ⁺	
722.263 ^c 6	5/2 ⁻	
748.974 ^a 6	(9/2 ⁻)	
757.869 ^b 19	(11/2 ⁺)	E(level): level proposed in 1988DzZW .
761.845 ^c 7	(5/2 ⁺)	
807.054 ^c 11	(7/2 ⁻)	
813.326 ^d 9	(1/2 ⁻)	
831.889 ^c 10	(7/2 ⁺)	
851.372 ^d 15	3/2 ⁻	
865.169 ^a 14	(11/2 ⁻)	E(level): possible level proposed in 1988DzZW .
911.654 ^d 12	(5/2 ⁻)	
919.749 ^c 11	(9/2 ⁻)	
946.450? 12		E(level): level proposed in 1988DzZW .
960.46 ^c 5	7/2 ⁻	
996.69 ^d 6	(7/2 ⁻)	
1033.883 ^c 6	(1/2 ⁺ , 3/2 ⁻)	
1061.06 ^c 4	(11/2 ⁻)	E(level): level proposed in 1988DzZW .

Continued on next page (footnotes at end of table)

$^{168}\text{Yb}(n,\gamma)$ E=thermal **1969Bo16,1972Wi12,1973GrZV (continued)** ^{169}Yb Levels (continued)

E(level) [†]	J π [‡]	Comments
1064.675 13	(5/2 ⁺ , 7/2, 9/2 ⁺)	
1070.78 ^f 4	7/2 ⁺	
1078.04? 4		E(level): level proposed in 1988DzZW.
1110.691 8	3/2 ⁻ , 5/2 ⁻	
1141.26 10	(9/2 ⁺)	E(level): level proposed in 1988DzZW.
1159.87 4	(5/2 ⁺)	
1176.662 15	(7/2, 9/2 ⁺)	
1202.163 15	(5/2 ⁺)	
1225.42 8	1/2, 3/2, 5/2 ⁺	
1232.16 4	(3/2 ⁻)	
1261.70 3	(5/2, 7/2 ⁻)	E(level): level proposed in 1988DzZW.
1270.726 9	(1/2 ⁻)	
1285.111 9	(3/2 ⁺ , 5/2, 7/2 ⁺)	E(level): level proposed in 1988DzZW.
1296.660 12	(3/2 ⁻ , 5/2, 7/2 ⁻)	
1311.793 13	(5/2 ⁺ , 7/2)	E(level): level proposed in 1988DzZW.
1319.60 ^e 16	(1/2 ⁻)	
1350.108 ^e 15	(3/2 ⁻)	
1354.836 15	(3/2 ⁻)	E(level): level not included in 1988DzZW.
1395.387 ^e 11	(5/2 ⁻)	E(level): level not included in 1988DzZW.
1398.692 14	(3/2 ⁻)	
1449.52 3	7/2 ⁻	E(level): level proposed in 1988DzZW.
1463.02 4	(7/2 ⁻)	E(level): level proposed in 1988DzZW.
1464.98 ^e 5	(7/2 ⁻)	
1478.485 17	(3/2 ⁻ , 5/2 ⁺)	
1509.7 9	1/2 ⁻	
1524.08 3	1/2, 3/2, 5/2 ⁺	
1531.559 13	(3/2 ⁻ , 5/2 ⁺)	
1554.829 24	(1/2 ⁻)	
1585.856 15	(1/2 ⁻)	
1616.676 12	(1/2 ⁺ , 3/2, 5/2 ⁺)	E(level): level proposed in 1988DzZW.
1618.692 18	1/2, 3/2	
1688.91 13	(5/2, 7/2 ⁻)	
1696.348 16	3/2 ⁻	
1724.49 4	(3/2 ⁻)	
1742.850 19	(3/2 ⁺ , 5/2, 7/2 ⁻)	E(level): level proposed in 1988DzZW.
1745.0 8	(1/2 ⁻)	
1757.3 9	1/2, 3/2, 5/2 ⁺	
1781.208 25	(3/2 ⁻ , 5/2 ⁻)	E(level): level proposed in 1988DzZW. Differs from 1781 level known from ε decay because decay pattern differs.
1787.3 8	1/2, 3/2, 5/2 ⁺	
1796.661 22	(3/2 ⁻ , 5/2 ⁺)	E(level): level proposed in 1988DzZW.
1828.037 16	1/2, 3/2, 5/2 ⁺	
1837.5 7	1/2, 3/2, 5/2 ⁺	
1857.4 9	1/2, 3/2, 5/2 ⁺	
1867.57 4	(3/2 ⁻ , 5/2 ⁺)	
1894.0 8	1/2, 3/2, 5/2 ⁺	
1910.9 10	1/2, 3/2, 5/2 ⁺	
1920.5 9	1/2, 3/2, 5/2 ⁺	
1939.0 7	1/2, 3/2, 5/2 ⁺	
1998.4 7	1/2, 3/2, 5/2 ⁺	
2037.7 8	1/2, 3/2, 5/2 ⁺	
2048.2 11	1/2, 3/2, 5/2 ⁺	
2103.6 7	1/2, 3/2, 5/2 ⁺	
2123.2 12	1/2, 3/2, 5/2 ⁺	
2192.9 10	1/2, 3/2, 5/2 ⁺	

Continued on next page (footnotes at end of table)

$^{168}\text{Yb}(n,\gamma)$ E=thermal **1969Bo16,1972Wi12,1973GrZV** (continued) ^{169}Yb Levels (continued)

$E(\text{level})^\dagger$	$J^\pi^\ddagger$
2217.5 10	1/2,3/2,5/2 ⁺
2234.5 9	1/2,3/2,5/2 ⁺
2244.5 7	1/2,3/2,5/2 ⁺
2286.2 12	1/2,3/2,5/2 ⁺
2299.1 9	1/2,3/2,5/2 ⁺
2313.6 7	1/2,3/2,5/2 ⁺
2342.4 9	1/2,3/2,5/2 ⁺
2350.1 8	1/2,3/2,5/2 ⁺
2355.6 8	1/2,3/2,5/2 ⁺
2375.9 10	1/2,3/2,5/2 ⁺
2381.4 10	1/2,3/2,5/2 ⁺
2388.0 9	1/2,3/2,5/2 ⁺
2401.0 9	1/2,3/2,5/2 ⁺
2407.4 9	1/2,3/2,5/2 ⁺
2415.4 9	1/2,3/2,5/2 ⁺
2427.5 10	1/2,3/2,5/2 ⁺
2441.1 10	1/2,3/2,5/2 ⁺
2449.8 8	1/2,3/2,5/2 ⁺
2477.9 10	1/2,3/2,5/2 ⁺
2498.7 8	1/2,3/2,5/2 ⁺
2504.4 9	1/2,3/2,5/2 ⁺
2517.1 10	1/2,3/2,5/2 ⁺
2522.8 8	1/2,3/2,5/2 ⁺
2530.3 8	1/2,3/2,5/2 ⁺
2551.1 8	1/2,3/2,5/2 ⁺
2620.9 10	1/2,3/2,5/2 ⁺
2634.0 12	1/2,3/2,5/2 ⁺
2655.4 7	1/2,3/2,5/2 ⁺
2679.7 8	1/2,3/2,5/2 ⁺
2684.8 11	1/2,3/2,5/2 ⁺
2705.9 8	1/2,3/2,5/2 ⁺
2741.8 9	1/2,3/2,5/2 ⁺
2774.5 9	1/2,3/2,5/2 ⁺
2781.0 10	1/2,3/2,5/2 ⁺
2801.9 10	1/2,3/2,5/2 ⁺
2827.2 7	1/2,3/2,5/2 ⁺
2856.0 9	1/2,3/2,5/2 ⁺
2869.9 9	1/2,3/2,5/2 ⁺
2891.6 7	1/2,3/2,5/2 ⁺
2917.3 8	1/2,3/2,5/2 ⁺
2932.8 15	1/2,3/2,5/2 ⁺
2952.0 10	1/2,3/2,5/2 ⁺
2988.6 9	1/2,3/2,5/2 ⁺
2998.9 10	1/2,3/2,5/2 ⁺
3015.2 12	1/2,3/2,5/2 ⁺
3027.4 9	1/2,3/2,5/2 ⁺
3038.4 8	1/2,3/2,5/2 ⁺
3043.8 8	1/2,3/2,5/2 ⁺
3066.1 8	1/2,3/2,5/2 ⁺
3094.5 9	1/2,3/2,5/2 ⁺
3105.6 7	1/2,3/2,5/2 ⁺
3118.9 11	1/2,3/2,5/2 ⁺
3130.3 9	1/2,3/2,5/2 ⁺
3142.6 8	1/2,3/2,5/2 ⁺
3173.8 8	1/2,3/2,5/2 ⁺

Continued on next page (footnotes at end of table)

$^{168}\text{Yb}(\text{n},\gamma)$ E=thermal [1969Bo16](#),[1972Wi12](#),[1973GrZV](#) (continued) ^{169}Yb Levels (continued)

E(level) [†]	J ^π [‡]	Comments
3246.5 9	1/2,3/2,5/2 ⁺	
3274.0 15	1/2,3/2,5/2 ⁺	
3344.4 8	1/2,3/2,5/2 ⁺	
3375.4 8	1/2,3/2,5/2 ⁺	
3450.0 9	1/2,3/2,5/2 ⁺	
3526.7 8	1/2,3/2,5/2 ⁺	
3559.9 9	1/2,3/2,5/2 ⁺	
3657.0 10	1/2,3/2,5/2 ⁺	
(6866.67 14)	1/2 ⁺	E(level): thermal neutron capture state(s). J ^π : s-wave capture by even-even nucleus.

[†] From least-squares fit to E_γ, excluding transitions with uncertain or multiple placements and the 545.54γ (from 707 level), 470.557γ (from 749 level), 469.50γ (from 1177 level), 611.626γ (from 1202 level) and 474.28γ from (1065 level), all of which fit their placements poorly. Note that E_γ for four additional transitions deviate by 3σ from expected values and one by 4σ. Some placements in this level scheme are almost certainly incorrect.

[‡] From Adopted Levels.

Band(A): 7/2[633] band.

@ Band(B): 1/2[521] band.

& Band(C): 5/2[512] band.

^a Band(D): 5/2[523] band.

^b Band(E): 5/2[642] band.

^c Band(F): 3/2[521] band + K=2 γ vibration built on 1/2[521].

^d Band(G): 1/2[510] band + K=2 γ vibration built on 5/2[512].

^e Band(H): 1/2[510] band + γ vibration. The γ vibration is possibly a K=2 γ vibration built on 5/2[523]. Tentative band assignment.

^f Band(I): β vibration band built on 7/2[633]. Band assignment from [1988DzZW](#).

γ(¹⁶⁹Yb)

I_γ normalization: I_γ normalization=0.0047 7 from absolute elemental cross section measurement (0.141 b 15) for the strongest secondary γ (720γ) (Budapest data in [2007ChZX](#)). If, instead, I_γ normalization is obtained by requiring that Σ(I(γ+ce) to g.s. + I(γ+ce) to 24 level)=100, a larger factor (0.0062 11) would be obtained, suggesting that some of the many unplaced transitions feed the g.s. or 24 level. The Budapest data in [2007ChZX](#) include only one primary γ (E_γ=5028.7 5); it cannot be used to normalize the primary γ intensity scale because it appears to arise largely from sources other than ¹⁶⁸Yb n capture. If one assumes Σ (I_γ from 6687 level)=100, a normalization factor of 0.050 1 is obtained but this probably is not reliable because it is very unlikely that all primary gammas have been observed.

E _γ [†]	I _γ ^a	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. ^d	δ	α ^f	Comments
(24.1996)		24.1996	1/2 ⁻	0.0	7/2 ⁺				E _γ : from level energy difference.
62.7190 6	451 72	86.9185	3/2 ⁻	24.1996	1/2 ⁻	M1+E2	0.51 14	14.6 8	α(L)exp=4.5 12. δ: from α(L)exp using the BriccMixing code (v2.3b).
70.8814 9	70 11	70.8817	9/2 ⁺	0.0	7/2 ⁺	M1(+E2)		10.9 18	α(L1)exp=1.15 30. δ: 0.0 6 from α(L1)exp using the BriccMixing code (v2.3b).
75.0404 8	106 17	99.2401	5/2 ⁻	24.1996	1/2 ⁻	E2		10.05 14	α(L2)exp+α(L3)exp=4.8 12.
79.793 9	1.1 2	1478.485	(3/2 ⁻ ,5/2 ⁺)	1398.692	(3/2) ⁻				E _γ : other: 81 3.
87.3836 10	115 18	278.5973	7/2 ⁻	191.2136	5/2 ⁻	M1(+E2)		5.20 24	α(L1)exp=0.90 24. δ: 0.0 6 from α(L1)exp using the BriccMixing code (v2.3b).
89.809 ⁱ 15	0.55 13	659.618	3/2 ⁻	569.831	5/2 ⁻				
90.7692 10	15.9 25	161.6508	11/2 ⁺	70.8817	9/2 ⁺	[M1]		4.46 6	
91.9737 12	66 11	191.2136	5/2 ⁻	99.2401	5/2 ⁻	[M1,E2]		4.37 10	α(L1)exp<1.0.
^x 102.346 15	0.68 19								
^x 103.659 7	0.43 10								
^x 103.9019 12	4.5 6								
104.2955 17	50 8	191.2136	5/2 ⁻	86.9185	3/2 ⁻	M1(+E2)		2.86 14	α(L1)exp=0.48 12. δ: 0.0 5 from α(L1)exp using the BriccMixing code (v2.3b).
108.0053 25	1.2 2	269.6556	13/2 ⁺	161.6508	11/2 ⁺				
110.9291 10	22 3	389.5266	9/2 ⁻	278.5973	7/2 ⁻				
111.961 9	0.39 6	831.889	(7/2) ⁺	719.936	3/2 ⁺				
113.569 15	6.9 9	1398.692	(3/2) ⁻	1285.111	(3/2 ⁺ ,5/2,7/2 ⁺)				
^x 119.882 20	0.24 7								
^x 121.614 8	0.34 4								
129.221 10	0.35 6	719.936	3/2 ⁺	590.695	(5/2) ⁺				
^x 129.458 9	0.28 14								
^x 130.383 12	1.14 23								

$^{168}\text{Yb}(n,\gamma)$ E=thermal 1969Bo16,1972Wi12,1973GrZV (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^a	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^d	δ	α^f	Comments
131.6883 ^{& 20}	0.74 16	1828.037	1/2,3/2,5/2 ⁺	1696.348	3/2 ⁻				
^x 133.216 12	0.34 6								
133.542 4	1.6 3	523.070	11/2 ⁻	389.5266	9/2 ⁻				
135.130 ^{& 15}	0.24 5	1311.793	(5/2 ⁺ ,7/2)	1176.662	(7/2,9/2) ⁺				
137.487 ^{& 8}	0.55 9	1202.163	(5/2 ⁺)	1064.675	(5/2 ⁺ ,7/2,9/2 ⁺)				
143.087 ^{& 25}	0.39 9	1867.57	(3/2 ⁻ ,5/2 ⁺)	1724.49	(3/2 ⁻)				
^x 143.933 17	0.23 5								
144.5758 9	116 16	243.8162	7/2 ⁻	99.2401	5/2 ⁻	M1(+E2)	0.4 12	1.13 21	$\alpha(\text{K})_{\text{exp}}=0.91$ 22. δ : from $\alpha(\text{K})_{\text{exp}}$ using the BriccMixing code (v2.3b).
149.790 ^{& 20}	0.52 13	911.654	(5/2) ⁻	761.845	(5/2) ⁺				
153.732 12	0.27 17	813.326	(1/2) ⁻	659.618	3/2 ⁻				
154.020 10	0.48 26	677.105	13/2 ⁻	523.070	11/2 ⁻				
^x 154.747 15	0.29 4								
156.8977 10	269 38	243.8162	7/2 ⁻	86.9185	3/2 ⁻	E2		0.616 9	K:(L1+L2):L3=10:4.2:1.8 (1969Bo16).
^x 157.33 3	0.24 9								
^x 158.541 4	0.63 3								
^x 159.300 6	0.8 3								
160.035 4	0.78 23	1270.726	(1/2) ⁻	1110.691	3/2 ⁻ ,5/2 ⁻				
161.6513 15	3.8 5	161.6508	11/2 ⁺	0.0	7/2 ⁺	[E2]		0.555 8	
^x 163.394 20	0.21 4								
^x 163.896 4	0.66 9								
165.0134 15	69 9	264.2533	9/2 ⁻	99.2401	5/2 ⁻	E2		0.517 7	$\alpha(\text{K})_{\text{exp}}=0.35$ 8; K:L2:L3=10:<7:2.8 (1969Bo16).
167.0141 25	1.6 2	191.2136	5/2 ⁻	24.1996	1/2 ⁻	[E2]		0.495 7	
170.731 ^{& 20}	0.17 4	919.749	(9/2) ⁻	748.974	(9/2) ⁻				
171.156 7	0.36 8	761.845	(5/2) ⁺	590.695	(5/2) ⁺				
174.017 ^{& 25}	0.48 15	1524.08	1/2,3/2,5/2 ⁺	1350.108	(3/2 ⁻)				
174.420 ^{& 2}	2.3 3	1285.111	(3/2 ⁺ ,5/2,7/2 ⁺)	1110.691	3/2 ⁻ ,5/2 ⁻				
^x 176.45 @ 2	1.2 3								
177.94 ^{& 4}	0.47 27	1463.02	(7/2 ⁻)	1285.111	(3/2 ⁺ ,5/2,7/2 ⁺)				
179.116 ^{& 12}	0.20 8	748.974	(9/2) ⁻	569.831	5/2 ⁻				
179.356 4	1.6 2	278.5973	7/2 ⁻	99.2401	5/2 ⁻				
181.27 ^{#c& 45}	9 ^c 4	1531.559	(3/2 ⁻ ,5/2 ⁺)	1350.108	(3/2 ⁻)				
^x 182.998 15	0.24 4								
183.920 ^{& 12}	0.23 10	706.981	9/2 ⁺	523.070	11/2 ⁻				
^x 184.286 6	1.7 2								
185.941 25	0.30 4	1296.660	(3/2 ⁻ ,5/2,7/2 ⁻)	1110.691	3/2 ⁻ ,5/2 ⁻				

¹⁶⁸Yb(n,γ) E=thermal [1969Bo16,1972Wi12,1973GrZV](#) (continued)

<u>γ(¹⁶⁹Yb) (continued)</u>								
E _γ [†]	I _γ ^a	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. ^d	α ^f	Comments
187.159 8 9	0.45 7	1585.856	(1/2 ⁻)	1398.692	(3/2 ⁻)			
187.817 8 17	0.20 4	1449.52	7/2 ⁻	1261.70	(5/2,7/2 ⁻)			
^x 189.0377 25	1.8 2							
191.2137 15	1.55×10 ³ 20	191.2136	5/2 ⁻	0.0	7/2 ⁺	E1	0.0623 9	α(K)exp=0.052 12.
197.508 30	0.36 4	919.749	(9/2 ⁻)	722.263	5/2 ⁻			
198.3136 17	6.9 9	389.5266	9/2 ⁻	191.2136	5/2 ⁻			
198.771 5	0.62 9	269.6556	13/2 ⁺	70.8817	9/2 ⁺			
^x 199.226 8	3.1 20							
^x 200.95 4	0.29 4							
204.705 8 25	0.26 7	1554.829	(1/2 ⁻)	1350.108	(3/2 ⁻)			
^x 205.541 25	0.25 4							
207.713 3	15 2	278.5973	7/2 ⁻	70.8817	9/2 ⁺			Placement from Adopted Levels, Gammas.
208.336 15	0.37 6	486.944	(11/2 ⁻)	278.5973	7/2 ⁻			
212.783 8 10	0.51 8	919.749	(9/2 ⁻)	706.981	9/2 ⁺			
^x 216.416 25	0.40 7							
217.321 8 15	0.45 12	865.169	(11/2 ⁻)	647.837	7/2 ⁻			
^x 219.140 10	0.14 6							
^x 220.859 7	0.60 12							
222.694 6	0.95 13	486.944	(11/2 ⁻)	264.2533	9/2 ⁻			
225.901 6	0.81 8	748.974	(9/2 ⁻)	523.070	11/2 ⁻			
226.379 8 5	0.96 15	1781.208	(3/2 ⁻ ,5/2 ⁻)	1554.829	(1/2 ⁻)			
227.878 3	2.3 3	389.5266	9/2 ⁻	161.6508	11/2 ⁺			
230.193 8 25	0.37 8	1176.662	(7/2,9/2) ⁺	946.450?				
^x 234.560 17	0.47 22							E _γ : placement from 1524 level suggested in 1988DzZW ; not adopted because E _γ does not fit that placement.
234.904 8 7	0.74 9	1531.559	(3/2 ⁻ ,5/2 ⁺)	1296.660	(3/2 ⁻ ,5/2,7/2 ⁻)			
^x 237.520 10	0.64 9							
239.464 8 15	0.45 8 7	946.450?		706.981	9/2 ⁺			
239.464 8 15	0.45 8 7	1350.108	(3/2 ⁻)	1110.691	3/2 ⁻ ,5/2 ⁻			
243.127 3	5.0 6	486.944	(11/2 ⁻)	243.8162	7/2 ⁻			
244.474 5	1.27 16	523.070	11/2 ⁻	278.5973	7/2 ⁻			
^x 246.133 7	1.18 14							
^x 246.60 3	0.33 7							1988DzZW suggest placement from 1078 level; not adopted because much stronger branches expected to accompany it are absent in (n,γ) E=thermal.
^x 246.917 25	0.36 7							E _γ : placement from 1311 level suggested in 1988DzZW ; not adopted because E _γ fits this placement poorly.

¹⁶⁸Yb(n,γ) E=thermal [1969Bo16,1972Wi12,1973GrZV](#) (continued)

$\gamma(^{169}\text{Yb})$ (continued)								
E_γ [†]	I_γ ^a	E_i (level)	J_i^π	E_f	J_f^π	Mult. ^d	α ^f	Comments
247.766 ^{& 15}	0.46 ¹¹	512.029	(13/2) ⁻	264.2533	9/2 ⁻			
^x 248.099 ¹⁵	0.65 ¹⁰							
^x 248.944 ¹⁷	0.58 ¹³							
^x 253.07 ³	0.31 ⁸							
254.01 ^{& 4}	0.45 ⁸	1061.06	(11/2) ⁻	807.054	(7/2) ⁻			
258.311 ³	11.8 ¹⁵	647.837	7/2 ⁻	389.5266	9/2 ⁻	M1	0.2358 ³³	$\alpha(\text{K})_{\text{exp}}=0.27$ 7.
262.164 ^{& i 8}	0.56 ²²	748.974	(9/2) ⁻	486.944	(11/2) ⁻			E_γ : placement shown as uncertain because E_γ fits this placement poorly.
262.753 ^{& 17}	0.53 ¹⁰	1296.660	(3/2 ⁻ ,5/2,7/2 ⁻)	1033.883	(1/2 ⁺ ,3/2)			
^x 263.341 ²⁵	0.37 ⁶							
264.365 ^{& 10}	0.61 ⁸	1742.850	(3/2 ⁺ ,5/2,7/2 ⁻)	1478.485	(3/2 ⁻ ,5/2 ⁺)			
^x 266.69 ⁶	0.60 ¹⁶							
271.70 ^{& 3}	0.44 ⁶	1232.16	(3/2) ⁻	960.46	7/2 ⁻			
272.053 ^{& 10}	1.16 ²¹	1033.883	(1/2 ⁺ ,3/2)	761.845	(5/2) ⁺			
^x 273.516 ¹²	0.56 ⁷							
^x 278.245 ¹²	0.83 ²²							
278.595 ⁵	4.7 ⁶	278.5973	7/2 ⁻	0.0	7/2 ⁺	[E1]	0.02391 ³³	
^x 279.52 ³	0.71 ¹¹							
^x 282.43 ^{#c 15}	16 ^{c 3}							
^x 283.66 ⁵	0.63 ¹⁶							
284.691 ⁸	0.88 ¹²	1395.387	(5/2) ⁻	1110.691	3/2 ⁻ ,5/2 ⁻			
^x 286.175 ⁶	2.6 ³							
287.585 ⁷	1.56 ²³	677.105	13/2 ⁻	389.5266	9/2 ⁻			
291.233 ³	48 ⁶	569.831	5/2 ⁻	278.5973	7/2 ⁻	M1	0.1704 ²⁴	$\alpha(\text{K})_{\text{exp}}=0.17$ 4.
^x 295.36 ^{‡ 2}	1.61 ²²							
296.53 ^{& 2}	0.82 ⁶	1828.037	1/2,3/2,5/2 ⁺	1531.559	(3/2 ⁻ ,5/2 ⁺)			
297.40 ⁴	0.44 ⁸	1110.691	3/2 ⁻ ,5/2 ⁻	813.326	(1/2) ⁻			
^x 298.317 ¹⁰	0.73 ¹¹							
^x 299.80 ⁴	0.41 ⁹							
^x 303.50 ³	0.65 ¹⁶							
304.880 ^{& 7}	3.3 ⁴	1616.676	(1/2 ⁺ ,3/2,5/2 ⁺)	1311.793	(5/2 ⁺ ,7/2)			
311.619 ⁵	4.0 ⁵	1033.883	(1/2 ⁺ ,3/2)	722.263	5/2 ⁻			
312.082 ^{g & 15}	0.5 ^{g 3}	590.695	(5/2) ⁺	278.5973	7/2 ⁻			
312.082 ^{g & 15}	0.5 ^{g 3}	1061.06	(11/2) ⁻	748.974	(9/2) ⁻			
313.940 ^{& 5}	6.5 ⁸	1033.883	(1/2 ⁺ ,3/2)	719.936	3/2 ⁺			
315.151 ²⁰	1.61 ²⁴	1585.856	(1/2) ⁻	1270.726	(1/2) ⁻			
^x 315.604 ^{& 25}	0.68 ¹²							E_γ : placed in 1988DzZW from 1450 level but E_γ does not fit that placement.

¹⁶⁸Yb(n,γ) E=thermal [1969Bo16,1972Wi12,1973GrZV](#) (continued)

γ(¹⁶⁹Yb) (continued)

E _γ [†]	I _γ ^a	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. ^d	α ^f	Comments
318.646 15	0.96 12	389.5266	9/2 ⁻	70.8817	9/2 ⁺			
320.013 & 7	3.1 4	1616.676	(1/2 ⁺ , 3/2, 5/2 ⁺)	1296.660	(3/2 ⁻ , 5/2, 7/2 ⁻)			
^x 320.816 @ 17	1.6 5							
325.987 12	1.64 19	569.831	5/2 ⁻	243.8162	7/2 ⁻			
^x 328.98 5	0.68 18							
^x 329.48 3	0.88 18							
^x 331.17 6	0.53 21							
^x 333.946 25	6.5 12							
^x 335.12 6	0.68 20							
^x 338.60 9	0.59 21							
^x 342.09 5	1.16 28							
342.32 & 5	1.05 27	865.169	(11/2 ⁻)	523.070	11/2 ⁻			
^x 346.72 4	0.93 13							
348.77 ⁱ 5	0.54 15	996.69	(7/2) ⁻	647.837	7/2 ⁻			
350.99 & 10	1.55 27	1202.163	(5/2 ⁺)	851.372	3/2 ⁻			
^x 351.65 6	0.48 13							
353.04 & 5	0.75 17	865.169	(11/2 ⁻)	512.029	(13/2) ⁻			
^x 355.14 5	0.8 3							
^x 356.413 25	1.17 18							
357.686 9	2.6 5	1064.675	(5/2 ⁺ , 7/2, 9/2 ⁺)	706.981	9/2 ⁺			
^x 358.72 3	0.93 16							
359.495 ‡ 17	2.7 4	748.974	(9/2) ⁻	389.5266	9/2 ⁻			
^x 364.16 #c 25	17 ^c 4							
^x 365.972 9	2.4 5							
369.232 5	30 4	647.837	7/2 ⁻	278.5973	7/2 ⁻	M1	0.0904 13	α(K)exp=0.092 22. E _γ : placement from 1202 level suggested in 1988DzZW ; not adopted because E _γ fits this placement poorly.
^x 370.588 9	4.4 6							
374.266 7	9.5 11	1033.883	(1/2 ⁺ , 3/2)	659.618	3/2 ⁻			
378.624 5	236 31	569.831	5/2 ⁻	191.2136	5/2 ⁻	(M1)	0.0846 12	α(K)exp=0.071 17.
383.595 15	3.0 4	647.837	7/2 ⁻	264.2533	9/2 ⁻			
^x 385.43 12	1.6 4							
^x 388.06 ‡ 3	1.1 3							
389.53 3	1.5 10	389.5266	9/2 ⁻	0.0	7/2 ⁺	[E1]	0.01067 15	
390.748 & 8	7.2 9	1110.691	3/2 ⁻ , 5/2 ⁻	719.936	3/2 ⁺			
^x 395.412 17	4.1 6							
^x 395.836 20	6.8 16							E _γ : placement from 1160 level suggested in 1988DzZW ; not adopted because E _γ does not fit that placement.

¹⁶⁸Yb(n,γ) E=thermal 1969Bo16,1972Wi12,1973GrZV (continued)

$\gamma(^{169}\text{Yb})$ (continued)								
E_γ [†]	I_γ ^a	E_i (level)	J_i^π	E_f	J_f^π	Mult. ^d	α ^f	Comments
399.621 ^{& 17}	5.5 7	1696.348	3/2 ⁻	1296.660	(3/2 ⁻ , 5/2, 7/2 ⁻)			E _γ : placement is doubtful because stronger branches expected from the 1078 level are not observed in (n,γ) E=thermal.
400.92 ^{& i 4}	1.8 4	1078.04?		677.105	13/2 ⁻			
^x 401.46 8	0.90 18							
401.87 ^{& 7}	0.75 22	1463.02	(7/2 ⁻)	1061.06	(11/2 ⁻)			
403.957 25	4.4 5	647.837	7/2 ⁻	243.8162	7/2 ⁻			
^x 410.954 25	2.6 4							
^x 412.525 25	2.5 4							
^x 413.850 17	3.9 6							
416.528 ^{& 10}	5.6 7	1618.692	1/2, 3/2	1202.163	(5/2 ⁺)			
417.50 ^{g & 11}	1.9 ^g 7	807.054	(7/2) ⁻	389.5266	9/2 ⁻			
417.50 ^{g 11}	1.9 ^g 7	1064.675	(5/2 ⁺ , 7/2, 9/2 ⁺)	647.281	7/2 ⁺			
418.76 ^{g & 5}	1.7 ^g 3	1176.662	(7/2, 9/2) ⁺	757.869	(11/2 ⁺)			
418.76 ^{g & 5}	1.7 ^g 3	1232.16	(3/2 ⁻)	813.326	(1/2) ⁻			
419.39 3	27 4	1270.726	(1/2) ⁻	851.372	3/2 ⁻	M1	0.0647 9	α(K)exp=0.077 19.
^x 419.67 6	3.0 6							
423.376 ^{g & 17}	4.3 ^g 5	946.450?		523.070	11/2 ⁻			
423.376 ^{g 17}	4.3 ^g 5	1070.78	7/2 ⁺	647.281	7/2 ⁺			
425.77 6	1.1 3	1696.348	3/2 ⁻	1270.726	(1/2) ⁻			
^x 426.59 9	1.9 4							
^x 428.95 ^{#c 55}	8 ^c 4							
432.75 3	1.8 2	919.749	(9/2) ⁻	486.944	(11/2 ⁻)			
^x 435.42 20	1.1 4							
436.98 ^{& 10}	2.1 5	706.981	9/2 ⁺	269.6556	13/2 ⁺			
^x 438.874 12	6.3 8							Placed in 1988DzZW from an otherwise unknown 1086 level.
439.42 ^{& 4}	4.2 12	1724.49	(3/2 ⁻)	1285.111	(3/2 ⁺ , 5/2, 7/2 ⁺)			
^x 441.42 ^{@ 15}	1.2 3							
^x 442.38 ^{@ 18}	1.0 3							Placed in 1988DzZW from a 1204 level but insufficient evidence for the existence of such a level is available.
443.182 9	18.1 24	1354.836	(3/2 ⁻)	911.654	(5/2) ⁻	(M1)	0.0560 8	α(K)exp=0.079 18.
443.659 25	3.8 6	722.263	5/2 ⁻	278.5973	7/2 ⁻			
444.69 ^{i 11}	2.6 5	1478.485	(3/2 ⁻ , 5/2 ⁺)	1033.883	(1/2 ⁺ , 3/2)			
445.17 7	0.9 3	1296.660	(3/2 ⁻ , 5/2, 7/2 ⁻)	851.372	3/2 ⁻			
^x 447.76 4	2.5 5							
^x 448.74 9	1.7 3							

¹⁶⁸Yb(n,γ) E=thermal **1969Bo16,1972Wi12,1973GrZV (continued)**

γ(¹⁶⁹Yb) (continued)

E _γ [†]	I _γ ^a	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. ^d	α ^f	Comments
451.15 ⁱ 11	1.0 3	1110.691	3/2 ⁻ ,5/2 ⁻	659.618	3/2 ⁻			
^x 452.43 8	1.4 3							
453.34 ^{&} 6	2.3 7	1285.111	(3/2 ⁺ ,5/2,7/2 ⁺)	831.889	(7/2) ⁺			
453.69 ^{&} 7	2.0 7	1724.49	(3/2 ⁻)	1270.726	(1/2) ⁻			
454.65 ^{&} 3	4.2 6	1261.70	(5/2,7/2 ⁻)	807.054	(7/2) ⁻			
^x 455.30 3	2.7 4							E _γ : placement from 1449 level suggested in 1988DzZW ; not adopted because E _γ does not fit this placement.
456.638 9	25 3	647.837	7/2 ⁻	191.2136	5/2 ⁻	(M1)	0.0518 7	α(K)exp=0.063 15.
457.43 2	6.6 9	1270.726	(1/2) ⁻	813.326	(1/2) ⁻			
^x 458.462 15	9.2 11							
459.25 ^{&} 5	2.2 6	1524.08	1/2,3/2,5/2 ⁺	1064.675	(5/2 ⁺ ,7/2,9/2 ⁺)			
^x 467.63 3	3.1 5							
468.434 ^{&} 12	14.3 ^g 19	659.618	3/2 ⁻	191.2136	5/2 ⁻			
468.434 ^g 12	14.3 ^g 19	1319.60	(1/2) ⁻	851.372	3/2 ⁻			
469.50 ^{&} 2	5.8 8	1176.662	(7/2,9/2) ⁺	706.981	9/2 ⁺			
470.55 ^h 17	12.2 ^h 12	569.831	5/2 ⁻	99.2401	5/2 ⁻			I _γ : deduced from total I _γ =19.3 27 and requirement that I(470γ from 570 level)/I(379γ) and I(470γ from 749 level)/I(360γ) should each be identical in ε decay and (n,γ) E=thermal. α(K)exp=0.043 12 (for 470.6γ doublet and 470.8γ combined).
470.55 ^h 17	^h 3	748.974	(9/2) ⁻	278.5973	7/2 ⁻			I _γ : see comment on 471γ from 569 level. α(K)exp=0.043 12 (for 470.6γ and 470.8γ combined).
^x 470.805 15	32 4							
^x 472.759 25	3.1 4							
474.28 6	2.1 4	1064.675	(5/2 ⁺ ,7/2,9/2 ⁺)	590.695	(5/2) ⁺			
^x 476.086 15	12.9 14							
^x 476.68 5	2.4 5							
477.98 3	6.4 11	1828.037	1/2,3/2,5/2 ⁺	1350.108	(3/2) ⁻			
478.449 10	34 5	722.263	5/2 ⁻	243.8162	7/2 ⁻	M1	0.0459 6	α(K)exp=0.044 11.
480.08 4	5.0 15	1070.78	7/2 ⁺	590.695	(5/2) ⁺			
482.894 12	20.0 26	569.831	5/2 ⁻	86.9185	3/2 ⁻	(M1)	0.0448 6	α(K)exp=0.067 16.
485.69 4	3.7 6	647.281	7/2 ⁺	161.6508	11/2 ⁺			
488.22 ^{&} 2	4.0 5	757.869	(11/2 ⁺)	269.6556	13/2 ⁺			
^x 491.90 3	2.3 3							
^x 492.69 6	2.8 4							
497.68 7	1.8 3	1531.559	(3/2 ⁻ ,5/2 ⁺)	1033.883	(1/2 ⁺ ,3/2)			
498.77 4	3.6 5	1350.108	(3/2 ⁻)	851.372	3/2 ⁻			
^x 501.478 15	17.4 21							

¹⁶⁸Yb(n,γ) E=thermal **1969Bo16,1972Wi12,1973GrZV (continued)**

γ(¹⁶⁹Yb) (continued)

E _γ [†]	I _γ ^a	E _i (level)	J _i ^π	E _f	J _f ^π	Comments
503.88 ^{&10}	2.7 7	590.695	(5/2) ⁺	86.9185	3/2 ⁻	
504.64 ^{&7}	3.8 10	1311.793	(5/2 ⁺ ,7/2)	807.054	(7/2) ⁻	
^x 505.40 3	5.4 8					
506.06 ^{&3}	7.1 9	1616.676	(1/2 ⁺ ,3/2,5/2 ⁺)	1110.691	3/2 ⁻ ,5/2 ⁻	
509.88 ^{@&6}	6.3 16	1232.16	(3/2 ⁻)	722.263	5/2 ⁻	
510.70 ^{&5}	11.0 15	1742.850	(3/2 ⁺ ,5/2,7/2 ⁻)	1232.16	(3/2 ⁻)	
511.55 ^{&2}	20.7 29	1796.661	(3/2 ⁻ ,5/2 ⁺)	1285.111	(3/2 ⁺ ,5/2,7/2 ⁺)	
512.03 ^{&5}	12.4 25	1159.87	(5/2 ⁺)	647.837	7/2 ⁻	
^x 513.80 ^{&6}	4.7 11					Placed in 1988DzZW from 1867 level but E _γ does not fit that placement.
518.07 ^{g&7}	4.0 ^g 11	761.845	(5/2) ⁺	243.8162	7/2 ⁻	
518.07 ^{g&7}	4.0 ^g 11	1478.485	(3/2 ⁻ ,5/2 ⁺)	960.46	7/2 ⁻	
518.56 ^{&8}	3.8 7	1464.98	(7/2) ⁻	946.450?		
519.788 ^{&15}	17.0 22	590.695	(5/2) ⁺	70.8817	9/2 ⁺	α(K)exp=0.061 15; exceeds α(K)(M1), but level scheme requires E2.
^x 521.17 7	2.6 6					
522.112 ^{&17}	18.8 24	911.654	(5/2) ⁻	389.5266	9/2 ⁻	
522.58 ^{g&6}	5.6 ^g 11	1724.49	(3/2 ⁻)	1202.163	(5/2 ⁺)	
^x 525.04 5	3.8 6					
^x 527.357 20	17.8 23					α(K)exp=0.035 10 (for 527.4γ+528.7γ).
528.672 ^{&25}	12.0 16	719.936	3/2 ⁺	191.2136	5/2 ⁻	α(K)exp=0.035 10 (for 527.4γ+528.7γ).
530.34 8	3.0 9	919.749	(9/2) ⁻	389.5266	9/2 ⁻	
531.04 3	5.1 8	722.263	5/2 ⁻	191.2136	5/2 ⁻	
^x 535.65 7	3.6 10					
^x 538.66 3	9.2 12					
539.10 ^{&25}	5.2 17	1261.70	(5/2,7/2 ⁻)	722.263	5/2 ⁻	
542.82 2	19.7 28	807.054	(7/2) ⁻	264.2533	9/2 ⁻	
^x 544.35 5	3.0 6					Placed in 1988DzZW from 1204 level but insufficient evidence for the existence of such a level is available.
545.54 ^{‡i} 2	20 4	569.831	5/2 ⁻	24.1996	1/2 ⁻	Placement proposed in 1988DzZW but not adopted; E _γ somewhat too low. In table in 1988DzZW , γ deexcites only the 707 level.
545.54 [‡] 2	20 4	706.981	9/2 ⁺	161.6508	11/2 ⁺	
547.45 ⁱ 20	3.7 9	1398.692	(3/2) ⁻	851.372	3/2 ⁻	
548.546 25	16.0 21	647.837	7/2 ⁻	99.2401	5/2 ⁻	
549.90 ^{&10}	2.0 4	1311.793	(5/2 ⁺ ,7/2)	761.845	(5/2) ⁺	
553.31 5	4.7 8	1464.98	(7/2) ⁻	911.654	(5/2) ⁻	
554.44 ^{&17}	2.0 8	1202.163	(5/2 ⁺)	647.837	7/2 ⁻	

¹⁶⁸Yb(n,γ) E=thermal [1969Bo16,1972Wi12,1973GrZV](#) (continued)

<u>γ(¹⁶⁹Yb) (continued)</u>								
E _γ [†]	I _γ ^a	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. ^d	α ^f	Comments
^x 555.191 15	44 6					(M1)	0.0313 4	α(K)exp=0.045 10.
^x 559.04 12	4.9 9							
560.369 15	87 11	659.618	3/2 ⁻	99.2401	5/2 ⁻	(M1)	0.0306 4	α(K)exp=0.053 13.
^x 562.50 6	8.0 13							Placed in 1988DzZW from 1232 level but E _γ does not fit that placement.
563.243 15	38 5	807.054	(7/2) ⁻	243.8162	7/2 ⁻			α(K)exp=0.046 11.
565.13 ^{&} 9	3.6 19	1285.111	(3/2 ⁺ , 5/2, 7/2 ⁺)	719.936	3/2 ⁺			
^x 567.05 5	8.5 27							
569.81 3	21 3	569.831	5/2 ⁻	0.0	7/2 ⁺	[E1]	0.00457 6	
^x 570.473 15	130 17					M1	0.0292 4	α(K)exp=0.031 7. E _γ : placed in 1988DzZW (in drawing, but not in table) from 1202 level but E _γ does not fit that placement.
571.36 ^{&} 20	4.7 10	1531.559	(3/2 ⁻ , 5/2 ⁺)	960.46	7/2 ⁻			
572.731 12	349 45	659.618	3/2 ⁻	86.9185	3/2 ⁻	M1	0.0289 4	α(K)exp=0.022 5.
574.10 ^{&} 8	4.2 16	1061.06	(11/2 ⁻)	486.944	(11/2 ⁻)			
576.396 12	169 22	647.281	7/2 ⁺	70.8817	9/2 ⁺	M1	0.0284 4	α(K)exp=0.031 7.
^x 579.68 10	4.0 7							
^x 580.579 25	18.8 24							
^x 581.50 5	8.2 12							
^x 585.061 25	19.2 25							E _γ : placed in 1988DzZW from 1618 level but E _γ does not fit that placement.
585.983 ^{&} 25	16.9 22	1176.662	(7/2, 9/2) ⁺	590.695	(5/2) ⁺			
587.29 ^{@&} 20	3.0 13	748.974	(9/2) ⁻	161.6508	11/2 ⁺			
588.46 4	8.8 12	1395.387	(5/2 ⁻)	807.054	(7/2) ⁻			
590.04 ^{&} 6	13.1 24	1159.87	(5/2 ⁺)	569.831	5/2 ⁻			
590.701 12	641 83	590.695	(5/2) ⁺	0.0	7/2 ⁺	M1	0.0267 4	α(K)exp=0.023 6.
591.78 ^{&} 6	8.9 26	1311.793	(5/2 ⁺ , 7/2)	719.936	3/2 ⁺			
^x 594.85 7	5.0 18							
596.15 ^{&} 6	6.4 14	757.869	(11/2 ⁺)	161.6508	11/2 ⁺			
597.83 ^{&} 7	8.0 13	1463.02	(7/2 ⁻)	865.169	(11/2 ⁻)			
602.08 ^{&} 7	5.4 9	1261.70	(5/2, 7/2 ⁻)	659.618	3/2 ⁻			
^x 606.17 12	4.1 8							
607.67 5	8.1 11	851.372	3/2 ⁻	243.8162	7/2 ⁻			
611.626 ^{g&} 17	46 ^g 6	1202.163	(5/2 ⁺)	590.695	(5/2) ⁺			α(K)exp<0.026 (ce peak complex).
611.626 ^{g&} 17	46 ^g 6	1463.02	(7/2 ⁻)	851.372	3/2 ⁻			α(K)exp<0.026 (ce peak complex).
614.5 ^{@&} 4	2.8 7	1261.70	(5/2, 7/2 ⁻)	647.281	7/2 ⁺			
616.14 ^{@&} 12	5.2 11	807.054	(7/2) ⁻	191.2136	5/2 ⁻			

¹⁶⁸Yb(n,γ) E=thermal ^{1969Bo16,1972Wi12,1973GrZV} (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^a	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^d	δ	α ^f	Comments
617.60 ^{& 8}	3.8 ²⁰	1449.52	7/2 ⁻	831.889	(7/2) ⁺				
622.092 ¹⁵	244 ³²	813.326	(1/2) ⁻	191.2136	5/2 ⁻				$\alpha(\text{K})_{\text{exp}}=0.018\ 5$ (for 622.1 γ and 623.0 γ combined).
623.026 ¹⁵	251 ³³	722.263	5/2 ⁻	99.2401	5/2 ⁻				See comment with 622.1 γ .
624.00 ^{& 25}	11 ⁵	1688.91	(5/2,7/2) ⁻	1064.675	(5/2 ⁺ ,7/2,9/2 ⁺)				
627.852 ²⁵	33 ⁴	1350.108	(3/2) ⁻	722.263	5/2 ⁻				
630.23 ^{& 3}	17.4 ²³	1350.108	(3/2) ⁻	719.936	3/2 ⁺				
632.38 ^{& 7}	10.7 ^{g 20}	1202.163	(5/2 ⁺)	569.831	5/2 ⁻				
632.38 ^{g 7}	10.7 ^{g 20}	1354.836	(3/2) ⁻	722.263	5/2 ⁻				
633.071 ²⁰	72 ⁹	911.654	(5/2) ⁻	278.5973	7/2 ⁻				
634.73 ^{& 8}	15 ^{g 4}	1225.42	1/2,3/2,5/2 ⁺	590.695	(5/2) ⁺				
634.73 ^{g 8}	15 ^{g 4}	1354.836	(3/2) ⁻	719.936	3/2 ⁺				
635.410 ^{g 15}	727 ^{g 94}	659.618	3/2 ⁻	24.1996	1/2 ⁻	M1		0.02218 ^{3/}	$\alpha(\text{K})_{\text{exp}}=0.019\ 5$.
635.410 ^{g 15}	727 ^{g 94}	722.263	5/2 ⁻	86.9185	3/2 ⁻	M1		0.02218 ^{3/}	
636.11 ⁷	27 ⁷	706.981	9/2 ⁺	70.8817	9/2 ⁺				
640.51 ¹⁰	4.3 ¹²	831.889	(7/2) ⁺	191.2136	5/2 ⁻				
^x 642.22 ^{‡ 10}	3.3 ¹¹								
^x 645.81 ⁷	7.8 ²⁰								
647.272 ¹⁷	91 ¹²	647.281	7/2 ⁺	0.0	7/2 ⁺	M1		0.02117 ³⁰	$\alpha(\text{K})_{\text{exp}}=0.020\ 5$.
^x 649.04 ⁵	16.0 ²⁴								
^x 653.00 ^{‡ 20}	2.1 ⁷								
655.41 ⁶	6.9 ¹⁵	919.749	(9/2) ⁻	264.2533	9/2 ⁻				
^x 657.70 ⁵	13.8 ¹⁸								
660.193 ^{g 17}	113 ^{g 15}	851.372	3/2 ⁻	191.2136	5/2 ⁻	M1+E2	1.3 ⁷	0.013 ⁴	$\alpha(\text{K})_{\text{exp}}=0.011\ 3$. δ : from $\alpha(\text{K})_{\text{exp}}$ using the BriccMixing code (v2.3b).
660.193 ^{g 17}	113 ^{g 15}	1319.60	(1/2) ⁻	659.618	3/2 ⁻	M1+E2		0.015 ⁶	
^x 666.90 ¹⁵	7.1 ¹⁸								
667.872 ²⁵	66 ⁷	911.654	(5/2) ⁻	243.8162	7/2 ⁻	M1		0.01956 ²⁷	$\alpha(\text{K})_{\text{exp}}=0.024\ 6$.
670.25 ³	42 ⁵	831.889	(7/2) ⁺	161.6508	11/2 ⁺				
671.94 ^{& 15}	5.5 ²⁰	1742.850	(3/2 ⁺ ,5/2,7/2 ⁻)	1070.78	7/2 ⁺				
674.29 ¹⁵	11.6 ¹⁹	1585.856	(1/2) ⁻	911.654	(5/2) ⁻				
675.92 ¹⁷	3.1 ⁸	919.749	(9/2) ⁻	243.8162	7/2 ⁻				
678.67 ¹⁰	4 ⁴	1398.692	(3/2) ⁻	719.936	3/2 ⁺				
688.3 ^{@ & 5}	5.6 ²⁰	1449.52	7/2 ⁻	761.845	(5/2) ⁺				
690.943 ²⁰	260 ³⁴	761.845	(5/2) ⁺	70.8817	9/2 ⁺	(E2)		0.00820 ^{1/}	$\alpha(\text{K})_{\text{exp}}=0.0076\ 18$.
695.53 ^{‡ & 10}	8.5 ¹⁴	719.936	3/2 ⁺	24.1996	1/2 ⁻				
^x 698.26 ⁴	25 ⁴								

¹⁶⁸Yb(n,γ) E=thermal **1969Bo16,1972Wi12,1973GrZV (continued)**

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^a	E_i (level)	J_i^π	E_f	J_f^π	Mult. ^d	δ	α ^f	Comments
^x 701.45 4	30 4								
703.38 9	15.7 22	1554.829	(1/2 ⁻)	851.372	3/2 ⁻				
705.07 & 10	5.9 23	1616.676	(1/2 ⁺ , 3/2, 5/2 ⁺)	911.654	(5/2) ⁻				
707.78 3	64 8	807.054	(7/2) ⁻	99.2401	5/2 ⁻	M1		0.01690 24	$\alpha(\text{K})_{\text{exp}}=0.012$ 3.
717.34 & 12	12 4	1828.037	1/2, 3/2, 5/2 ⁺	1110.691	3/2 ⁻ , 5/2 ⁻				
719.979 25	1000	719.936	3/2 ⁺	0.0	7/2 ⁺	E2		0.00747 10	$\alpha(\text{K})_{\text{exp}}=0.0064$ 13.
^x 724.93 10	11.2 20								
726.417 25	296 38	813.326	(1/2) ⁻	86.9185	3/2 ⁻	M1(+E2)	0.7 9	0.0130 33	$\alpha(\text{K})_{\text{exp}}=0.011$ 3. δ : from $\alpha(\text{K})_{\text{exp}}$ using the BriceMixing code (v2.3b).
^x 727.72 8	30 5								
^x 730.83 17	5.9 11								
^x 733.54 20	3.7 10								
739.02 ⁱ 10	10.8 17	1398.692	(3/2) ⁻	659.618	3/2 ⁻				$\alpha(\text{K})_{\text{exp}}=0.051$ 16 (for 739.0γ and 740.1γ combined). See comment with 739.0γ.
^x 740.06 7	20 3								
741.54 12	11.4 22	1554.829	(1/2) ⁻	813.326	(1/2) ⁻				
^x 746.23 6	17.6 25								
752.19 5	25 3	851.372	3/2 ⁻	99.2401	5/2 ⁻				
756.30 9	8.5 13	1478.485	(3/2 ⁻ , 5/2 ⁺)	722.263	5/2 ⁻				
758.89 ⁱ 20	5.6 15	1478.485	(3/2 ⁻ , 5/2 ⁺)	719.936	3/2 ⁺				
760.95 4	92 13	831.889	(7/2) ⁺	70.8817	9/2 ⁺				$\alpha(\text{K})_{\text{exp}}=0.0071$ 19 (for 761.0γ and 761.9γ combined).
761.864 25	279 36	761.845	(5/2) ⁺	0.0	7/2 ⁺	[M1]		0.01405 20	See comment with 761.0γ.
764.46 4	52 7	851.372	3/2 ⁻	86.9185	3/2 ⁻				
767.29 20	5.5 14	1618.692	1/2, 3/2	851.372	3/2 ⁻				
^x 771.92 7	14 7								
^x 774.68 15	5.9 9								
777.31 15	5.9 10	1688.91	(5/2, 7/2) ⁻	911.654	(5/2) ⁻				
781.77 & 25	4.7 10	1061.06	(11/2) ⁻	278.5973	7/2 ⁻				
784.88 ^g & 15	6.5 ^g 13	946.450?		161.6508	11/2 ⁺				
784.88 ^g 15	6.5 ^g 13	1696.348	3/2 ⁻	911.654	(5/2) ⁻				
792.97 & 12	6.1 10	1554.829	(1/2) ⁻	761.845	(5/2) ⁺				
796.36 & 25	7.5 15	1061.06	(11/2) ⁻	264.2533	9/2 ⁻				
^x 800.22 15	8.5 17								
^x 802.90 15	6.7 15								
805.47 ^{gi} 25	3.8 ^g 11	996.69	(7/2) ⁻	191.2136	5/2 ⁻				
805.47 ^{gi} 25	3.8 ^g 11	1618.692	1/2, 3/2	813.326	(1/2) ⁻				
812.41 8	25 4	911.654	(5/2) ⁻	99.2401	5/2 ⁻				$\alpha(\text{K})_{\text{exp}}<0.026$ (ce peak complex).

¹⁶⁸Yb(n,γ) E=thermal [1969Bo16,1972Wi12,1973GrZV](#) (continued)

$\gamma(^{169}\text{Yb})$ (continued)								
E_γ [†]	I_γ ^a	E_i (level)	J_i^π	E_f	J_f^π	Mult. ^d	α^f	Comments
814.02 ^{@&i} 20	10.4 24	1078.04?		264.2533	9/2 ⁻			E_γ : placement is doubtful because stronger branches expected from the 1078 level are not observed in (n,γ) E=thermal.
^x 816.53 7	24 3							
^x 818.24 [@] 17	8 4							
^x 822.79 10	19 3							
824.68 6	42 6	911.654	(5/2) ⁻	86.9185	3/2 ⁻			
827.15 3	163 23	851.372	3/2 ⁻	24.1996	1/2 ⁻	M1		
831.72 7	25 4	831.889	(7/2) ⁺	0.0	7/2 ⁺	[M1,E2]	0.01144 16 0.0084 29	$\alpha(K)_{\text{exp}}=0.011$ 3.
834.94 ^{&} 8	17.8 28	1554.829	(1/2) ⁻	719.936	3/2 ⁺			
^x 841.95 10	12.4 20							
845.10 25	6.0 14	1696.348	3/2 ⁻	851.372	3/2 ⁻			
^x 851.48 9	15.2 23							
^x 858.38 10	18.6 28					M1(+E2+E0)	0.0078 27	$\alpha(K)_{\text{exp}}=0.022$ 6.
869.64 8	17.7 26	1781.208	(3/2 ⁻ ,5/2 ⁻)	911.654	(5/2) ⁻			
871.51 ^{&} 25	15 5	1141.26	(9/2) ⁺	269.6556	13/2 ⁺			
^x 874.21 12	13.2 21							
^x 886.85 25	9.8 21							
889.89 20	5.7 21	960.46	7/2 ⁻	70.8817	9/2 ⁺			
^x 893.73 15	18 3							
897.45 6	59 8	996.69	(7/2) ⁻	99.2401	5/2 ⁻	M1	0.00935 13	$\alpha(K)_{\text{exp}}=0.0080$ 20.
908.8 ^{gi} 4	5.2 ^g 17	1070.78	7/2 ⁺	161.6508	11/2 ⁺			
908.8 ^{g&} 4	5.2 ^g 17	1478.485	(3/2 ⁻ ,5/2 ⁺)	569.831	5/2 ⁻			
917.4 ^{@&} 4	6.3 21	1724.49	(3/2) ⁻	807.054	(7/2) ⁻			
920.2 10		919.749	(9/2) ⁻	0.0	7/2 ⁺			
^x 924.1 [@] 8	8 3							
926.49 ^{&} 12	20 3	1449.52	7/2 ⁻	523.070	11/2 ⁻			I_γ : far too strong relative to 1448γ based on Adopted Gammas; possibly the 926γ is complex in (n,γ) E=thermal.
934.87 20	12.3 21	1033.883	(1/2 ⁺ ,3/2)	99.2401	5/2 ⁻			
947.37 15	22 3	1033.883	(1/2 ⁺ ,3/2)	86.9185	3/2 ⁻			
^x 959.58 17	26 4							$\alpha(K)_{\text{exp}}=0.0066$ 20 (for 959.6γ+960.6γ).
960.59 17	35 6	960.46	7/2 ⁻	0.0	7/2 ⁺	[E1]	1.61×10 ⁻³ 2	See comment with 959.6γ.
968.77 ^{&} 17	11.9 19	1159.87	(5/2 ⁺)	191.2136	5/2 ⁻			
979.74 ^{&} 12	40 6	1141.26	(9/2) ⁺	161.6508	11/2 ⁺			
^x 981.01 8	112 16							Placed in 1988DzZW from 1724 level but E_γ does not fit that placement.
989.34 ^{‡&} 25	10.6 21	1796.661	(3/2 ⁻ ,5/2 ⁺)	807.054	(7/2) ⁻			

¹⁶⁸Yb(n,γ) E=thermal 1969Bo16,1972Wi12,1973GrZV (continued)

$\gamma(^{169}\text{Yb})$ (continued)								
E_γ [†]	I_γ ^a	E_i (level)	J_i^π	E_f	J_f^π	Mult. ^d	α^f	Comments
^x 995.7 [@] 4	10.2 26							
999.9 ⁱ 4	9.4 22	1070.78	7/2 ⁺	70.8817	9/2 ⁺			
1009.64 6	95 13	1033.883	(1/2 ⁺ ,3/2)	24.1996	1/2 ⁻			
1018.0 ^{g&} 3	14.8 ^g 27	1261.70	(5/2,7/2 ⁻)	243.8162	7/2 ⁻			
1018.0 ^g 3	14.8 ^g 27	1296.660	(3/2 ⁻ ,5/2,7/2 ⁻)	278.5973	7/2 ⁻			
1023.72 7	69 10	1110.691	3/2 ⁻ ,5/2 ⁻	86.9185	3/2 ⁻			
1033.72 ^{&} 25	20 4	1311.793	(5/2 ⁺ ,7/2)	278.5973	7/2 ⁻			
^x 1037.45 15	42 6							
^x 1043.06 15	25 4							
^x 1051.8 3	23 7							
^x 1053.6 3	21 7							
1061.60 17	34 6	1781.208	(3/2 ⁻ ,5/2 ⁻)	719.936	3/2 ⁺			
1064.7 ^g 4	18 ^g 4	1064.675	(5/2 ⁺ ,7/2,9/2 ⁺)	0.0	7/2 ⁺			
1064.7 ^{g&} 4	18 ^g 4	1724.49	(3/2 ⁻)	659.618	3/2 ⁻			
1067.64 ^{&} 20	40 7	1311.793	(5/2 ⁺ ,7/2)	243.8162	7/2 ⁻			
1069.6 6		1070.78	7/2 ⁺	0.0	7/2 ⁺			Seen in ce spectrum only.
1076.56 ^{†&} 8	135 20	1724.49	(3/2 ⁻)	647.837	7/2 ⁻			$\alpha(\text{K})_{\text{exp}}=0.0048$ 12 suggests M1 multipolarity but line is probably complex.
1086.35 10	62 9	1110.691	3/2 ⁻ ,5/2 ⁻	24.1996	1/2 ⁻			
1088.9 ^{@&} 4	21 5	1159.87	(5/2 ⁺)	70.8817	9/2 ⁺			
1095.58 ^{&} 12	56 8	1742.850	(3/2 ⁺ ,5/2,7/2 ⁻)	647.281	7/2 ⁺			$\alpha(\text{K})_{\text{exp}}=0.013$ 3.
^x 1099.45 20	31 5							
1105.5 ^{g&} 3	24 ^g 4	1176.662	(7/2,9/2) ⁺	70.8817	9/2 ⁺			
1105.5 ^g 3	24 ^g 4	1296.660	(3/2 ⁻ ,5/2,7/2 ⁻)	191.2136	5/2 ⁻			$\alpha(\text{K})_{\text{exp}}=0.0081$ 25 (for 1105.5γ and 1109.4γ combined).
1105.5 ^{g&} 3	24 ^g 4	1828.037	1/2,3/2,5/2 ⁺	722.263	5/2 ⁻			
^x 1109.40 10	55 8							See comment with 1105.5γ.
1115.1 ^{&} 4	17 4	1202.163	(5/2 ⁺)	86.9185	3/2 ⁻			
1131.29 ^{&} 17	29 13	1202.163	(5/2 ⁺)	70.8817	9/2 ⁺			
1131.29 17	29 13	1395.387	(5/2 ⁻)	264.2533	9/2 ⁻			
1133.4 5	20 5	1781.208	(3/2 ⁻ ,5/2 ⁻)	647.837	7/2 ⁻			
1140.78 ^{&} 25	31 18	1141.26	(9/2) ⁺	0.0	7/2 ⁺			
^x 1144.55 15	78 14							
1151.36 20	44 7	1395.387	(5/2 ⁻)	243.8162	7/2 ⁻			
^x 1155.75 25	86 ^c 13					M1	0.00503 7	$\alpha(\text{K})_{\text{exp}}=0.0047$ 12.
1163.14 20	66 ^c 13	1354.836	(3/2 ⁻)	191.2136	5/2 ⁻	(M1)	0.00495 7	$\alpha(\text{K})_{\text{exp}}=0.0060$ 17.
1177.1 ^{&} 4	22 4	1176.662	(7/2,9/2) ⁺	0.0	7/2 ⁺			
1183.63 25	78 ^c 16	1270.726	(1/2) ⁻	86.9185	3/2 ⁻	M1	0.00475 7	$\alpha(\text{K})_{\text{exp}}=0.0050$ 14.

¹⁶⁸Yb(n,γ) E=thermal [1969Bo16,1972Wi12,1973GrZV](#) (continued)

$\gamma(^{169}\text{Yb})$ (continued)									
E_γ [†]	I_γ ^a	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^d	δ	α ^f	Comments
^x 1188.21 ¹⁵	72 ¹¹								
1197.8 ^c 7	73 ^c 21	1296.660	(3/2 ⁻ ,5/2,7/2 ⁻)	99.2401	5/2 ⁻				
1200.9 ¹⁰	22 ⁶	1464.98	(7/2) ⁻	264.2533	9/2 ⁻				
1207.5 ³	128 ^c 25	1398.692	(3/2) ⁻	191.2136	5/2 ⁻	M1		0.00453 ⁶	$\alpha(\text{K})\text{exp}=0.0038$ ¹¹ .
1209.8 ³	40 ⁸	1296.660	(3/2 ⁻ ,5/2,7/2 ⁻)	86.9185	3/2 ⁻				
1218.7 ^{@&} 7	20 ⁶	1463.02	(7/2 ⁻)	243.8162	7/2 ⁻				
1221.1 ²	108 ^c 16	1464.98	(7/2) ⁻	243.8162	7/2 ⁻	M1(+E2)	0.9 ¹⁰	0.0036 ⁹	$\alpha(\text{K})\text{exp}=0.0030$ ⁸ . δ : from $\alpha(\text{K})\text{exp}$ using the BriceMixing code (v2.3b).
1227.3 ^{&} 7	19 ⁶	1796.661	(3/2 ⁻ ,5/2 ⁺)	569.831	5/2 ⁻				
1232.64 ¹⁷	125 ^c 16	1319.60	(1/2) ⁻	86.9185	3/2 ⁻	M1		0.00431 ⁶	$\alpha(\text{K})\text{exp}=0.0032$ ⁸ .
1246.5 ³	56 ¹⁰	1270.726	(1/2) ⁻	24.1996	1/2 ⁻	^e			$\alpha(\text{K})\text{exp}=0.024$ ⁷ .
^x 1248.3 ⁶	86 ⁴⁴								$\alpha(\text{K})\text{exp}=0.0022$ ¹⁴ (for 1248.3γ and 1257.2γ combined).
^x 1256.4 ⁵	160 ⁶⁰								
^x 1257.2 ⁸	164 ⁵⁶								
1263.08 ²⁰	169 ²⁷	1350.108	(3/2 ⁻)	86.9185	3/2 ⁻	(M1)		0.00407 ⁶	See comment with 1248.3γ. $\alpha(\text{K})\text{exp}=0.0033$ ⁹ (complex spectrum makes assignment of ce peak to 1263.1γ uncertain).
^x 1266.4 ^c 6	112 ^c 19								$\alpha(\text{K})\text{exp}=0.018$ ⁵ . E_γ : placed in 1988DzZW from an otherwise unknown 1354 level.
1284.7 ^{&} 8	156 ⁵⁶	1285.111	(3/2 ⁺ ,5/2,7/2 ⁺)	0.0	7/2 ⁺				$\alpha(\text{K})\text{exp}=0.013$ ⁶ .
1295.6 ⁴	124 ^c 20	1319.60	(1/2) ⁻	24.1996	1/2 ⁻	(M1)		0.00384 ⁵	$\alpha(\text{K})\text{exp}=0.0058$ ¹⁵ .
^x 1304.7 ⁹	156 ⁵⁸								
1325.5 ^c 6	74 ^c 16	1350.108	(3/2 ⁻)	24.1996	1/2 ⁻	(M1)		0.00364 ⁵	$\alpha(\text{K})\text{exp}=0.0075$ ²³ .
^x 1336.0 ⁴	67 ²⁴								
1373.6 ^c 5	149 ^c 22	1398.692	(3/2) ⁻	24.1996	1/2 ⁻	(M1)		0.00336 ⁵	$\alpha(\text{K})\text{exp}=0.0053$ ¹⁴ .
^x 1380.3 ⁴	50 ²¹								$\alpha(\text{K})\text{exp}=0.008$ ⁴ .
1391.8 ^{gc} 17	33 ^{gc} 17	1478.485	(3/2 ⁻ ,5/2 ⁺)	86.9185	3/2 ⁻				
1391.8 ^{gc} 17	33 ^{gc} 17	1781.208	(3/2 ⁻ ,5/2 ⁻)	389.5266	9/2 ⁻				
^x 1402.9 ⁵									Seen in ce spectrum only.
^x 1407.0 ¹⁰	24 ¹¹								
1410.6 ⁶	108 ⁵³	1688.91	(5/2,7/2) ⁻	278.5973	7/2 ⁻				
^x 1414.4 ⁷	43 ²¹								$\alpha(\text{K})\text{exp}=0.0035$ ²⁵ (for 1414.4γ+1417.7γ).
1417.7 ^{&} 5	70 ³²	1696.348	3/2 ⁻	278.5973	7/2 ⁻				See comment with 1414.4γ for $\alpha(\text{K})\text{exp}$.
1432.5 ^c 7	115 ^c 23	1531.559	(3/2 ⁻ ,5/2 ⁺)	99.2401	5/2 ⁻				
1445.2 ^g 17	26 ^g 13	1531.559	(3/2 ⁻ ,5/2 ⁺)	86.9185	3/2 ⁻				
1445.2 ^{g&} 17	26 ^g 13	1724.49	(3/2 ⁻)	278.5973	7/2 ⁻				
1448.3 ^{&} 7	116 ⁵⁹	1449.52	7/2 ⁻	0.0	7/2 ⁺				
^x 1465.2 ¹⁰	63 ¹⁸								

¹⁶⁸Yb(n,γ) E=thermal [1969Bo16,1972Wi12,1973GrZV](#) (continued)

γ(¹⁶⁹Yb) (continued)

E _γ [†]	I _γ ^a	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. ^d	α ^f	Comments
1467.3 <i>12</i>	21 <i>10</i>	1554.829	(1/2 ⁻)	86.9185	3/2 ⁻			
^x 1470.4 <i>25</i>	28 <i>14</i>							
1480.1 <i>& 20</i>	123 <i>69</i>	1724.49	(3/2 ⁻)	243.8162	7/2 ⁻			
^x 1485.2 <i>@ 6</i>	152 <i>99</i>					(E2)	1.77×10 ⁻³ <i>3</i>	α(K)exp=0.0016 <i>11</i> .
1497.6 <i>c 20</i>	70 <i>c 21</i>	1688.91	(5/2,7/2) ⁻	191.2136	5/2 ⁻	M1	0.00278 <i>4</i>	α(K)exp=0.0034 <i>12</i> .
1505.9 <i>c 10</i>	129 <i>c 26</i>	1696.348	3/2 ⁻	191.2136	5/2 ⁻	M1	0.00275 <i>4</i>	α(K)exp=0.0025 <i>7</i> .
1518.5 <i>g& 8</i>	44 <i>g 32</i>	1616.676	(1/2 ⁺ ,3/2,5/2 ⁺)	99.2401	5/2 ⁻			
1518.5 <i>g& 8</i>	44 <i>g 32</i>	1796.661	(3/2 ⁻ ,5/2 ⁺)	278.5973	7/2 ⁻			
1530.5 <i>gc 10</i>	79 <i>gc 24</i>	1554.829	(1/2 ⁻)	24.1996	1/2 ⁻	<i>e</i>		α(K)exp=0.013 <i>5</i> .
1530.5 <i>gc& 10</i>	79 <i>gc 24</i>	1616.676	(1/2 ⁺ ,3/2,5/2 ⁺)	86.9185	3/2 ⁻	<i>e</i>		α(K)exp=0.013 <i>5</i> .
^x 1540.7 <i>c 10</i>	74 <i>c 24</i>							
1551.5 <i>c& 15</i>	37 <i>c 19</i>	1742.850	(3/2 ⁺ ,5/2,7/2 ⁻)	191.2136	5/2 ⁻			
1563.0 <i>c&i 10</i>	78 <i>c 24</i>	1828.037	1/2,3/2,5/2 ⁺	264.2533	9/2 ⁻			Placement from 1988DzZW , but 1/2,3/2,5/2 ⁺ to 9/2 ⁻ transition is unlikely. The evaluator identifies it as a questionable transition. E _γ : placed in 1988DzZW from 1867 level but E _γ does not fit that placement.
^x 1578.2 <i>c 12</i>	45 <i>c 18</i>							
1583.6 <i>c& 10</i>	54 <i>c 21</i>	1828.037	1/2,3/2,5/2 ⁺	243.8162	7/2 ⁻			
1594.5 <i>c 11</i>	82 <i>c 24</i>	1618.692	1/2,3/2	24.1996	1/2 ⁻			
1604.8 <i>c& 12</i>	54 <i>c 21</i>	1796.661	(3/2 ⁻ ,5/2 ⁺)	191.2136	5/2 ⁻			
^x 1614.6 <i>c 12</i>	57 <i>c 28</i>							
1623.6 <i>& 9</i>	47 <i>31</i>	1867.57	(3/2 ⁻ ,5/2 ⁺)	243.8162	7/2 ⁻			
1625.3 <i>& 8</i>	≈189	1724.49	(3/2 ⁻)	99.2401	5/2 ⁻			Placed in 1988DzZW from the 1696 level also, but that placement would require an M3 transition so is rejected by the evaluator.
1637.2 <i>gc& 12</i>	101 <i>gc 30</i>	1724.49	(3/2 ⁻)	86.9185	3/2 ⁻			
1637.2 <i>gc& 12</i>	101 <i>gc 30</i>	1828.037	1/2,3/2,5/2 ⁺	191.2136	5/2 ⁻			
^x 1649.5 <i>c 12</i>	68 <i>c 28</i>							
^x 1659.8 <i>c 10</i>	75 <i>c 25</i>							
^x 1676.0 <i>c 10</i>	93 <i>c 27</i>							
1689.2 <i>c 12</i>	51 <i>c 25</i>	1688.91	(5/2,7/2) ⁻	0.0	7/2 ⁺			
1743.8 <i>c& 15</i>	81 <i>c 25</i>	1742.850	(3/2 ⁺ ,5/2,7/2 ⁻)	0.0	7/2 ⁺			
3209.6 <i>10</i>	7.8 <i>b 23</i>	(6866.67)	1/2 ⁺	3657.0	1/2,3/2,5/2 ⁺			
3306.7 <i>8</i>	16 <i>b 5</i>	(6866.67)	1/2 ⁺	3559.9	1/2,3/2,5/2 ⁺			
3339.9 <i>7</i>	27 <i>b 5</i>	(6866.67)	1/2 ⁺	3526.7	1/2,3/2,5/2 ⁺			
3416.6 <i>8</i>	12.7 <i>b 25</i>	(6866.67)	1/2 ⁺	3450.0	1/2,3/2,5/2 ⁺			

$^{168}\text{Yb}(n,\gamma)$ E=thermal **1969Bo16,1972Wi12,1973GrZV (continued)** **$\gamma(^{169}\text{Yb})$ (continued)**

E_γ [†]	I_γ ^a	$E_i(\text{level})$	J_i^π	E_f	J_f^π	E_γ [†]	I_γ ^a	$E_i(\text{level})$	J_i^π	E_f	J_f^π
3491.2 7	9.4 ^b 23	(6866.67)	1/2 ⁺	3375.4	1/2,3/2,5/2 ⁺	4232.6 12	3.3 ^b 10	(6866.67)	1/2 ⁺	2634.0	1/2,3/2,5/2 ⁺
3522.2 7	17.1 ^b 26	(6866.67)	1/2 ⁺	3344.4	1/2,3/2,5/2 ⁺	4245.7 10	9.4 ^b 19	(6866.67)	1/2 ⁺	2620.9	1/2,3/2,5/2 ⁺
3592.6 15	15 ^b 6	(6866.67)	1/2 ⁺	3274.0	1/2,3/2,5/2 ⁺	4315.5 7	11.4 ^b 17	(6866.67)	1/2 ⁺	2551.1	1/2,3/2,5/2 ⁺
3620.1 8	11 ^b 5	(6866.67)	1/2 ⁺	3246.5	1/2,3/2,5/2 ⁺	4336.3 7	6.5 ^b 16	(6866.67)	1/2 ⁺	2530.3	1/2,3/2,5/2 ⁺
3692.8 7	15 ^b 3	(6866.67)	1/2 ⁺	3173.8	1/2,3/2,5/2 ⁺	4343.8 7	13.9 ^b 21	(6866.67)	1/2 ⁺	2522.8	1/2,3/2,5/2 ⁺
3724.0 7	20 ^b 3	(6866.67)	1/2 ⁺	3142.6	1/2,3/2,5/2 ⁺	4349.5 10	6.5 ^b 16	(6866.67)	1/2 ⁺	2517.1	1/2,3/2,5/2 ⁺
3736.3 8	9.8 ^b 29	(6866.67)	1/2 ⁺	3130.3	1/2,3/2,5/2 ⁺	4362.2 8	6.1 ^b 12	(6866.67)	1/2 ⁺	2504.4	1/2,3/2,5/2 ⁺
3747.7 11	12 ^b 4	(6866.67)	1/2 ⁺	3118.9	1/2,3/2,5/2 ⁺	4367.9 7	10.6 ^b 21	(6866.67)	1/2 ⁺	2498.7	1/2,3/2,5/2 ⁺
3761.0 6	25.6 ^b 26	(6866.67)	1/2 ⁺	3105.6	1/2,3/2,5/2 ⁺	4388.7 10	10.2 ^b 20	(6866.67)	1/2 ⁺	2477.9	1/2,3/2,5/2 ⁺
3772.1 8	8.2 ^b 24	(6866.67)	1/2 ⁺	3094.5	1/2,3/2,5/2 ⁺	4416.8 7	6.9 ^b 10	(6866.67)	1/2 ⁺	2449.8	1/2,3/2,5/2 ⁺
3800.5 7	11.4 ^b 17	(6866.67)	1/2 ⁺	3066.1	1/2,3/2,5/2 ⁺	4425.5 9	6.1 ^b 12	(6866.67)	1/2 ⁺	2441.1	1/2,3/2,5/2 ⁺
3822.8 7	16 ^b 3	(6866.67)	1/2 ⁺	3043.8	1/2,3/2,5/2 ⁺	4439.1 10	4.1 ^b 10	(6866.67)	1/2 ⁺	2427.5	1/2,3/2,5/2 ⁺
3828.2 7	18 ^b 4	(6866.67)	1/2 ⁺	3038.4	1/2,3/2,5/2 ⁺	4451.2 8	16 ^b 6	(6866.67)	1/2 ⁺	2415.4	1/2,3/2,5/2 ⁺
3839.2 8	14.3 ^b 29	(6866.67)	1/2 ⁺	3027.4	1/2,3/2,5/2 ⁺	4459.2 8	8.6 ^b 13	(6866.67)	1/2 ⁺	2407.4	1/2,3/2,5/2 ⁺
3851.4 12	9 ^b 3	(6866.67)	1/2 ⁺	3015.2	1/2,3/2,5/2 ⁺	4465.6 8	12 ^b 2	(6866.67)	1/2 ⁺	2401.0	1/2,3/2,5/2 ⁺
3867.7 9	5.3 ^b 16	(6866.67)	1/2 ⁺	2998.9	1/2,3/2,5/2 ⁺	4478.6 8	14 ^b 1	(6866.67)	1/2 ⁺	2388.0	1/2,3/2,5/2 ⁺
3878.0 8	16.3 ^b 24	(6866.67)	1/2 ⁺	2988.6	1/2,3/2,5/2 ⁺	4485.2 10	4.9 ^b 15	(6866.67)	1/2 ⁺	2381.4	1/2,3/2,5/2 ⁺
3914.6 10	9.0 ^b 22	(6866.67)	1/2 ⁺	2952.0	1/2,3/2,5/2 ⁺	4490.7 10	4.1 ^b 12	(6866.67)	1/2 ⁺	2375.9	1/2,3/2,5/2 ⁺
3933.8 15	8 ^b 3	(6866.67)	1/2 ⁺	2932.8	1/2,3/2,5/2 ⁺	4511.0 7	21 ^b 2	(6866.67)	1/2 ⁺	2355.6	1/2,3/2,5/2 ⁺
3949.3 7	9.0 ^b 27	(6866.67)	1/2 ⁺	2917.3	1/2,3/2,5/2 ⁺	4516.5 7	22 ^b 2	(6866.67)	1/2 ⁺	2350.1	1/2,3/2,5/2 ⁺
3975.0 6	32 ^b 3	(6866.67)	1/2 ⁺	2891.6	1/2,3/2,5/2 ⁺	4524.2 8	10 ^b 2	(6866.67)	1/2 ⁺	2342.4	1/2,3/2,5/2 ⁺
3996.7 8	7.3 ^b 15	(6866.67)	1/2 ⁺	2869.9	1/2,3/2,5/2 ⁺	4553.0 6	14 ^b 1	(6866.67)	1/2 ⁺	2313.6	1/2,3/2,5/2 ⁺
4010.6 8	10.6 ^b 21	(6866.67)	1/2 ⁺	2856.0	1/2,3/2,5/2 ⁺	4567.5 8	8.6 ^b 13	(6866.67)	1/2 ⁺	2299.1	1/2,3/2,5/2 ⁺
4039.4 6	27 ^b 3	(6866.67)	1/2 ⁺	2827.2	1/2,3/2,5/2 ⁺	4580.4 12	3.3 ^b 10	(6866.67)	1/2 ⁺	2286.2	1/2,3/2,5/2 ⁺
4064.7 9	16 ^b 3	(6866.67)	1/2 ⁺	2801.9	1/2,3/2,5/2 ⁺	4622.1 6	29 ^b 2	(6866.67)	1/2 ⁺	2244.5	1/2,3/2,5/2 ⁺
4085.6 9	8.6 ^b 26	(6866.67)	1/2 ⁺	2781.0	1/2,3/2,5/2 ⁺	4632.1 8	12 ^b 2	(6866.67)	1/2 ⁺	2234.5	1/2,3/2,5/2 ⁺
4092.1 8	14.3 ^b 21	(6866.67)	1/2 ⁺	2774.5	1/2,3/2,5/2 ⁺	4649.1 10	5.7 ^b 17	(6866.67)	1/2 ⁺	2217.5	1/2,3/2,5/2 ⁺
4124.8 8	11.4 ^b 23	(6866.67)	1/2 ⁺	2741.8	1/2,3/2,5/2 ⁺	4673.7 9	5.3 ^b 11	(6866.67)	1/2 ⁺	2192.9	1/2,3/2,5/2 ⁺
4160.7 7	18.4 ^b 18	(6866.67)	1/2 ⁺	2705.9	1/2,3/2,5/2 ⁺	4743.4 12	4.1 ^b 12	(6866.67)	1/2 ⁺	2123.2	1/2,3/2,5/2 ⁺
4181.8 11	7 ^b 3	(6866.67)	1/2 ⁺	2684.8	1/2,3/2,5/2 ⁺	4763.0 6	11 ^b 1	(6866.67)	1/2 ⁺	2103.6	1/2,3/2,5/2 ⁺
4186.9 7	17 ^b 4	(6866.67)	1/2 ⁺	2679.7	1/2,3/2,5/2 ⁺	4818.4 11	3.7 ^b 15	(6866.67)	1/2 ⁺	2048.2	1/2,3/2,5/2 ⁺
4211.2 6	33.1 ^b 23	(6866.67)	1/2 ⁺	2655.4	1/2,3/2,5/2 ⁺	4828.9 7	22 ^b 3	(6866.67)	1/2 ⁺	2037.7	1/2,3/2,5/2 ⁺

¹⁶⁸Yb(n,γ) E=thermal **1969Bo16,1972Wi12,1973GrZV (continued)**

γ(¹⁶⁹Yb) (continued)

E _γ [†]	I _γ ^a	E _i (level)	J _i ^π	E _f	J _f ^π	E _γ [†]	I _γ ^a	E _i (level)	J _i ^π	E _f	J _f ^π
4868.2 6	20 ^b 2	(6866.67)	1/2 ⁺	1998.4	1/2,3/2,5/2 ⁺	5342.7 7	8 ^b 1	(6866.67)	1/2 ⁺	1524.08	1/2,3/2,5/2 ⁺
4927.6 6	32 ^b 2	(6866.67)	1/2 ⁺	1939.0	1/2,3/2,5/2 ⁺	5356.9 8	3.7 ^b 7	(6866.67)	1/2 ⁺	1509.7	1/2 ⁻
4946.1 8	6.5 ^b 20	(6866.67)	1/2 ⁺	1920.5	1/2,3/2,5/2 ⁺	5388.3 7	10 ^b 1	(6866.67)	1/2 ⁺	1478.485	(3/2 ⁻ ,5/2 ⁺)
4955.7 10	2.9 ^b 9	(6866.67)	1/2 ⁺	1910.9	1/2,3/2,5/2 ⁺	5468.3 6	45 ^b 3	(6866.67)	1/2 ⁺	1398.692	(3/2 ⁻)
4972.6 7	10 ^b 1	(6866.67)	1/2 ⁺	1894.0	1/2,3/2,5/2 ⁺	5511.9 7	25 ^b 2	(6866.67)	1/2 ⁺	1354.836	(3/2 ⁻)
4997.6 12	3.7 ^b 11	(6866.67)	1/2 ⁺	1867.57	(3/2 ⁻ ,5/2 ⁺)	5517.2 7	21 ^b 2	(6866.67)	1/2 ⁺	1350.108	(3/2 ⁻)
5009.2 8	12 ^b 2	(6866.67)	1/2 ⁺	1857.4	1/2,3/2,5/2 ⁺	5595.6 6	32 ^b 2	(6866.67)	1/2 ⁺	1270.726	(1/2 ⁻)
5029.1 6	11 ^b 1	(6866.67)	1/2 ⁺	1837.5	1/2,3/2,5/2 ⁺	5633.5 12	2.0 ^b 6	(6866.67)	1/2 ⁺	1232.16	(3/2 ⁻)
5037.8 8	13 ^b 1	(6866.67)	1/2 ⁺	1828.037	1/2,3/2,5/2 ⁺	5643.0 12	2.0 ^b 6	(6866.67)	1/2 ⁺	1225.42	1/2,3/2,5/2 ⁺
5069.2 7	22 ^b 2	(6866.67)	1/2 ⁺	1796.661	(3/2 ⁻ ,5/2 ⁺)	5664.2 8	4.5 ^b 7	(6866.67)	1/2 ⁺	1202.163	(5/2 ⁺)
5079.3 7	22 ^b 2	(6866.67)	1/2 ⁺	1787.3	1/2,3/2,5/2 ⁺	5706.7 8	3.7 ^b 7	(6866.67)	1/2 ⁺	1159.87	(5/2 ⁺)
5109.3 8	4.5 ^b 7	(6866.67)	1/2 ⁺	1757.3	1/2,3/2,5/2 ⁺	5832.7 10	6.1 ^b 9	(6866.67)	1/2 ⁺	1033.883	(1/2 ⁺ ,3/2)
5121.6 7	8 ^b 1	(6866.67)	1/2 ⁺	1745.0	(1/2 ⁻)	6017.7 20	3.7 ^b 18	(6866.67)	1/2 ⁺	851.372	3/2 ⁻
5142.7 7	7.8 ^b 12	(6866.67)	1/2 ⁺	1724.49	(3/2 ⁻)	6053.4 6	73 ^b 4	(6866.67)	1/2 ⁺	813.326	(1/2 ⁻)
5169.5 6	24 ^b 2	(6866.67)	1/2 ⁺	1696.348	3/2 ⁻	6146.8 7	8.2 ^b 8	(6866.67)	1/2 ⁺	719.936	3/2 ⁺
5247.4 6	100 ^b 7	(6866.67)	1/2 ⁺	1618.692	1/2,3/2	6207.1 6	62 ^b 3	(6866.67)	1/2 ⁺	659.618	3/2 ⁻
5281.1 8	4.9 ^b 7	(6866.67)	1/2 ⁺	1585.856	(1/2 ⁻)	6779.8 6	408 ^b 20	(6866.67)	1/2 ⁺	86.9185	3/2 ⁻
5312.0 7	7.3 ^b 7	(6866.67)	1/2 ⁺	1554.829	(1/2 ⁻)	6842.5 6	94 ^b 5	(6866.67)	1/2 ⁺	24.1996	1/2 ⁻
5334.4 6	13 ^b 1	(6866.67)	1/2 ⁺	1531.559	(3/2 ⁻ ,5/2 ⁺)						

[†] From 1972Wi12, except where otherwise noted.

[‡] Complex peak (broader than normal).

Seen only by 1968Mi08; assignment to ¹⁶⁹Yb uncertain.

@ Existence questionable.

& Placement from 1988DzZW.

^a Arbitrary units relative to I_γ=1000 for 720γ (secondary gammas only; see footnote defining scale for primary gammas). See also the comment on I_γ normalization.

^b Arbitrary units relative to I_γ=100 for 5247.4γ (primary gammas only). See also the comment on I_γ normalization.

^c From 1968Mi08 (measured E_γ, I_γ (semi)).

^d From α(K)exp, α(L)exp, and/or ce subshell ratios. The photon and ce intensity scales have been normalized through α(K)=0.326 (E2 theory) for 156.9γ. Evaluator assigns 20% uncertainty to Ice values of 1969Bo16 (Tabulated Ice data are also available on p. 401 – 403 in 1973Ha76). For multiply placed γ's, multipolarity assignments are based on supposition of just one transition.

^e Large α(K)exp indicates probable E0 component.

^f Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with "Frozen Orbitals" approximation based on γ-ray energies, assigned

¹⁶⁸Yb(n,γ) E=thermal [1969Bo16,1972Wi12,1973GrZV](#) (continued)

γ(¹⁶⁹Yb) (continued)

multipolarities, and mixing ratios, unless otherwise specified.

^g Multiply placed with undivided intensity.

^h Multiply placed with intensity suitably divided.

ⁱ Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

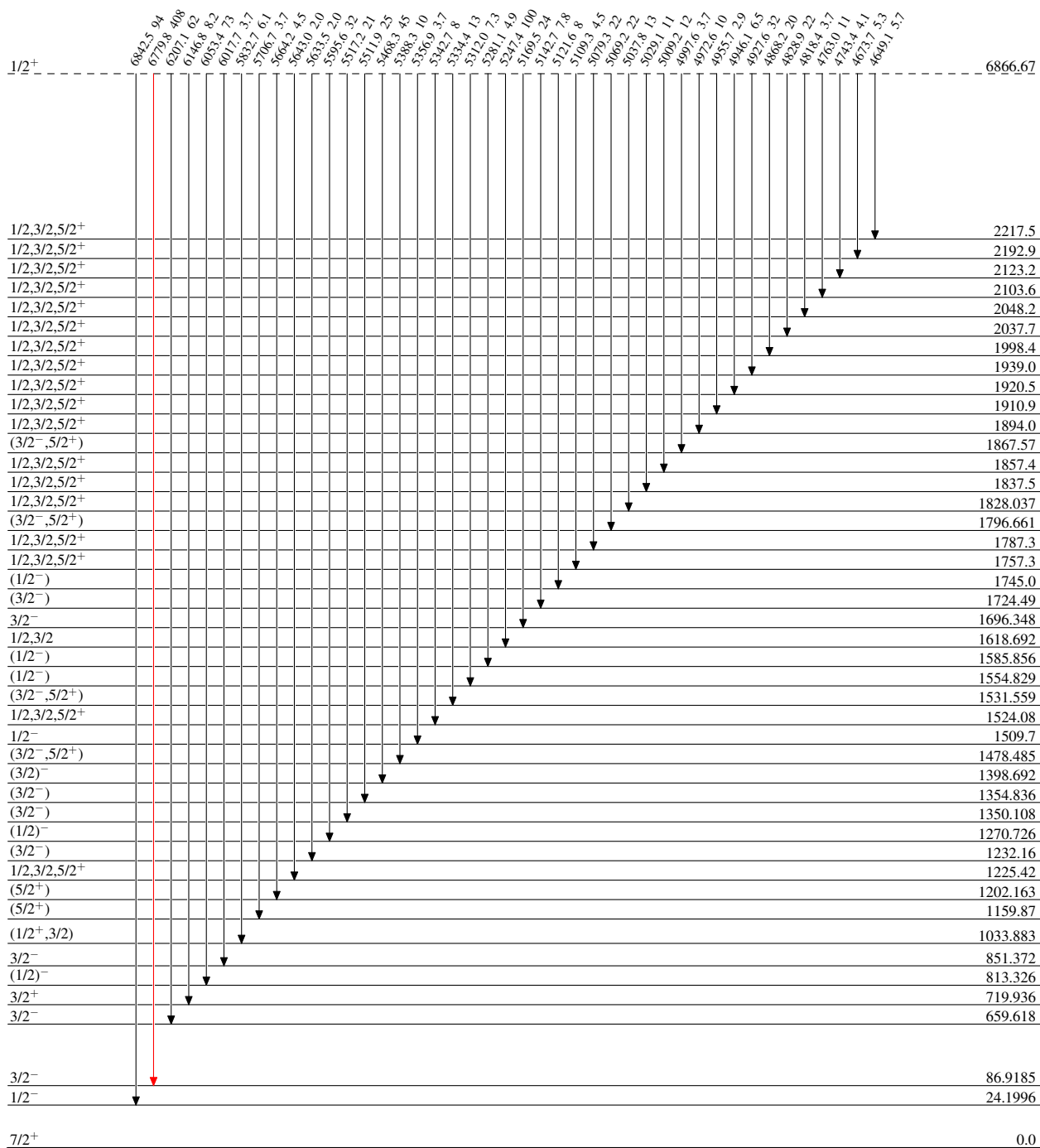
¹⁶⁸Yb(n,γ) E=thermal 1969Bo16,1972Wi12,1973GrZV

Legend

Level Scheme

Intensities: relative I_γ

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}



¹⁶⁹Yb₉₉

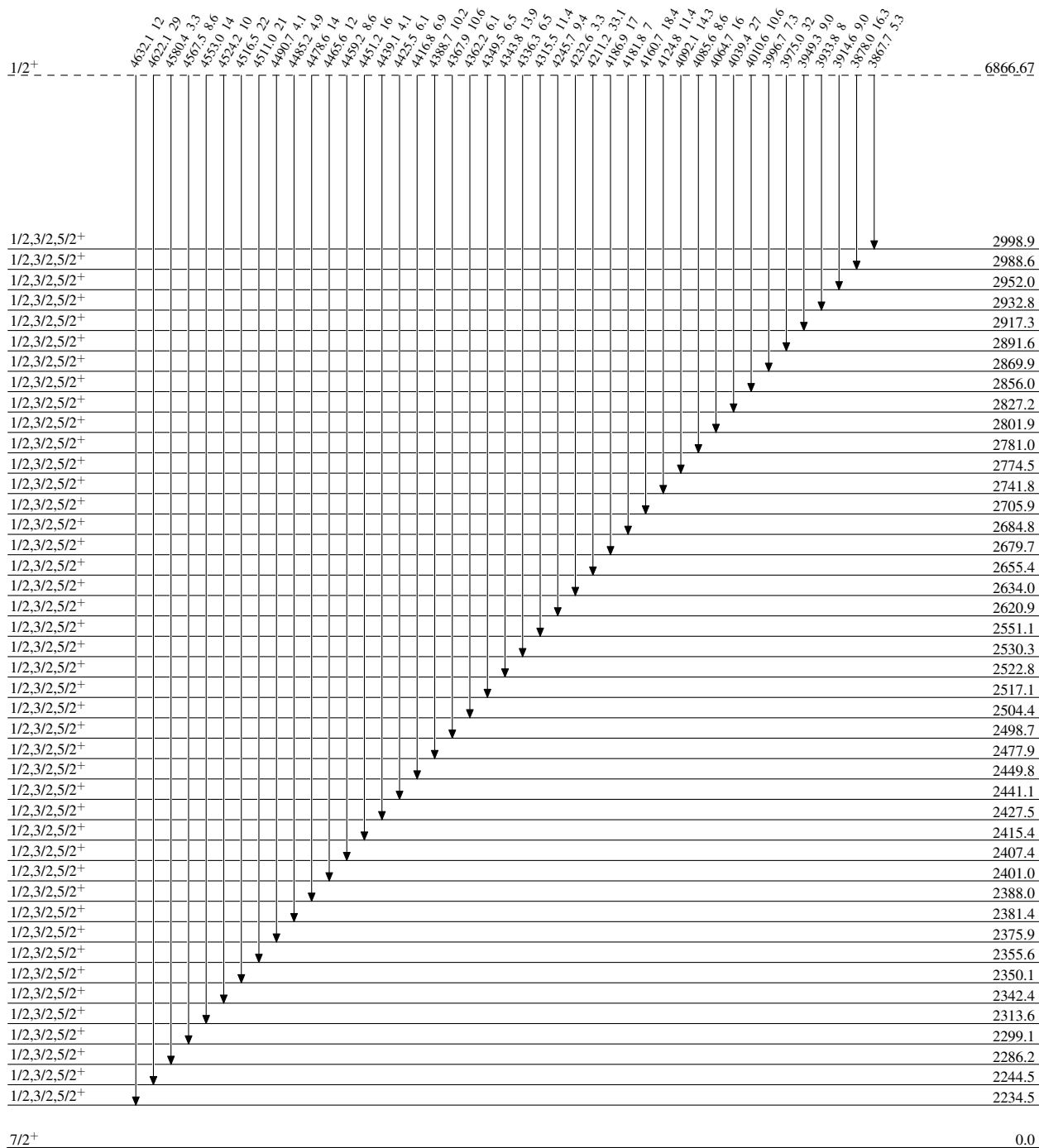
¹⁶⁸Yb(n,γ) E=thermal 1969Bo16,1972Wi12,1973GrZV

Level Scheme (continued)

Intensities: relative I_γ

Legend

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}



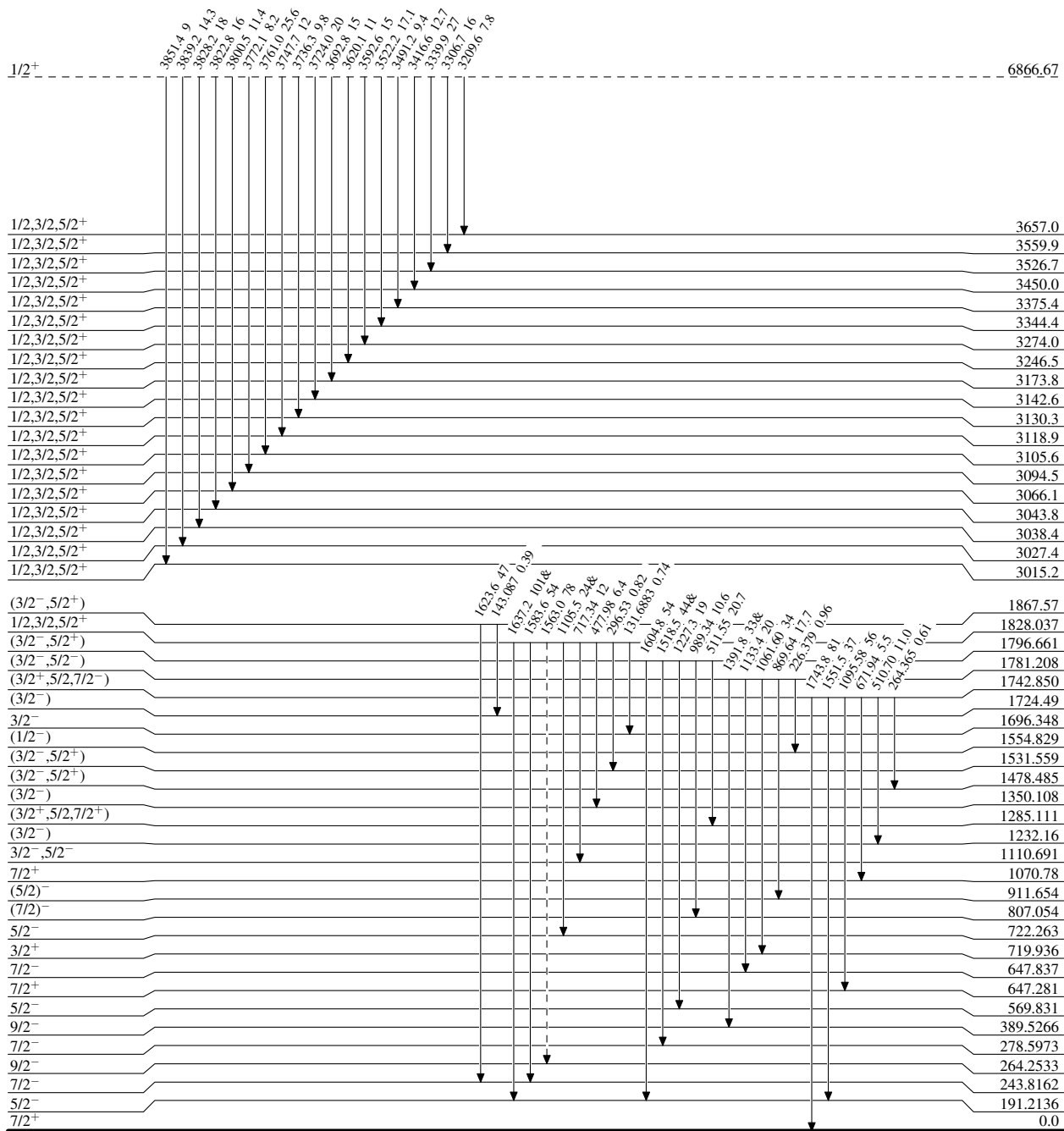
¹⁶⁸Yb(n,γ) E=thermal 1969Bo16,1972Wi12,1973GrZV

Level Scheme (continued)

Intensities: relative I_γ
& Multiply placed: undivided intensity given

Legend

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}
- - - - - γ Decay (Uncertain)



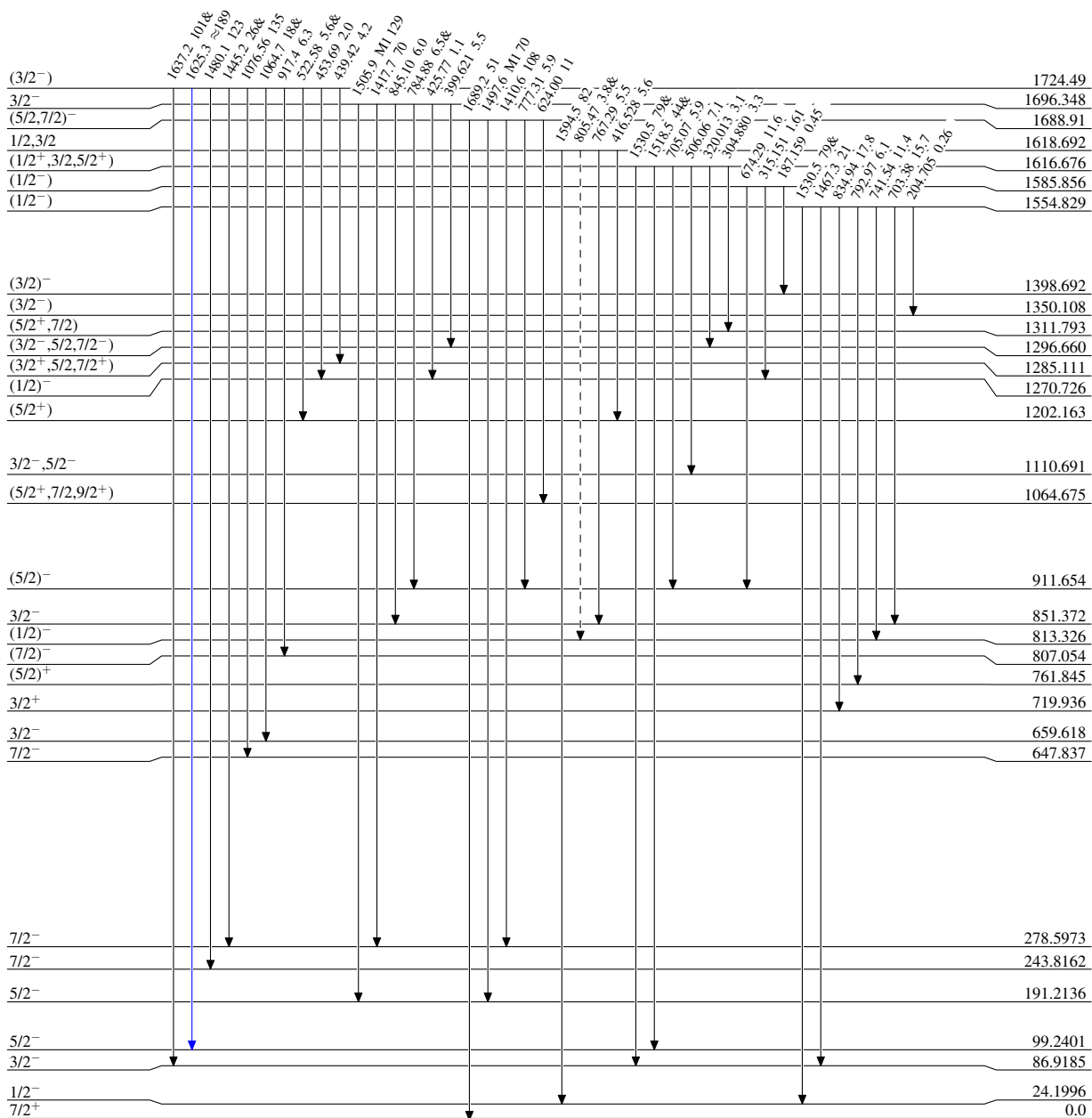
¹⁶⁸Yb(n,γ) E=thermal 1969Bo16,1972Wi12,1973GrZV

Level Scheme (continued)

Intensities: relative I_γ
& Multiply placed: undivided intensity given

Legend

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}
- - - - - γ Decay (Uncertain)



¹⁶⁹Yb₉₉

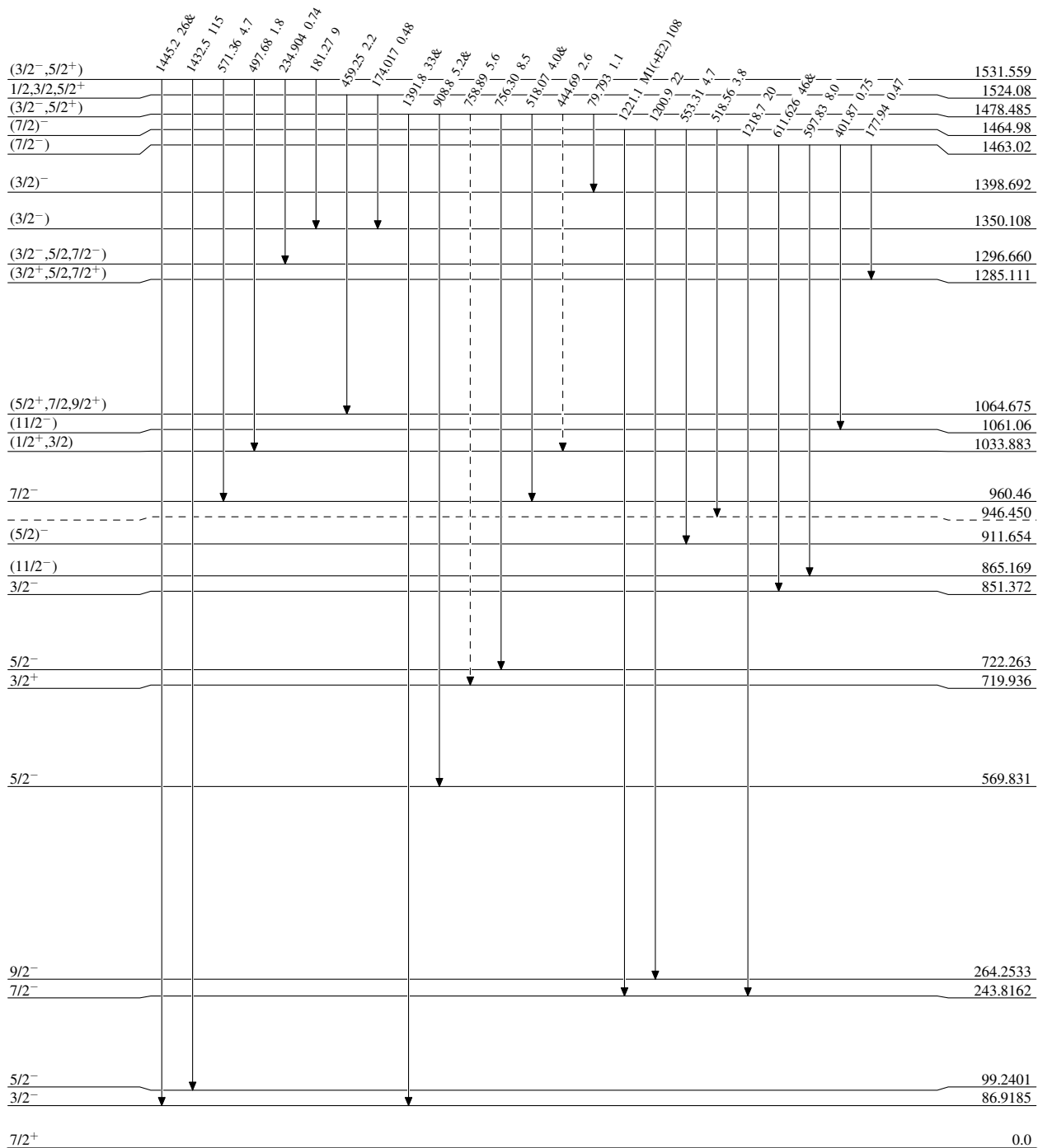
$^{168}\text{Yb}(n,\gamma)$ E=thermal 1969Bo16,1972Wi12,1973GrZV

Level Scheme (continued)

Intensities: relative I_γ
& Multiply placed: undivided intensity given

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\cdots\cdots\cdots$ γ Decay (Uncertain)



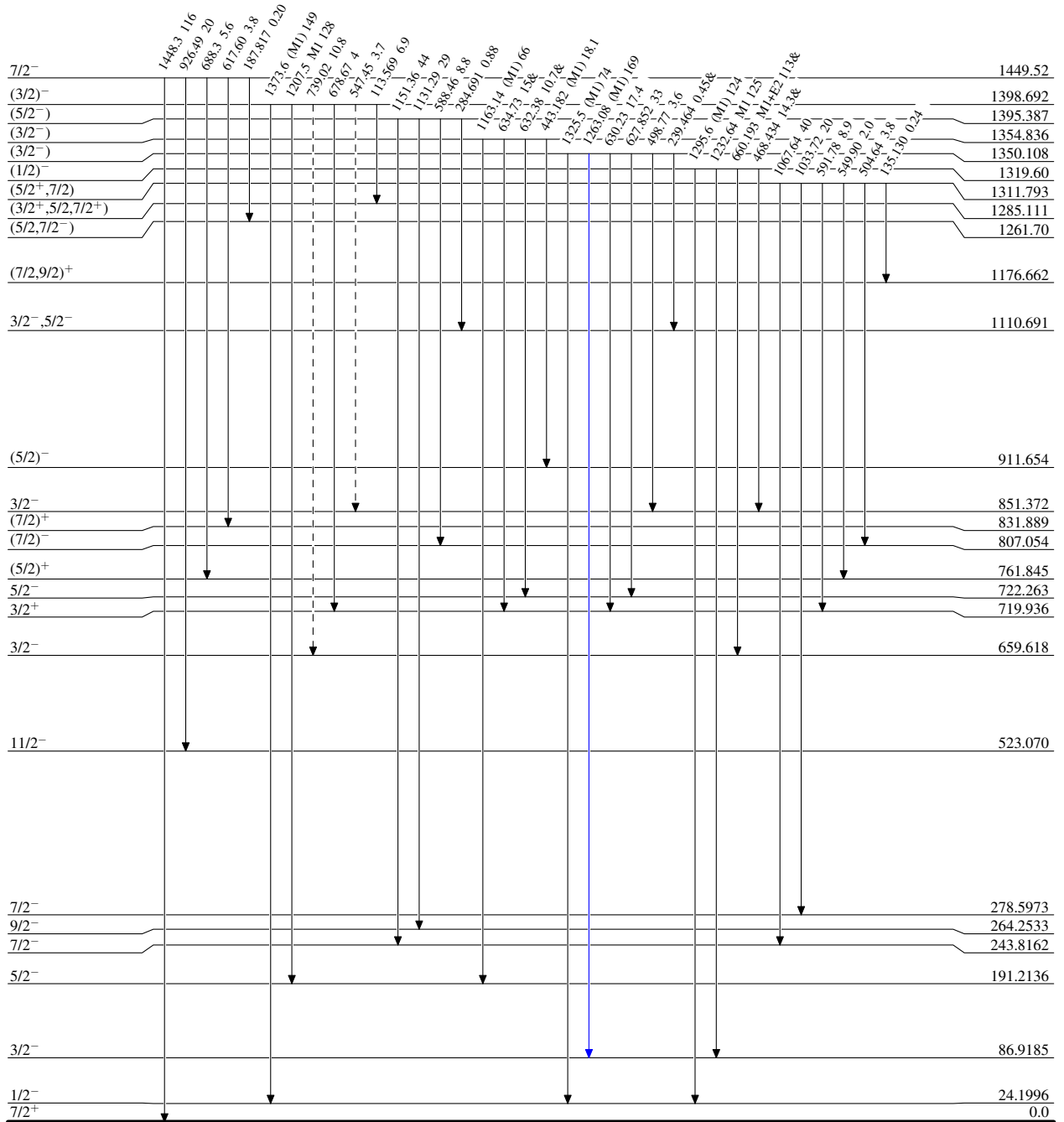
$^{168}\text{Yb}(n,\gamma) \text{ E=thermal}$ $^{1969}\text{Bo16}, ^{1972}\text{Wi12}, ^{1973}\text{GrZV}$

Legend

Level Scheme (continued)

Intensities: relative I_γ
& Multiply placed: undivided intensity given

$\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $-----$ γ Decay (Uncertain)


 $^{169}_{70}\text{Yb}_{99}$

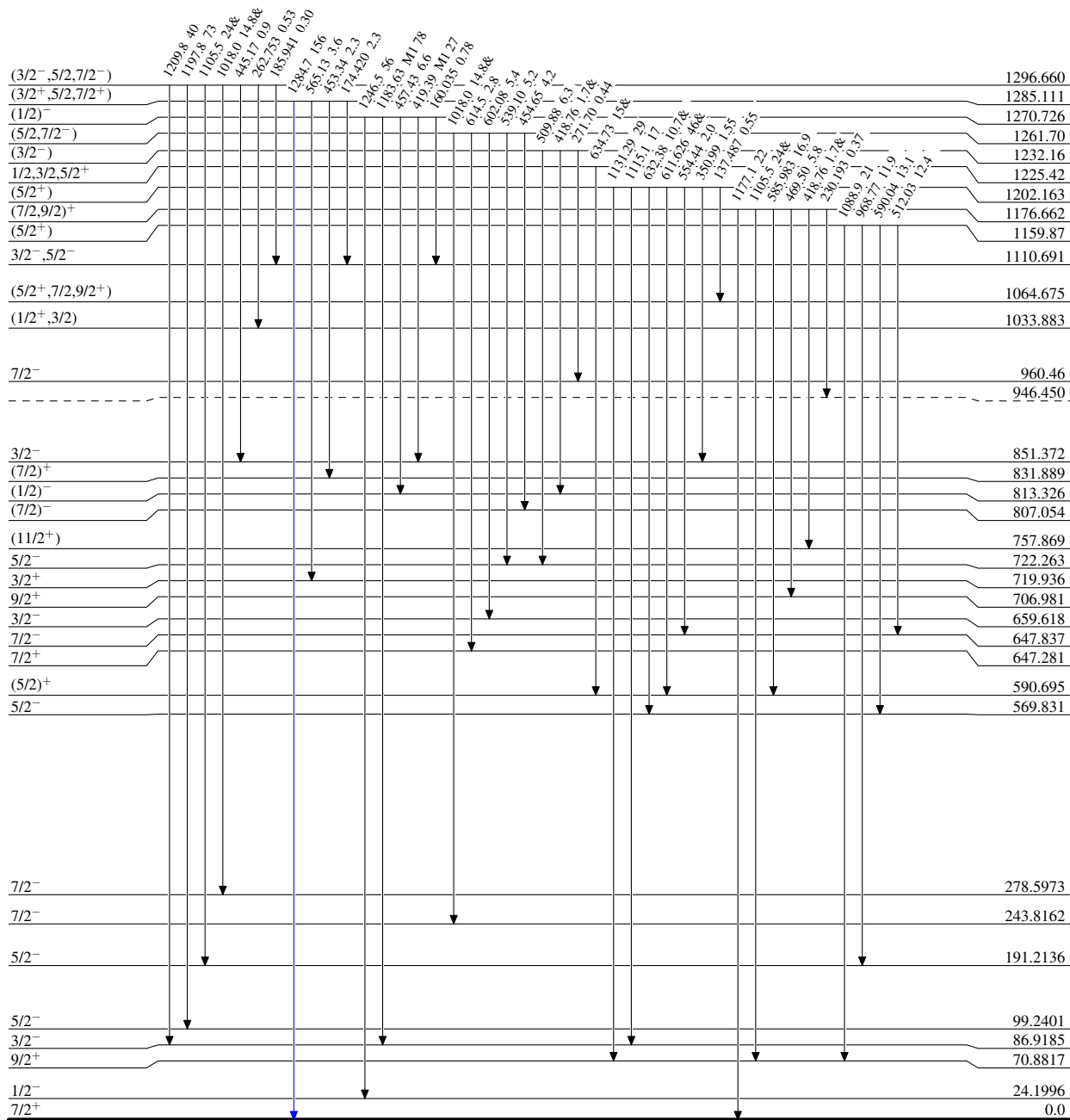
$^{168}\text{Yb}(n,\gamma)$ E=thermal 1969Bo16,1972Wi12,1973GrZV

Level Scheme (continued)

Legend

 Intensities: relative I γ
 & Multiply placed: undivided intensity given

$\longrightarrow$ I γ < 2% $\times$ I γ^{max}
 $\longrightarrow$ I γ < 10% $\times$ I γ^{max}
 $\longrightarrow$ I γ > 10% $\times$ I γ^{max}


 $^{169}_{70}\text{Yb}_{99}$

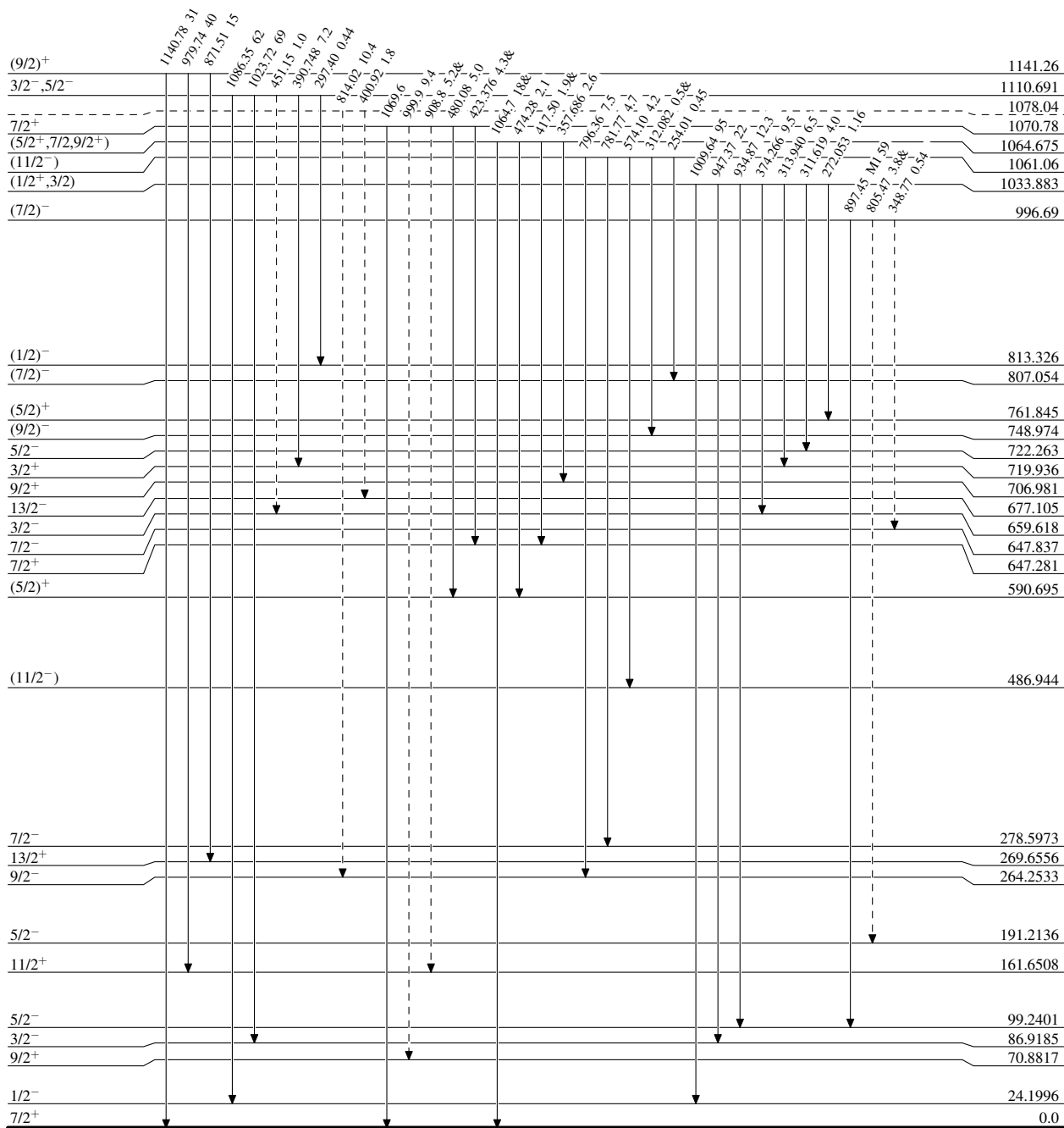
¹⁶⁸Yb(n,γ) E=thermal 1969Bo16,1972Wi12,1973GrZV

Level Scheme (continued)

Intensities: relative I_γ
& Multiply placed: undivided intensity given

Legend

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}
- - - - - γ Decay (Uncertain)



¹⁶⁹Yb₉₉

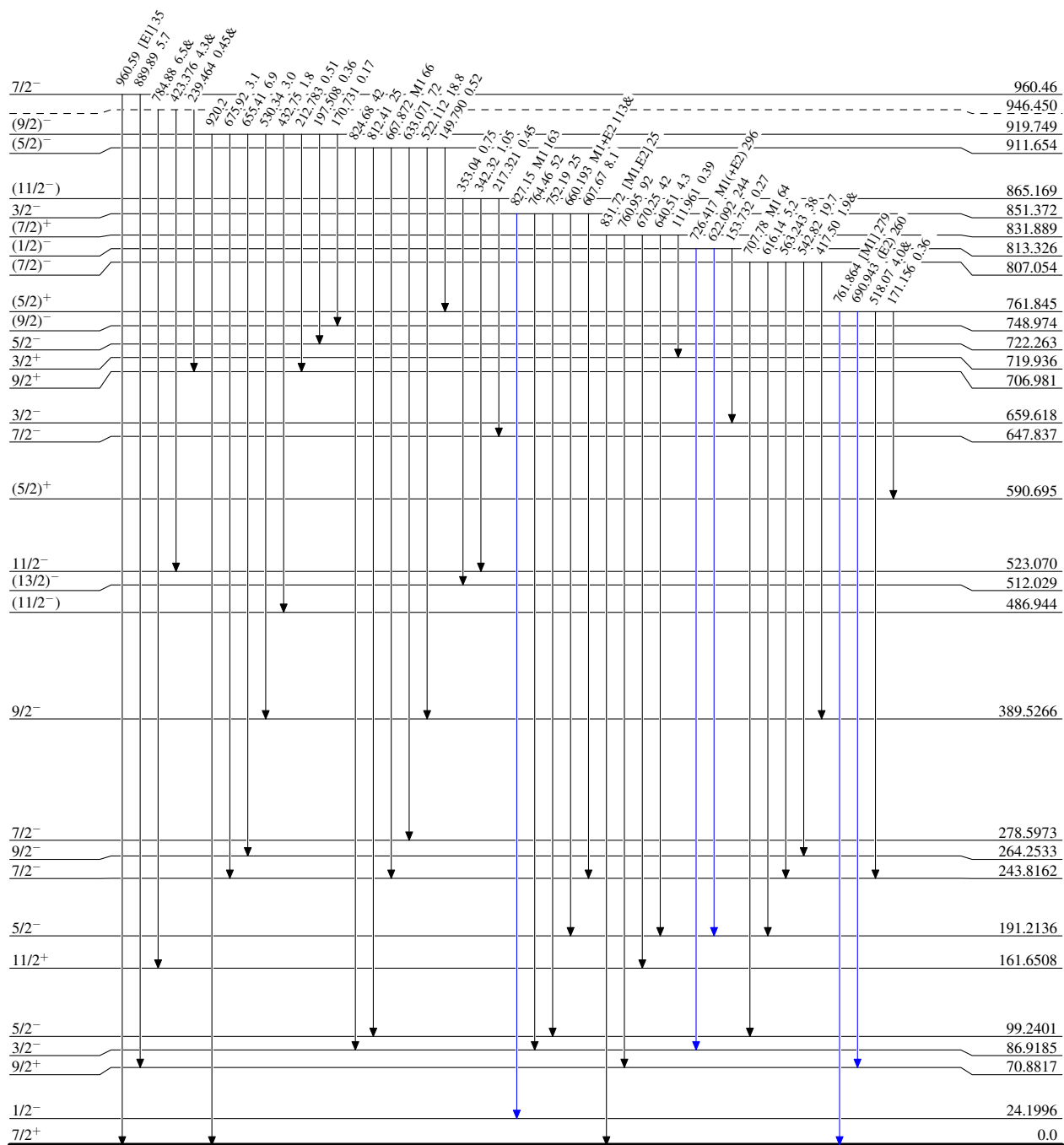
$^{168}\text{Yb}(n,\gamma)$ E=thermal 1969Bo16,1972Wi12,1973GrZV

Level Scheme (continued)

Legend

Intensities: relative I_γ
& Multiply placed: undivided intensity given

— $I_\gamma < 2\% \times I_\gamma^{\max}$
— $I_\gamma < 10\% \times I_\gamma^{\max}$
— $I_\gamma > 10\% \times I_\gamma^{\max}$

 $^{169}_{70}\text{Yb}_{99}$

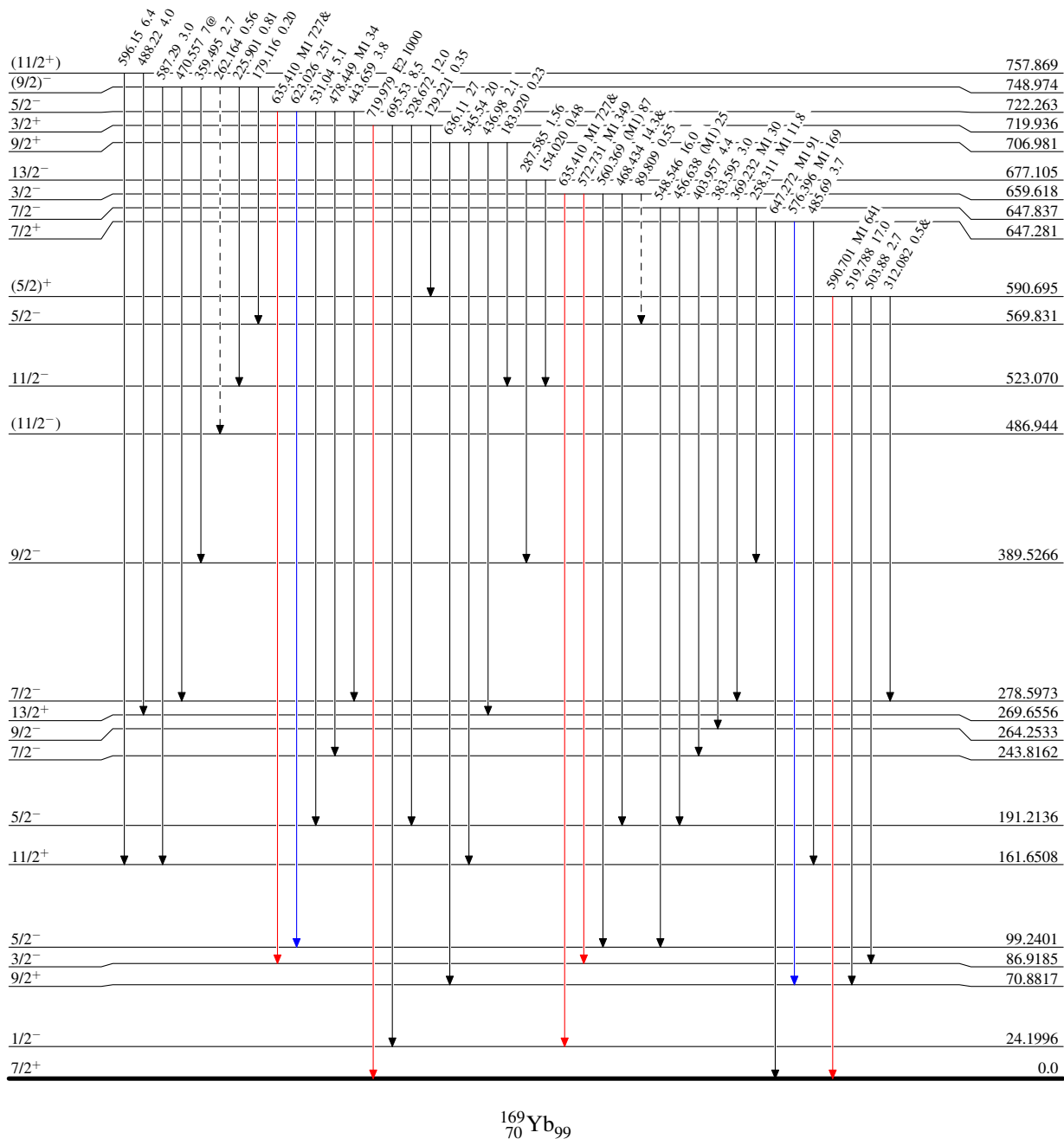
$^{168}\text{Yb}(n,\gamma) \text{E=thermal}$ 1969Bo16,1972Wi12,1973GrZV

Level Scheme (continued)

Legend

Intensities: relative I_γ
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided

$\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ γ Decay (Uncertain)



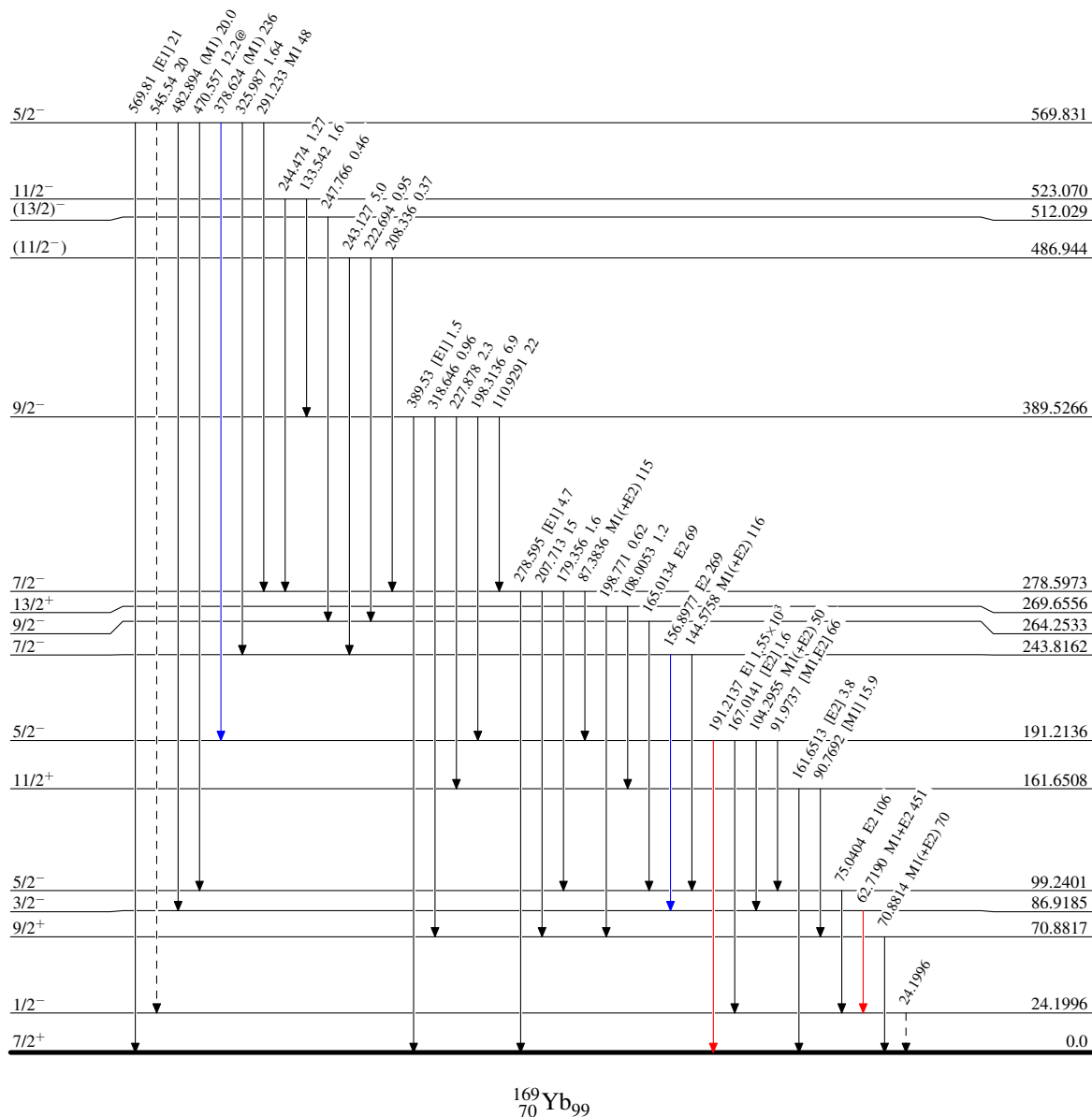
$^{168}\text{Yb}(n,\gamma)$ E=thermal 1969Bo16,1972Wi12,1973GrZV

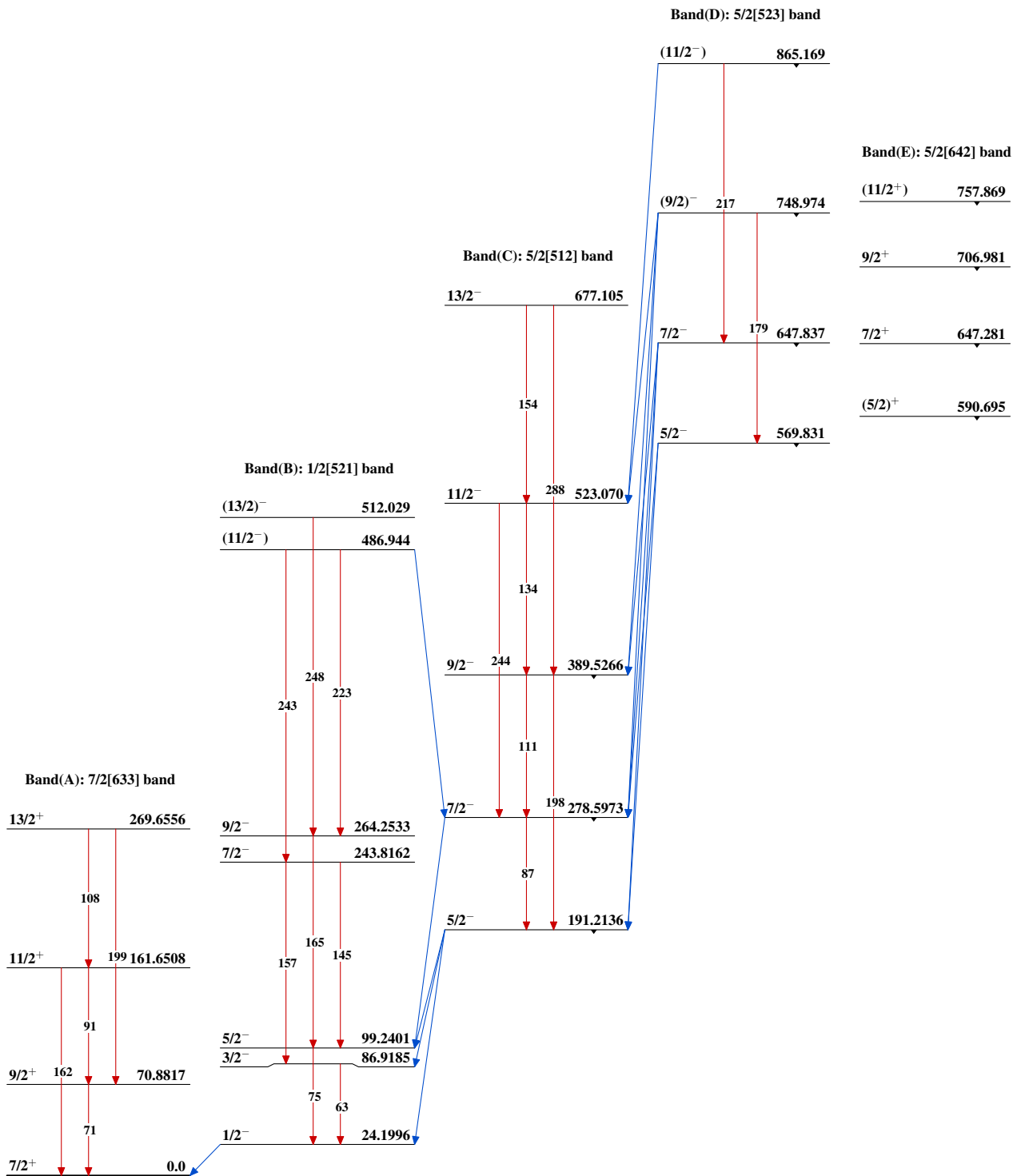
Level Scheme (continued)

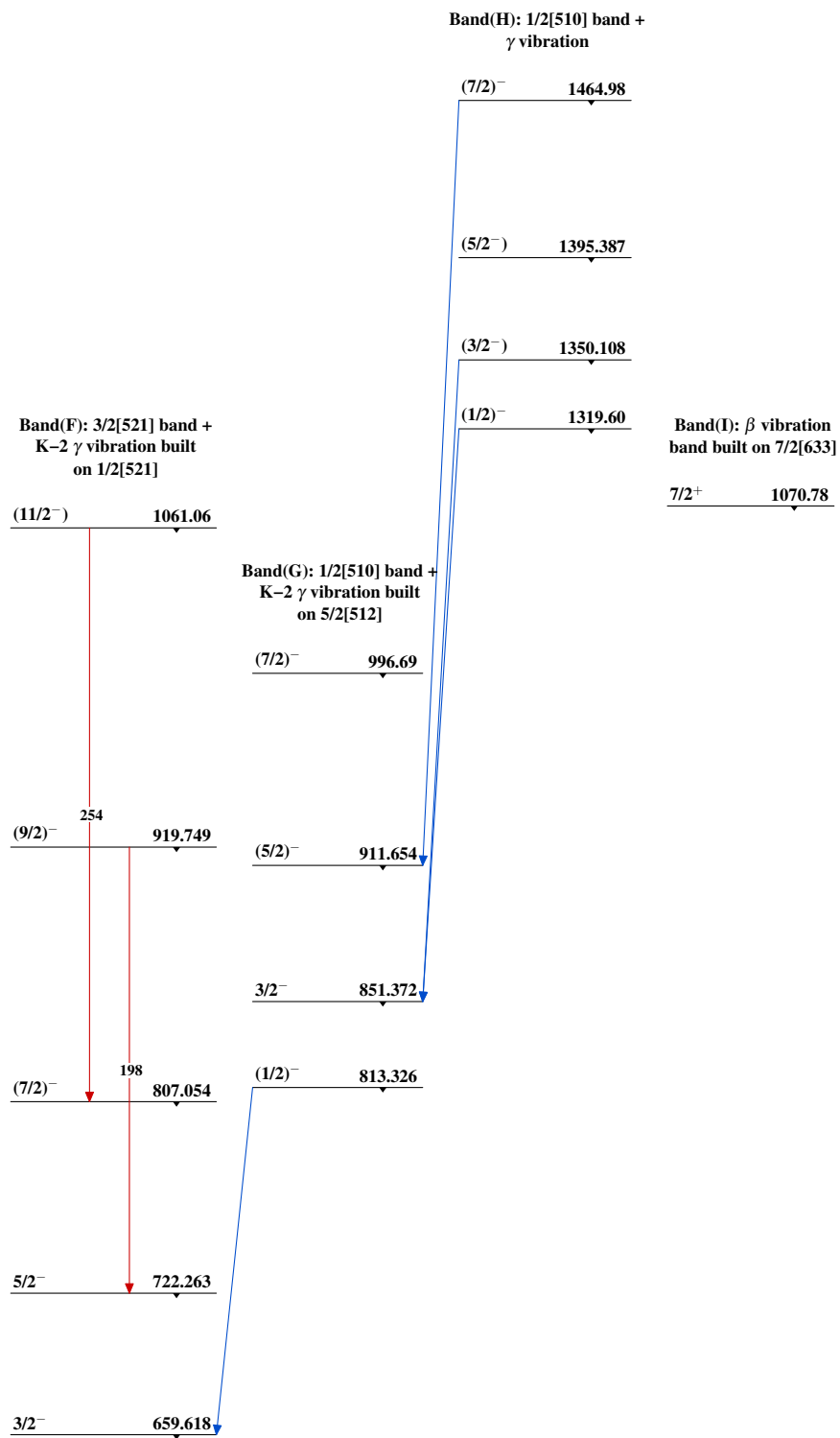
Intensities: relative I_γ
 & Multiply placed: undivided intensity given
 @ Multiply placed: intensity suitably divided

Legend

—————▶ $I_\gamma < 2\% \times I_\gamma^{\max}$
 —————▶ $I_\gamma < 10\% \times I_\gamma^{\max}$
 —————▶ $I_\gamma > 10\% \times I_\gamma^{\max}$
 - - - - -▶ γ Decay (Uncertain)


 $^{169}_{70}\text{Yb}_{99}$

$^{168}\text{Yb}(n,\gamma)$ E=thermal 1969Bo16,1972Wi12,1973GrZV

$^{168}\text{Yb}(n,\gamma)$ E=thermal 1969Bo16,1972Wi12,1973GrZV (continued)

 $^{169}_{70}\text{Yb}_{99}$

 $^{168}\text{Yb}(\text{n},\gamma)$ **E=**resonance

See [1966Wa14](#), [1972VeZP](#), and [2018MuZZ](#) for properties of resonance states. Seven resonances are reported in [2018MuZZ](#) from 0.597 eV to 188.09 eV. Two resonances are reported in [2025Ch28](#) at 22.53 eV *198* and 27.27 eV *240*.

¹⁶⁸Yb(d,p), ¹⁷⁰Yb(d,t) **1966Bu16**
¹⁶⁸Yb(d,p): E(d)=12 MeV, θ=56°, 60°, 85°.

¹⁷⁰Yb(d,t): E(d)=12 MeV, θ=60°, 90°.

Enriched Yb targets (>99% for ¹⁶⁸Yb, 85.4% for ¹⁷⁰Yb); measured E(level) (mag spect, resolution≈0.1%), differential cross sections.

¹⁶⁹Yb Levels

E(level) [†]	J ^π [‡]	Comments
0.0 [?] #	7/2 ⁺	
24 [@] 3	1/2 ⁻	dσ/dΩ(60° and 90°)(d,t)=162 and 155 μb/sr, respectively. dσ/dΩ(56°, 60°, and 85°)(d,p)=238, ≈230, and 115 μb/sr, respectively.
70 [#] 3	9/2 ⁺	dσ/dΩ(60° and 90°)(d,t)=12 and 22 μb/sr, respectively. dσ/dΩ(56° and 85°)(d,p) ≈13 and 14 μb/sr, respectively.
84 [@] 3	3/2 ⁻	dσ/dΩ(60° and 90°)(d,t)=30 μb/sr for doublet 84+98 and 8 μb/sr, respectively. dσ/dΩ(56° and 85°)(d,p)=63 and 49 μb/sr, respectively, both for doublet 84+98.
98 [@] 3	5/2 ⁻	dσ/dΩ(90°)(d,t)=26 μb/sr.
162 [?] #	11/2 ⁺	E(level): Adopted value (rounded); level weakly populated and/or unresolved.
192 ^{&} 3	5/2 ⁻	dσ/dΩ(60° and 85°)(d,p)=8 and 4 μb/sr, respectively.
244 [@] 3	7/2 ⁻	dσ/dΩ(60° and 90°)(d,t)=32 and 48 μb/sr, respectively. dσ/dΩ(56° and 85°)(d,p)=99 and 72 μb/sr, respectively.
266 [@] 3	9/2 ⁻	dσ/dΩ(60° and 90°)(d,t)=46 μb/sr for triplet 266+266+277 and 26 μb/sr for doublet 266+266. dσ/dΩ(56° and 85°)(d,p)=300 and 228 μb/sr, respectively, both for triplet 266+266+277.
266 [#] 3	13/2 ⁺	
277 ^{&} 3	7/2 ⁻	dσ/dΩ(90°)(d,t)=65 μb/sr.
390 ^{&} 3	9/2 ⁻	dσ/dΩ(56°, 60°, and 85°)(d,p)=7, 7, and 7 μb/sr, respectively.
487 [@] 3	11/2 ⁻	dσ/dΩ(56° and 85°)(d,p)=3 and 4 μb/sr, respectively.
523 ^{&} 3	11/2 ⁻	dσ/dΩ(56°, 60°, and 85°)(d,p)=5, 6, and 4 μb/sr, respectively.
569 ^a 3	5/2 ⁻	dσ/dΩ(60° and 90°)(d,t)=9 μb/sr for doublet 569+584 and 20 μb/sr, respectively. dσ/dΩ(56° and 85°)(d,p)=5 and 4 μb/sr, respectively, both for doublet 569+584.
584 ^b 3	5/2 ⁺	dσ/dΩ(90°)(d,t)=11 μb/sr.
647 ^a 3	7/2 ⁻	dσ/dΩ(60° and 90°)(d,t)=69 μb/sr for doublet 647+657 and ≈13 μb/sr, respectively. dσ/dΩ(56°, 60° and 85°)(d,p)=53 and 43 μb/sr both for doublet 647+657 and ≈10 μb/sr, respectively.
657 ^c 3	3/2 ⁻	dσ/dΩ(90°)(d,t)=80 μb/sr. dσ/dΩ(85°)(d,p) ≈17 μb/sr.
704 ^b 3	9/2 ⁺	dσ/dΩ(60° and 90°)(d,t)=23 μb/sr for doublet 704+718 and 30 μb/sr, respectively. dσ/dΩ(56°, 60°, and 90°)(d,p)=9, ≈6 μb/sr, and 10 μb/sr for doublet 704+718, respectively.
718 ^c 3	5/2 ⁻	dσ/dΩ(90°)(d,t)≈12 μb/sr. dσ/dΩ(60°)(d,p) ≈9 μb/sr.
747 ^a 3	9/2 ⁻	dσ/dΩ(60° and 90°)(d,t)=6 and ≈22 μb/sr, respectively. dσ/dΩ(56°, 60°, and 85°)(d,p) ≈6, 9, and 11 μb/sr, respectively.
805 ^c 3	7/2 ⁻	dσ/dΩ(60° and 90°)(d,t)=56 and 100 μb/sr, respectively. dσ/dΩ(56°, 60°, and 85°)(d,p)=43, 42, and 36 μb/sr, respectively.
849 3		dσ/dΩ(60° and 90°)(d,t)≈3 and ≈15 μb/sr, respectively. dσ/dΩ(56°, 60°, and 85°)(d,p)=236, 178, and 145 μb/sr, respectively. Possible J=3/2 member of K-2 γ-vibration built on 5/2[512].
871 ^a	11/2 ⁻	E(level): from literature in 1966Bu16 (source not cited). dσ/dΩ(60° and 90°)(d,t)=8 and 31 μb/sr, respectively, both for doublet 871+877.
877 ^b 3	13/2 ⁺	dσ/dΩ(56°, 60°, and 85°)(d,p) ≈9, ≈6, and ≈4 μb/sr, respectively.
911 3		Possible J=5/2 member of K-2 γ-vibration built on 5/2[512]. dσ/dΩ(56°, 60°, and 85°)(d,p)=70, 47, and 49 μb/sr, respectively.
925 ^c 3	(9/2 ⁻)	J ^π : assignment tentative. dσ/dΩ(60° and 90°)(d,t)=6 and 22 μb/sr, respectively.
959 3		dσ/dΩ(56°, 60°, and 85°)(d,p)=76, 48, and 37 μb/sr, respectively.

Continued on next page (footnotes at end of table)

¹⁶⁸Yb(d,p), ¹⁷⁰Yb(d,t) **1966Bu16** (continued)

¹⁶⁹Yb Levels (continued)

E(level) [†]	J ^π [‡]	Comments
996 3		Possible J=7/2 member of K-2 γ-vibration built on 5/2[512]. dσ/dΩ(56° and 85°)(d,p)=21 and 19 μb/sr, respectively.
1030 3		dσ/dΩ(60° and 90°)(d,t)=55 and 110 μb/sr, respectively. dσ/dΩ(56°)(d,p)=19 μb/sr.
1064 3		dσ/dΩ(60° and 90°)(d,t)=6 μb/sr for doublet 1064+1074 and 17 μb/sr, respectively. dσ/dΩ(56° and 60°)(d,p) ≈ 18 and ≈ 14 μb/sr, respectively.
1074 3		dσ/dΩ(90°)(d,t)=8 μb/sr. dσ/dΩ(56° and 60°)(d,p) ≈ 8 and ≈ 14 μb/sr, respectively.
1106 3		dσ/dΩ(60° and 90°)(d,t)=54 and 105 μb/sr, respectively. dσ/dΩ(56° and 60°)(d,p)=44 and 23 μb/sr, respectively.
1134 3		dσ/dΩ(90°)(d,t)=8 μb/sr. dσ/dΩ(56°)(d,p)=8 μb/sr.
1170 3		dσ/dΩ(90°)(d,t) ≈ 6 μb/sr. dσ/dΩ(56°)(d,p)=11 μb/sr.
1182 3		dσ/dΩ(56°, 60°, and 85°)(d,p) ≈ 2, and 10 μb/sr, respectively.
1198 3		dσ/dΩ(60° and 90°)(d,t) ≈ 6 and 21 μb/sr, respectively. dσ/dΩ(56°)(d,p)=9 μb/sr.
1225 3		dσ/dΩ(90°)(d,t)=11 μb/sr. dσ/dΩ(56° and 60°)(d,p)=13 and 14 μb/sr, respectively.
1285 3		dσ/dΩ(90°)(d,t) ≈ 9 μb/sr. dσ/dΩ(56° and 60°)(d,p)=173 and 120 μb/sr, respectively.
1317 ^d 3	(1/2 ⁻)	dσ/dΩ(90°)(d,t)=18 μb/sr. dσ/dΩ(56° and 60°)(d,p) ≈ 20 and 18 μb/sr, respectively.
1351 ^d 3	(3/2 ⁻)	dσ/dΩ(90°)(d,t) ≈ 14 μb/sr. dσ/dΩ(56° and 60°)(d,p)=171 and 111 μb/sr, respectively.
1395 ^d 3	(5/2 ⁻)	dσ/dΩ(60° and 90°)(d,t) ≈ 7 and 20 μb/sr, respectively. dσ/dΩ(56° and 60°)(d,p)=68 and 58 μb/sr, respectively.
≈1421		dσ/dΩ(90°)(d,t)=5 μb/sr. dσ/dΩ(56° and 60°)(d,p) ≈ 4 and 7 μb/sr, respectively.
1459 3		dσ/dΩ(90°)(d,t)=16 μb/sr. dσ/dΩ(56° and 60°)(d,p) ≈ 61 and 29 μb/sr, respectively.
1473 ^d 3	(7/2 ⁻)	dσ/dΩ(56° and 60°)(d,p) ≈ 40 and 23 μb/sr, respectively.
1526 6		dσ/dΩ(56° and 60°)(d,p)=73 and 46 μb/sr, respectively.
1553 6		dσ/dΩ(56° and 60°)(d,p) ≈ 88 and 56 μb/sr, respectively.
1567 6		dσ/dΩ(60°)(d,p) ≈ 21 μb/sr.
1607 6		dσ/dΩ(60°)(d,p) ≈ 50 μb/sr.
1640 6		dσ/dΩ(60°)(d,p)=238 μb/sr.
1688 6		dσ/dΩ(60°)(d,p)=334 μb/sr.
1733 6		dσ/dΩ(60°)(d,p) ≈ 61 μb/sr.
1767 6		dσ/dΩ(60°)(d,p) ≈ 150 μb/sr.

[†] Authors' weighted average from (d,p) and (d,t).

[‡] Authors' values from systematics of Yb isotopes and comparison of relative level populations with predictions from stripping theory. Consistent, apart from the use of parentheses, with adopted values.

[#] Band(A): 7/2[633] band.

[@] Band(B): 1/2[521] band.

[&] Band(C): 5/2[512] band.

^a Band(D): 5/2[523] band.

^b Band(E): 5/2[642] band.

^c Band(F): 3/2[521] band + K-2 γ vibration built on 1/2[521].

^d Band(G): 1/2[510] band + possible K-2 γ vibration built on 5/2[512]. Tentative assignment; (d,p) populations are ≈40% of expected strength.

$^{168}\text{Yb}(\text{d,p}), ^{170}\text{Yb}(\text{d,t})$ 1966Bu16

				Band(F): 3/2[521] band + K=2 γ vibration built on 1/2[521]	
				(9/2 ⁻)	925
				Band(D): 5/2[523] band	Band(E): 5/2[642] band
				11/2 ⁻	13/2 ⁺
				871	877
					7/2 ⁻
					805
				9/2 ⁻	
				747	
					5/2 ⁻
					718
				9/2 ⁺	
				704	
					3/2 ⁻
					657
				7/2 ⁻	
				647	
				5/2 ⁻	5/2 ⁺
				569	584
				Band(C): 5/2[512] band	
				11/2 ⁻	523
				Band(B): 1/2[521] band	
				11/2 ⁻	487
				9/2 ⁻	390
				Band(A): 7/2[633] band	
				13/2 ⁺	266
				9/2 ⁻	266
				7/2 ⁻	244
				5/2 ⁻	192
				11/2 ⁺	162
				5/2 ⁻	98
				3/2 ⁻	84
				9/2 ⁺	70
				1/2 ⁻	24
				7/2 ⁺	0.0

¹⁶⁸Yb(d,p), ¹⁷⁰Yb(d,t) 1966Bu16 (continued)

Band(G): 1/2[510] band +
possible K=2 γ
vibration built on
5/2[512]

(7/2⁻) 1473

(5/2⁻) 1395

(3/2⁻) 1351

(1/2⁻) 1317

¹⁶⁹₇₀Yb₉₉

$^{171}\text{Yb}(\text{p},\text{t})$ 1973Oo01

Target $J^\pi=1/2^-$.

E(p)=19 MeV; Yb metal targets enriched to 96.0% in ^{171}Yb ; measured E(level) (mag spect with nuclear emulsions and position sensitive detectors; FWHM=10-12 keV), angular distributions, absolute differential cross sections ($^{176}\text{Yb}(\text{p},\text{p})$ data used for spectrometer calibration).

 ^{169}Yb Levels

$\Sigma\sigma_{\text{c.m.}}$ data listed in comments is the sum of measured values at 12.5°, 27.5°, 42.5°, and 55°.

E(level)	L [†]	Comments
27 5	0	$\Sigma\sigma_{\text{c.m.}}=349.0 \mu\text{b/sr}$ 46.
71 5		$\Sigma\sigma_{\text{c.m.}}=6.4 \mu\text{b/sr}$ 15.
87 5	2	$\Sigma\sigma_{\text{c.m.}}=43.1 \mu\text{b/sr}$ 57.
99 5	2	$\Sigma\sigma_{\text{c.m.}}=130.0 \mu\text{b/sr}$ 84.
194 7		$\Sigma\sigma_{\text{c.m.}}=1.6 \mu\text{b/sr}$ 3.
245 5	(4)	$\Sigma\sigma_{\text{c.m.}}=11.5 \mu\text{b/sr}$ 16.
268 5	4	$\Sigma\sigma_{\text{c.m.}}=27.6 \mu\text{b/sr}$ 29.
484 10		$\Sigma\sigma_{\text{c.m.}}=1.7 \mu\text{b/sr}$ 2.
516 5		$\Sigma\sigma_{\text{c.m.}}=3.5 \mu\text{b/sr}$ 4.
570 5		$\Sigma\sigma_{\text{c.m.}}=10.4 \mu\text{b/sr}$ 8.
659 5		$\Sigma\sigma_{\text{c.m.}}=33.4 \mu\text{b/sr}$ 10.
750 5		$\Sigma\sigma_{\text{c.m.}}=5.5 \mu\text{b/sr}$ 6.
808 5		$\Sigma\sigma_{\text{c.m.}}=17.3 \mu\text{b/sr}$ 7.
1033 5		$\Sigma\sigma_{\text{c.m.}}=9.7 \mu\text{b/sr}$ 5.
1108 5	2	$\Sigma\sigma_{\text{c.m.}}=6.1 \mu\text{b/sr}$ 4.
1169 5		$\Sigma\sigma_{\text{c.m.}}=4.9 \mu\text{b/sr}$ 5.
1350 [‡] 5		$\Sigma\sigma_{\text{c.m.}}=27.8 \mu\text{b/sr}$ 11.
1426 5		$\Sigma\sigma_{\text{c.m.}}=10.8 \mu\text{b/sr}$ 7.
1463 10		$\Sigma\sigma_{\text{c.m.}}=2.0 \mu\text{b/sr}$ 14.
1479 5		$\Sigma\sigma_{\text{c.m.}}=43.0 \mu\text{b/sr}$ 7.
1513 10	0	$\Sigma\sigma_{\text{c.m.}}=5.3 \mu\text{b/sr}$ 11.
1528 5		$\Sigma\sigma_{\text{c.m.}}=9.8 \mu\text{b/sr}$ 8.
1582 5	(0)	$\Sigma\sigma_{\text{c.m.}}=20.2 \mu\text{b/sr}$ 15.
1621 5		$\Sigma\sigma_{\text{c.m.}}=9.3 \mu\text{b/sr}$ 9.
1714 5		$\Sigma\sigma_{\text{c.m.}}=7.4 \mu\text{b/sr}$ 12.
1740 [‡] 5	(0)	$\Sigma\sigma_{\text{c.m.}}=14.0 \mu\text{b/sr}$ 9.
1785 [‡] 5		$\Sigma\sigma_{\text{c.m.}}=13.5 \mu\text{b/sr}$ 11.
1943 7		$\Sigma\sigma_{\text{c.m.}}=10.7 \mu\text{b/sr}$ 13.
1971 7		$\Sigma\sigma_{\text{c.m.}}=9.7 \mu\text{b/sr}$ 14.
1997 7		$\Sigma\sigma_{\text{c.m.}}=4.7 \mu\text{b/sr}$ 13.
2053 12		$\Sigma\sigma_{\text{c.m.}}=10.4 \mu\text{b/sr}$ 8.
2129 12		$\Sigma\sigma_{\text{c.m.}}=9.0 \mu\text{b/sr}$ 11.
2286 12		$\Sigma\sigma_{\text{c.m.}}=6.3 \mu\text{b/sr}$ 15.

[†] DWBA analysis of angular distributions.

[‡] Doublet (broader than normal peak).

Adopted Levels, Gammas

$Q(\beta^-) = -3366$ 28; $S(n) = 9080$ 40; $S(p) = 3792$ 3; $Q(\alpha) = 2423$ 3 2021Wa16

$S(2n) = 16700$ 40, $S(2p) = 10117$ 3 (2021Wa16).

Measured production cross section of ¹⁶⁹Lu:

2022Ma34: ¹⁵⁴Sm(¹⁹F,4n γ), $E(\text{lab}) = 79.4\text{--}102.7$ MeV, at five energies.

2019Ta15: ¹⁶⁵Ho(¹²C, α 4n), $E(\text{lab}) = 61.78\text{--}87.38$ MeV, at seven energies.

2019De15: ¹³⁶Xe + ¹⁹⁸Pt, $E(\text{c.m.}) = 451$ MeV, cumulative and independent yield.

2019Ba40: ^{204,206,207,208}Pb(d,x), $E = 4.4$ GeV, independent and cumulative cross sections.

2016Ka36: ²⁰⁹Bi(¹¹Be,x), $E = 146.0$ MeV, and ¹⁸¹Ta(¹¹Be,x), $E = 125.7, 245.4$ MeV; independent and cumulative cross sections.

Also production cross section reported in 2015Ju02, 2013Is01, 2011Ti05,

For isotope shift data see, e.g., 1998Ge13.

¹⁶⁹Lu Levels

Cross Reference (XREF) Flags

A	¹⁶⁹ Lu IT decay (160 s)	D	¹⁶⁸ Yb(p,p) IAR
B	¹⁶⁹ Hf ε decay (3.24 min)	E	¹⁶⁹ Tm(α ,4n γ), ¹⁷¹ Yb(p,3n γ)
C	¹⁵⁴ Sm(¹⁹ F,4n γ)		

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$T_{1/2}$	XREF	Comments
0.0 [@]	7/2 ⁺	34.06 h 5	ABC E	$\% \varepsilon + \% \beta^+ = 100$ $\mu = 2.288$ 4; $Q = 3.48$ 3 $\Delta \langle r^2 \rangle(170,169) = -0.078$ fm ² 8 (1998Ge13). μ : from 1998Ge13, 2019StZV – collinear laser spectroscopy. Other: 2.297 13 from NMR on oriented nuclei (1996Ko26). Q : from 1998Ge13, 2021StZZ – collinear laser spectroscopy. Other: 3.42 12 from NMR on oriented nuclei (1996Ko26). $\langle r^2 \rangle^{1/2}(\text{charge}) = 5.329$ fm 30 (2013An02). J^π : atomic beam (1976Fu06, 1968Ek01); parity from comparison between μ and theoretical value for 7/2[404] orbital (1976Fu06). $T_{1/2}$: from 1970Ka23. Others: 36 h (from 1.5 days in 1961Me05), 36 h (1975Gr44).
29.0 ^{&} 5	1/2 ⁻	160 s 10	AB E	$\% \text{IT} = 100$ $\mu = 0.536$ 7 $\Delta \langle r^2 \rangle(170,169) = +0.130$ fm ² 13 (1998Ge13). μ : from 1998Ge13, 2019StZV – collinear laser spectroscopy. J^π : E3 γ to 7/2 ⁺ ; large cross section for (p,2n) on J=0 target (≈ 20 mb at $E(p) = 12$ MeV) for production of isomer rules out 13/2 ⁻ ; $\mu = 0.54$ cf. 0.70 expected for 1/2[541] orbital. $T_{1/2}$: from ¹⁶⁹ Lu IT decay (160 s) (1965Bj01 – ce(t)).
43.1 ^{&} 6	(5/2 ⁻)		BC E	
97.4 ^b 5	(1/2 ⁺)		B E	J^π : from proposed 1/2[411] bandhead in 1973Fo03 (α ,4n γ), (p,3n γ), based on the cranked-shell model calculation of the quasiproton routhians in 1993Og01: (¹⁹ F,4n γ).
113.8 ^c 6	(3/2 ⁺)		BC E	
123.45 [#] 8	(9/2 ⁺)		BC E	J^π : M1, E2 γ to 7/2 ⁺ g.s.; 9/2 ⁺ consistent with band assignment.
140.8 ^{&} 6	(9/2 ⁻)		C E	
157.7 ^a 6	(3/2 ⁻)		E	
186.5 ^d 6	(5/2 ⁺)		BC E	
225.2 ^b 6	(5/2 ⁺)		C E	
260.7 ^c 6	(7/2 ⁺)		C E	
270.59 [@] 12	(11/2 ⁺)		C E	

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Adopted Levels, Gammas (continued) ^{169}Lu Levels (continued)

E(level) [†]	J ^π [‡]	XREF	Comments
288.8 ^e 6	(7/2 ⁺)	C E	
328.9 ^a 6	(7/2 ⁻)	E	
330.5 ^{&} 6	(13/2 ⁻)	C E	
414.9 ^d 6	(9/2 ⁺)	C E	
439.11 ^f 15	(9/2 ⁻)	C E	
439.67 [#] 14	(13/2 ⁺)	C E	
449.5 ^b 6	(9/2 ⁺)	C E	
492.88 9	7/2 ⁻	B	J ^π : E1 γ to 7/2 ⁺ ; allowed, unhindered ε decay ($\log ft < 4.5$) from ^{169}Hf supports assignment of ν 5/2[523] Nilsson orbital to $^{169}\text{Hf}(\text{g.s.})$ and π 7/2[523] to $^{169}\text{Lu}(492.9 \text{ level})$; consistent with systematics of 97-neutron nuclei.
508.5 ^c 6	(11/2 ⁺)	C E	
546.11 ^g 16	(11/2 ⁻)	C E	
569.1 ^e 6	(11/2 ⁺)	C E	
576.6 ^a 6	(11/2 ⁻)	E	
610.9 ^{&} 6	(17/2 ⁻)	C E	
628.86 [@] 17	(15/2 ⁺)	C E	
683.35 ^f 17	(13/2 ⁻)	C E	
733.7 ^d 6	(13/2 ⁺)	C E	
763.5 ^b 6	(13/2 ⁺)	C E	
836.34 [#] 19	(17/2 ⁺)	C E	
842.6 ^c 6	(15/2 ⁺)	C E	
844.72 ^g 18	(15/2 ⁻)	C E	
896.4 ^a 6	(15/2 ⁻)	C E	
937.9 ^e 7	(15/2 ⁺)	C E	
978.1 ^{&} 7	(21/2 ⁻)	C E	
1031.72 ^f 21	(17/2 ⁻)	C E	
1060.29 [@] 24	(19/2 ⁺)	C E	
1117.0 ^d 6	(17/2 ⁺)	C	
1151.7 ^b 7	(17/2 ⁺)	C E	
1234.92 ^g 24	(19/2 ⁻)	C E	
1244.6 ^c 6	(19/2 ⁺)	C E	
1288.8 ^a 7	(19/2 ⁻)	C E	
1298.43 [#] 24	(21/2 ⁺)	C E	
1423.7 ^{&} 7	(25/2 ⁻)	C E	
1461.98 ^f 27	(21/2 ⁻)	C E	
1549.17 [@] 28	(23/2 ⁺)	C E	
1551.0 ^d 7	(21/2 ⁺)	C	
1697.19 ^g 31	(23/2 ⁻)	C E	
1698.7 ^c 7	(23/2 ⁺)	C E	
1747.6 ^a 7	(23/2 ⁻)	C E	
1810.02 [#] 34	(25/2 ⁺)	C E	
1936.7 ^{&} 7	(29/2 ⁻)	C E	
1955.9 ^f 4	(25/2 ⁻)	C E	
2027.8 ^d 7	(25/2 ⁺)	C	
2080.8 [@] 4	(27/2 ⁺)	C E	
2197.0 ^c 7	(27/2 ⁺)	C E	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Lu Levels (continued)

<u>E(level)[†]</u>	<u>J$\pi^{\ddagger}$</u>	<u>XREF</u>
2214.9 ^g 5	(27/2 ⁻)	C
2260.1 [?] ^a 8	(27/2 ⁻)	E
2357.3 [#] 4	(29/2 ⁺)	C E
2495.8 ^f 5	(29/2 ⁻)	C
2506.6 ^{&} 8	(33/2 ⁻)	C E
2542.4 ^d 7	(29/2 ⁺)	C
2644.2 [@] 5	(31/2 ⁺)	C
2740.1 ^c 7	(31/2 ⁺)	C
2772.1 ^g 6	(31/2 ⁻)	C
2931.1 [#] 6	(33/2 ⁺)	C
3065.6 ^f 6	(33/2 ⁻)	C
3091.4 ^d 8	(33/2 ⁺)	C
3124.9 ^{&} 9	(37/2 ⁻)	C
3231.3 [@] 6	(35/2 ⁺)	C
3329.1 ^c 8	(35/2 ⁺)	C
3352.4 ^g 6	(35/2 ⁻)	C
3528.3 [#] 6	(37/2 ⁺)	C
3647.9 ^f 7	(37/2 ⁻)	C
3673.1 ^d 9	(37/2 ⁺)	C
3789.4 ^{&} 10	(41/2 ⁻)	C
3843.6 [@] 7	(39/2 ⁺)	C
3937.1 ^g 7	(39/2 ⁻)	C
3963.9 ^c 9	(39/2 ⁺)	C
4157.3 [#] 8	(41/2 ⁺)	C
4240.7 ^f 8	(41/2 ⁻)	C
4293.2 ^d 11	(41/2 ⁺)	C
4495.6 [@] 9	(43/2 ⁺)	C
4503.0 ^{&} 10	(45/2 ⁻)	C
4542.7 ^g 8	(43/2 ⁻)	C
4644.1 ^c 10	(43/2 ⁺)	C
4836.6 [#] 10	(45/2 ⁺)	C
4879.5 ^f 8	(45/2 ⁻)	C
4963.2 ^d 12	(45/2 ⁺)	C
5203.6 [@] 10	(47/2 ⁺)	C
5204.4 ^g 9	(47/2 ⁻)	C
5269.9 ^{&} 11	(49/2 ⁻)	C
5370.7 ^c 10	(47/2 ⁺)	C
5578.6 [#] 11	(49/2 ⁺)	C
5689.2 [?] ^d 13	(49/2 ⁺)	C
5975.6 [@] 11	(51/2 ⁺)	C
6091.6 ^{&} 12	(53/2 ⁻)	C
6127.8 [?] ^c 11	(51/2 ⁺)	C
6382.6 [#] 12	(53/2 ⁺)	C
6903.5 [?] ^c 12	(55/2 ⁺)	C
6963.6 ^{&} 13	(57/2 ⁻)	C

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Lu Levels (continued)

<u>E(level)[†]</u>	<u>J^π[‡]</u>	<u>T_{1/2}</u>	<u>XREF</u>	<u>Comments</u>
14065 20	1/2 ⁻	53 keV	D	E(level): from $^{168}\text{Yb}(p,p)$ IAR. $\Gamma_p=5.9$ keV, $\Gamma=53$ keV. J ^π : Analog of 1/2 ⁻ 24.2 level in ^{169}Yb .

[†] From least-squares fit to adopted E_γ . Exceptions are noted.

[‡] Values given without comment are from $^{154}\text{Sm}(^{19}\text{F},4n\gamma)$, based on deduced band structure, analogy to neighboring nuclides and alignment gains, band crossing frequencies and B(M1)/B(E2) ratios for intraband transitions, when available.

Band(A): 7/2[404] $\alpha=+1/2$ band ([1993Og01](#)). First band crossing at $\hbar\omega\approx 0.28$ MeV, alignment gain $\approx 6.2\hbar$. Band assignment supported by observed B(M1)/B(E2) ratios for intraband transitions.

@ Band(a): 7/2[404] $\alpha=-1/2$ band ([1993Og01](#)). See comment on signature partner band.

& Band(B): 1/2[541] $\alpha=+1/2$ band ([1993Og01](#)). (A=9.7, a=3.2 (1/2, 3/2, 5/2, 7/2, 9/2 levels)). First band crossing at $\hbar\omega\approx 0.32$ MeV, alignment gain $\approx 3.5\hbar$. Average Q(transition)=7.5 b 10 for J=33/2 through 57/2 band members ([1993Og01](#)).

^a Band(b): 1/2[541] $\alpha=-1/2$ band ([1973Fo03](#)).

^b Band(C): 1/2[411] $\alpha=+1/2$ band ([1993Og01](#)). Band parameters: A=13.3, a=-0.59 (1/2, 3/2, 5/2, 7/2, 9/2 levels). Strongly mixed with 5/2[402] $\alpha=+1/2$ band.

^c Band(c): 1/2[411] $\alpha=-1/2$ band ([1993Og01](#)). First band crossing at $\hbar\omega\approx 0.28$ MeV, alignment gain $\geq 7.9\hbar$.

^d Band(D): 5/2[402] $\alpha=+1/2$ band ([1993Og01](#)). Band parameters: A=14.8, B=-13.9 (5/2, 7/2, 9/2, 11/2 levels). Strongly mixed with 1/2[411] $\alpha=+1/2$ band. First band crossing at $\hbar\omega\approx 0.26$ MeV, alignment gain $\approx 6.1\hbar$.

^e Band(d): 5/2[402] $\alpha=-1/2$ band ([1993Og01](#)).

^f Band(E): 9/2[514] $\alpha=+1/2$ band ([1993Og01](#)). First band crossing at $\hbar\omega\approx 0.27$ MeV, alignment gain $\geq 6.2\hbar$. Band parameters: A=8.8, B=18.2 (9/2, 11/2, 13/2, 15/2 levels).

^g Band(e): 9/2[514] $\alpha=-1/2$ band ([1993Og01](#)). See comment on signature partner band.

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Lu})$								
$E_i(\text{level})$	J_i^π	$E_\gamma^{\ddagger}$	I_γ^a	E_f	J_f^π	Mult. ^b	α^d	Comments
29.0	1/2 ⁻	29.0 5	100	0.0	7/2 ⁺	E3	9.4×10^4 10	B(E3)(W.u.)=0.0028 +6-4
43.1	(5/2 ⁻)	(14.1)	100	29.0	1/2 ⁻			$E_\gamma, \text{Mult.}$: from ^{169}Lu IT decay (160 s).
97.4	(1/2 ⁺)	68.4 1	100	29.0	1/2 ⁻	(E1)	0.931 13	E_γ : from level energy difference.
113.8	(3/2 ⁺)	(16.4 8)		97.4	(1/2 ⁺)			E_γ : from level energy difference.
		70.9 ^{#g} 2		43.1	(5/2 ⁻)	[E1]	0.852 13	
		84.8 ^{#g} 2		29.0	1/2 ⁻	[E1]	0.538 8	
123.45	(9/2 ⁺)	123.5 1	100	0.0	7/2 ⁺	M1,E2 [@]	1.76 ^c 25	
140.8	(9/2 ⁻)	97.7 1	100	43.1	(5/2 ⁻)			
157.7?	(3/2 ⁻)	114.4 ^g 2	100	43.1	(5/2 ⁻)			
186.5	(5/2 ⁺)	72.9 [#] 2	100	113.8	(3/2 ⁺)	[M1,E2]	10.6 15	
225.2	(5/2 ⁺)	111.5 2		113.8	(3/2 ⁺)			
		181.9 [#] 2		43.1	(5/2 ⁻)			
260.7	(7/2 ⁺)	120.0 [#] 2		140.8	(9/2 ⁻)			
		146.8 2	100 7	113.8	(3/2 ⁺)			
		217.3 3	≤ 6.3	43.1	(5/2 ⁻)			
270.59	(11/2 ⁺)	147.2 2	85 5	123.45	(9/2 ⁺)			
		270.5 2	100 5	0.0	7/2 ⁺			
288.8	(7/2 ⁺)	102.3 1	100	186.5	(5/2 ⁺)			
328.9?	(7/2 ⁻)	170.8 ^g 3		157.7?	(3/2 ⁻)			
		188.8 ^g 2		140.8	(9/2 ⁻)			
		285.6 ^f 3	^f	43.1	(5/2 ⁻)			
330.5	(13/2 ⁻)	189.0	100	140.8	(9/2 ⁻)			
414.9	(9/2 ⁺)	126.1 1	100 13	288.8	(7/2 ⁺)			
		153.8	13 4	260.7	(7/2 ⁺)			
		228.5 2	≤ 24	186.5	(5/2 ⁺)			Other I_γ : 79 in ($\alpha, 4n\gamma$), ($p, 3n\gamma$).
439.11	(9/2 ⁻)	315.7 2	100 4	123.45	(9/2 ⁺)			
		439.0 3	42.8 15	0.0	7/2 ⁺			
439.67	(13/2 ⁺)	169.1 1	56.9 27	270.59	(11/2 ⁺)			
		316.2 2	100 3	123.45	(9/2 ⁺)			
449.5?	(9/2 ⁺)	188.7	90 14	260.7	(7/2 ⁺)			
		224.0	100 14	225.2	(5/2 ⁺)			
		263.5	29 10	186.5	(5/2 ⁺)			
492.88	7/2 ⁻	369.5 [@] 2	11.7 [@] 8	123.45	(9/2 ⁺)	[E1]	0.01253 18	
		492.86 [@] 10	100 [@]	0.0	7/2 ⁺	E1 [@]	0.00651 9	
508.5	(11/2 ⁺)	93.1 ^g		414.9	(9/2 ⁺)			
		247.8 ^e 1	100 5	260.7	(7/2 ⁺)			
		367.5 ^g 2	≤ 2.1	140.8	(9/2 ⁻)			E_γ : for multiply-placed γ .

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Lu})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^{\ddagger}$	I_γ^a	E_f	J_f^π	Mult. ^b	α^d	Comments
546.11	(11/2 ⁻)	107.0 [#] 2	<190 ^{&}	439.11	(9/2 ⁻)			
		275.0 [#] 3	<150 ^{&}	270.59	(11/2 ⁺)			
		422.8 3	≈100 ^{&}	123.45	(9/2 ⁺)			
569.1	(11/2 ⁺)	154.0 2	100 23	414.9	(9/2 ⁺)			
		280.6 2	36 9	288.8	(7/2 ⁺)			
576.6?	(11/2 ⁻)	245.3 ^{#g} 3	70 ^{&}	330.5	(13/2 ⁻)			
		247.8 ^{eg} 1		328.9?	(7/2 ⁻)			
		433.2 ^{†#g} 3	100 ^{&}	140.8	(9/2 ⁻)	&		E_γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=435.78.
610.9	(17/2 ⁻)	280.6 ^f 2	100 ^f	330.5	(13/2 ⁻)			
628.86	(15/2 ⁺)	189.2 2	41.7 26	439.67	(13/2 ⁺)			I_γ : other I_γ : ≈29 from (α ,4n γ).
		358.3 2	100 5	270.59	(11/2 ⁺)			
683.35	(13/2 ⁻)	137.2 1	100 5	546.11	(11/2 ⁻)			
		243.6 4	79 11	439.67	(13/2 ⁺)			
		244.1		439.11	(9/2 ⁻)			
		413.1 4	36 3	270.59	(11/2 ⁺)			
733.7	(13/2 ⁺)	164.7 1	100 7	569.1	(11/2 ⁺)			
		224.8	27 3	508.5	(11/2 ⁺)			
		284.3	12 3	449.5?	(9/2 ⁺)			
		318.5 3	55 3	414.9	(9/2 ⁺)			
763.5	(13/2 ⁺)	254.6 3	49 6	508.5	(11/2 ⁺)			
		314.1 3	100 9	449.5?	(9/2 ⁺)			
		349.2	31 6	414.9	(9/2 ⁺)			
836.34	(17/2 ⁺)	207.4 2	34.5 24	628.86	(15/2 ⁺)			
		396.7 2	100.0 21	439.67	(13/2 ⁺)			
842.6	(15/2 ⁺)	333.7 3	100.0 22	508.5	(11/2 ⁺)	(E2)	0.0558 8	
		512.5	8.3 18	330.5	(13/2 ⁻)			
844.72	(15/2 ⁻)	161.3 2	100.0 24	683.35	(13/2 ⁻)			
		215.7		628.86	(15/2 ⁺)			
		298.6 2	33.1 21	546.11	(11/2 ⁻)			
		405.4	24 3	439.67	(13/2 ⁺)			
896.4	(15/2 ⁻)	285.6 ^f 3	<12 ^{f&}	610.9	(17/2 ⁻)			
		319.9 [#] 3	100 ^{&}	576.6?	(11/2 ⁻)			
		565.6 4		330.5	(13/2 ⁻)			
937.9	(15/2 ⁺)	203.8	100 6	733.7	(13/2 ⁺)			
		369.0	95 5	569.1	(11/2 ⁺)			
978.1	(21/2 ⁻)	367.6	100	610.9	(17/2 ⁻)	(E2)	0.0423 6	
1031.72	(17/2 ⁻)	186.9 2	100 3	844.72	(15/2 ⁻)			
		197.0		836.34	(17/2 ⁺)			

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Lu})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^{\ddagger}$	I_γ^a	E_f	J_f^π	Mult. ^b	α^d	Comments
1031.72	(17/2 ⁻)	348.3 3	44 5	683.35	(13/2 ⁻)			Other I γ : 134 in (α ,4n γ), (p,3n γ).
		403.0	18.4 23	628.86	(15/2 ⁺)			
1060.29	(19/2 ⁺)	224.1	26.6 14	836.34	(17/2 ⁺)			Other I γ : >44 in (α ,4n γ).
		431.7 3	100.0 23	628.86	(15/2 ⁺)			
1117.0	(17/2 ⁺)	179.0	34 3	937.9	(15/2 ⁺)			
		274.3	37 3	842.6	(15/2 ⁺)			
		353.3	36 3	763.5	(13/2 ⁺)			
		383.3	100 6	733.7	(13/2 ⁺)			
1151.7	(17/2 ⁺)	388.2 4	100	763.5	(13/2 ⁺)			
1234.92	(19/2 ⁻)	175.0 ^g		1060.29	(19/2 ⁺)			
		203.2	100.0 20	1031.72	(17/2 ⁻)			
		390.3 3	62 4	844.72	(15/2 ⁻)			
		397.0	6.5 15	836.34	(17/2 ⁺)			
1244.6	(19/2 ⁺)	401.7 3	100 3	842.6	(15/2 ⁺)	Q		Mult.: from (^{19}F ,4n γ).
		635.0	20 4	610.9	(17/2 ⁻)			
1288.8	(19/2 ⁻)	$\approx$ 310		978.1	(21/2 ⁻)			E γ : from (α ,4n γ).
		392.2 4		896.4	(15/2 ⁻)			
		677.6 5		610.9	(17/2 ⁻)			
1298.43	(21/2 ⁺)	238.3 3	21.7 12	1060.29	(19/2 ⁺)			
		462.0 2	100 5	836.34	(17/2 ⁺)			
1423.7	(25/2 ⁻)	445.6 2	100	978.1	(21/2 ⁻)			
1461.98	(21/2 ⁻)	226.9 2	100 7	1234.92	(19/2 ⁻)			
		430.6 3	74.6 21	1031.72	(17/2 ⁻)			
1549.17	(23/2 ⁺)	250.8 3	19.6 6	1298.43	(21/2 ⁺)			
		488.9 2	100 3	1060.29	(19/2 ⁺)			
1551.0	(21/2 ⁺)	306.7	28.8 25	1244.6	(19/2 ⁺)			
		433.6	100 8	1117.0	(17/2 ⁺)			
1697.19	(23/2 ⁻)	235.2 2	100 5	1461.98	(21/2 ⁻)			
		462.3	83 6	1234.92	(19/2 ⁻)			
1698.7	(23/2 ⁺)	454.2 3	100 5	1244.6	(19/2 ⁺)	(E2)	0.02379 34	
		720.8	18.5 25	978.1	(21/2 ⁻)			
1747.6	(23/2 ⁻)	324.0 ^{e#} 5		1423.7	(25/2 ⁻)			
		458.5 3	100	1288.8	(19/2 ⁻)			
1810.02	(25/2 ⁺)	261.0 3	20.5 18	1549.17	(23/2 ⁺)			
		511.3	100 4	1298.43	(21/2 ⁺)			
1936.7	(29/2 ⁻)	513.4	100	1423.7	(25/2 ⁻)			
1955.9	(25/2 ⁻)	258.7 3	98 8	1697.19	(23/2 ⁻)			
		494.0 4	100 5	1461.98	(21/2 ⁻)			
2027.8	(25/2 ⁺)	329.4	17.8 17	1698.7	(23/2 ⁺)			
		476.8	100 6	1551.0	(21/2 ⁺)			
2080.8	(27/2 ⁺)	270.7	16.7 14	1810.02	(25/2 ⁺)			

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Lu})$ (continued)							
$E_i(\text{level})$	J_i^π	$E_\gamma^{\ddagger}$	I_γ^a	E_f	J_f^π	Mult. ^b	Comments
2080.8	(27/2 ⁺)	531.6 3	100.0 24	1549.17	(23/2 ⁺)		
2197.0	(27/2 ⁺)	498.5 3	100 6	1698.7	(23/2 ⁺)		
		773.1	31 4	1423.7	(25/2 ⁻)		
2214.9	(27/2 ⁻)	258.9	85 9	1955.9	(25/2 ⁻)		
		517.7	100 10	1697.19	(23/2 ⁻)		
2260.1?	(27/2 ⁻)	324.0 ^{eg} 5		1936.7	(29/2 ⁻)		
		512.0 ^{eg} 5		1747.6	(23/2 ⁻)		
2357.3	(29/2 ⁺)	276.4	16.6 12	2080.8	(27/2 ⁺)		
		547.4 4	100 5	1810.02	(25/2 ⁺)		
2495.8	(29/2 ⁻)	281.0	79 11	2214.9	(27/2 ⁻)	D+Q	Mult.: from (¹⁹ F,4n γ).
		539.8	100 10	1955.9	(25/2 ⁻)		
2506.6	(33/2 ⁻)	569.9 4	100	1936.7	(29/2 ⁻)		
2542.4	(29/2 ⁺)	345.3	12.2 22	2197.0	(27/2 ⁺)		
		514.8	100 11	2027.8	(25/2 ⁺)		
2644.2	(31/2 ⁺)	286.9	22.7 15	2357.3	(29/2 ⁺)		
		563.2	100 6	2080.8	(27/2 ⁺)		
2740.1	(31/2 ⁺)	543.2	100 7	2197.0	(27/2 ⁺)		
		803.2	27 5	1936.7	(29/2 ⁻)		
2772.1	(31/2 ⁻)	276.5	79 5	2495.8	(29/2 ⁻)	D+Q	Mult.: from (¹⁹ F,4n γ).
		557.2	100 3	2214.9	(27/2 ⁻)		
2931.1	(33/2 ⁺)	286.5	14 3	2644.2	(31/2 ⁺)		
		574.1	100.0 16	2357.3	(29/2 ⁺)		
3065.6	(33/2 ⁻)	293.5	100 13	2772.1	(31/2 ⁻)		
		569.8	97 9	2495.8	(29/2 ⁻)		
3091.4	(33/2 ⁺)	351.2	17 5	2740.1	(31/2 ⁺)		
		549.1	100 17	2542.4	(29/2 ⁺)		
3124.9	(37/2 ⁻)	618.4	100	2506.6	(33/2 ⁻)		
3231.3	(35/2 ⁺)	300.0	15 3	2931.1	(33/2 ⁺)		
		587.3	100 6	2644.2	(31/2 ⁺)		
3329.1	(35/2 ⁺)	589.0	100 8	2740.1	(31/2 ⁺)		
		822.4	16 4	2506.6	(33/2 ⁻)		
3352.4	(35/2 ⁻)	286.8	89 4	3065.6	(33/2 ⁻)	D+Q	Mult.: from (¹⁹ F,4n γ).
		580.2	100 5	2772.1	(31/2 ⁻)		
3528.3	(37/2 ⁺)	297.0	14 4	3231.3	(35/2 ⁺)		
		597.2	100 6	2931.1	(33/2 ⁺)		
3647.9	(37/2 ⁻)	295.5	88 8	3352.4	(35/2 ⁻)		
		582.3	100 7	3065.6	(33/2 ⁻)		
3673.1	(37/2 ⁺)	581.7	100	3091.4	(33/2 ⁺)		
3789.4	(41/2 ⁻)	664.7	100	3124.9	(37/2 ⁻)		
3843.6	(39/2 ⁺)	315.3		3528.3	(37/2 ⁺)		
		612.3	100 7	3231.3	(35/2 ⁺)		

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Lu})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\ddagger$	I_γ^a	E_f	J_f^π	$E_i(\text{level})$	J_i^π	$E_\gamma^\ddagger$	I_γ^a	E_f	J_f^π
3937.1	(39/2 ⁻)	289.3	80 8	3647.9	(37/2 ⁻)	4879.5	(45/2 ⁻)	638.8	100 37	4240.7	(41/2 ⁻)
		584.8	100 11	3352.4	(35/2 ⁻)	4963.2	(45/2 ⁺)	670.0	100	4293.2	(41/2 ⁺)
3963.9	(39/2 ⁺)	634.7	100 18	3329.1	(35/2 ⁺)	5203.6	(47/2 ⁺)	708.0	100	4495.6	(43/2 ⁺)
		839.0	25 8	3124.9	(37/2 ⁻)	5204.4	(47/2 ⁻)	325.0	75 45	4879.5	(45/2 ⁻)
4157.3	(41/2 ⁺)	629.0	100	3528.3	(37/2 ⁺)			661.6	100 34	4542.7	(43/2 ⁻)
4240.7	(41/2 ⁻)	303.5	100 10	3937.1	(39/2 ⁻)	5269.9	(49/2 ⁻)	766.9	100	4503.0	(45/2 ⁻)
		592.7	93 15	3647.9	(37/2 ⁻)	5370.7	(47/2 ⁺)	726.7	100 24	4644.1	(43/2 ⁺)
4293.2	(41/2 ⁺)	620.1	100	3673.1	(37/2 ⁺)			867.6	≤18	4503.0	(45/2 ⁻)
4495.6	(43/2 ⁺)	652.0	100	3843.6	(39/2 ⁺)	5578.6	(49/2 ⁺)	742.0	100	4836.6	(45/2 ⁺)
4503.0	(45/2 ⁻)	713.4	100	3789.4	(41/2 ⁻)	5689.2?	(49/2 ⁺)	726.0 ^g	100	4963.2	(45/2 ⁺)
4542.7	(43/2 ⁻)	302.0	71 14	4240.7	(41/2 ⁻)	5975.6	(51/2 ⁺)	772.0	100	5203.6	(47/2 ⁺)
		605.7	100 14	3937.1	(39/2 ⁻)	6091.6	(53/2 ⁻)	821.7	100	5269.9	(49/2 ⁻)
4644.1	(43/2 ⁺)	680.0	100 16	3963.9	(39/2 ⁺)	6127.8?	(51/2 ⁺)	757.1 ^g	100	5370.7	(47/2 ⁺)
		855.0	25 5	3789.4	(41/2 ⁻)	6382.6	(53/2 ⁺)	804.0	100	5578.6	(49/2 ⁺)
4836.6	(45/2 ⁺)	679.3	100	4157.3	(41/2 ⁺)	6903.5?	(55/2 ⁺)	775.7 ^g	100	6127.8?	(51/2 ⁺)
4879.5	(45/2 ⁻)	337.0	98 49	4542.7	(43/2 ⁻)	6963.6	(57/2 ⁻)	872.0	100	6091.6	(53/2 ⁻)

[†] Poor fit; uncertainty multiplied by a factor in the fitting.

[‡] E_γ with uncertainty are from ($\alpha, 4n\gamma$) and those without uncertainty are from ($^{19}\text{F}, 4n\gamma$), except where otherwise noted.

Assignment to ^{169}Lu uncertain.

@ From ^{169}Hf ε decay.

& From $^{169}\text{Tm}(\alpha, 4n\gamma)$, $^{171}\text{Yb}(p, 3n\gamma)$.

^a Relative photon branching from each level; values are from $^{154}\text{Sm}(^{19}\text{F}, 4n\gamma)$, except as noted.

^b From $^{154}\text{Sm}(^{19}\text{F}, 4n\gamma)$, except where noted. Multipolarities are based on DCO ratio measurements, assigning $\Delta\pi=(\text{no})$ to intraband transitions, except as noted.

^c Value and uncertainty cover combined range for M1 and E2.

^d Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with “Frozen Orbitals” approximation based on γ -ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

^e Multiply placed.

^f Multiply placed with undivided intensity.

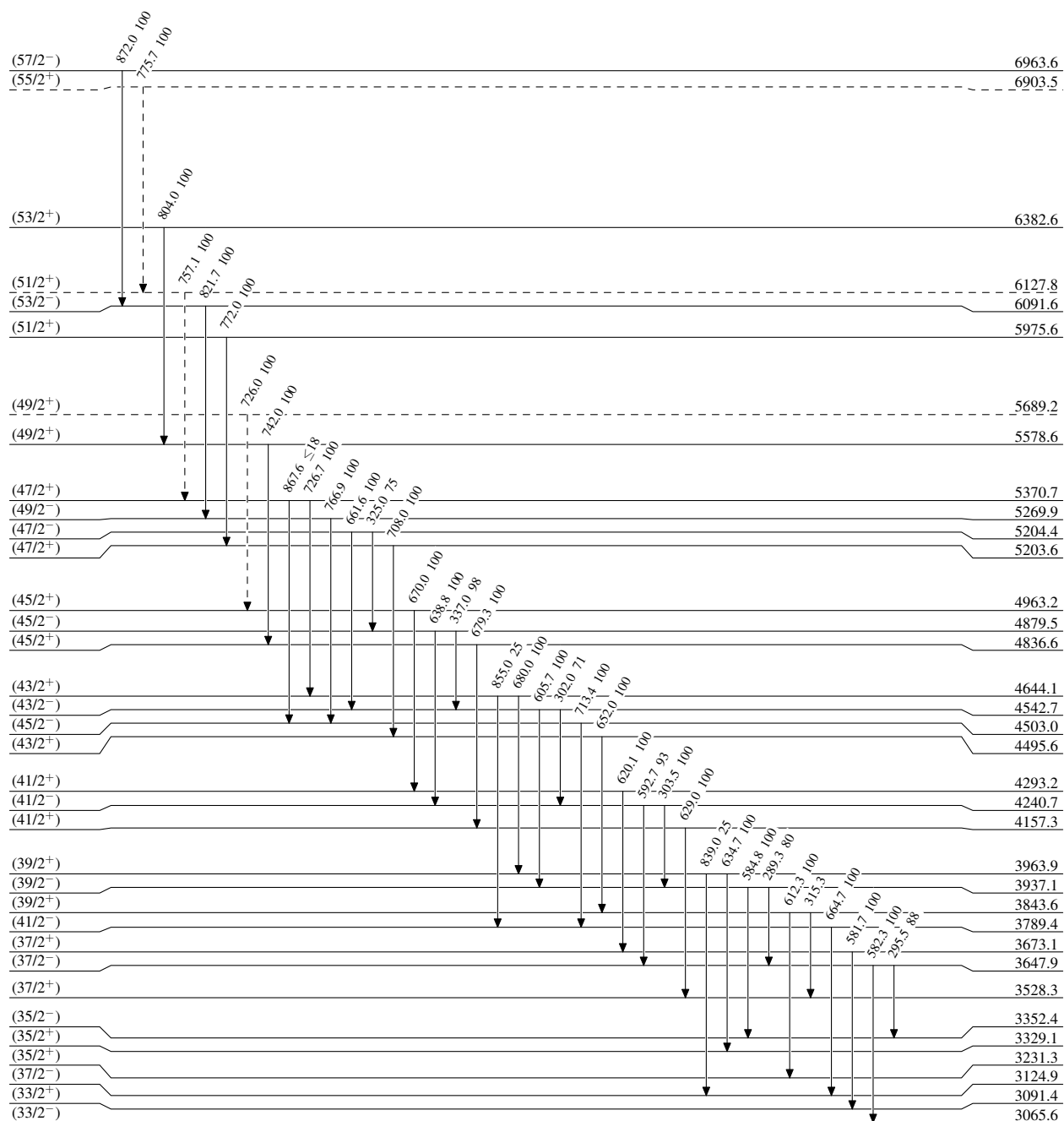
^g Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

 - - - - - $\rightarrow$ γ Decay (Uncertain)

 $7/2^{+}$

0.0

34.06 h 5

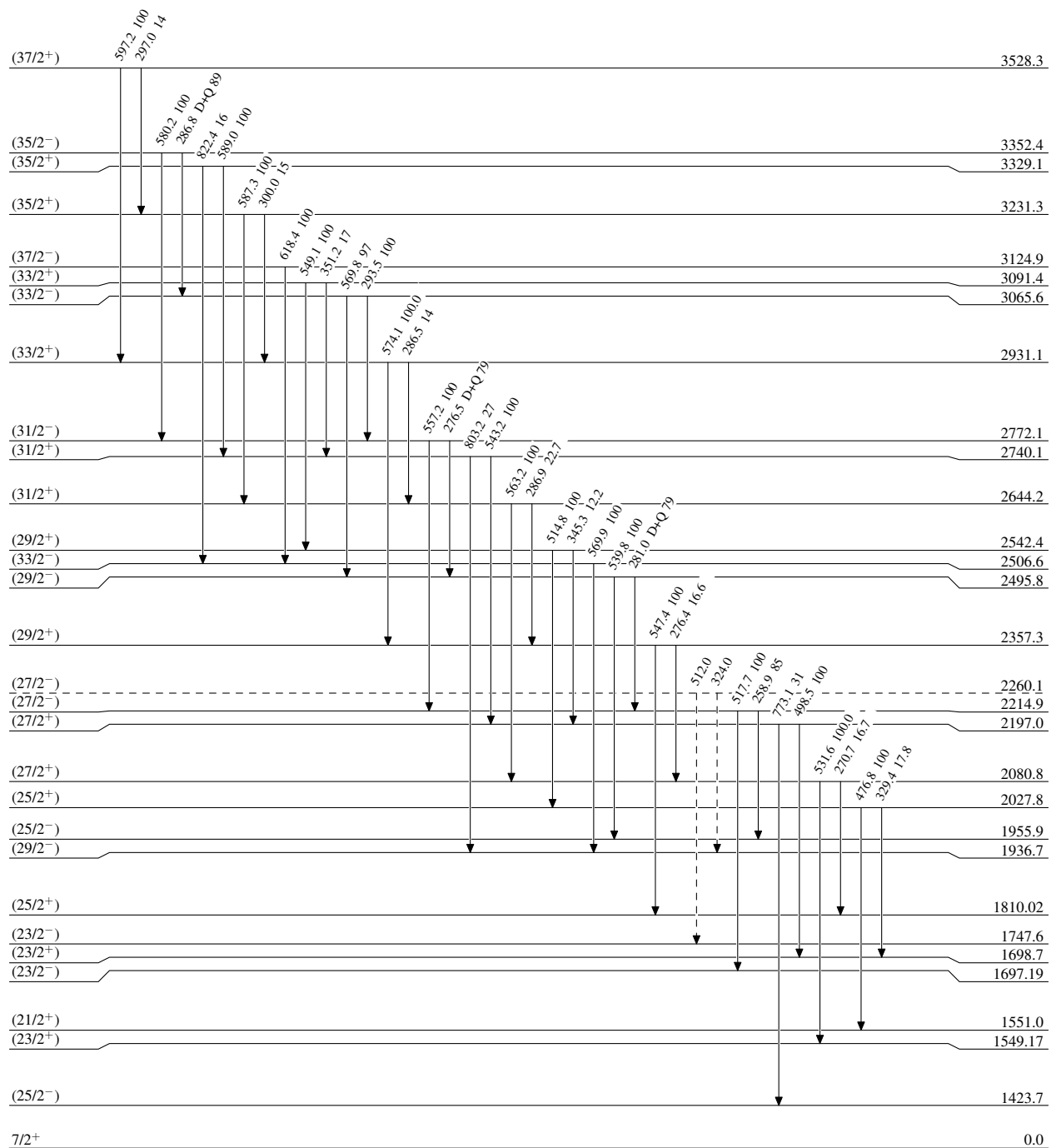
 $^{169}_{71}\text{Lu}_{98}$

Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

-----► γ Decay (Uncertain)

7/2⁺

0.0

34.06 h 5

¹⁶⁹₇₁Lu₉₈

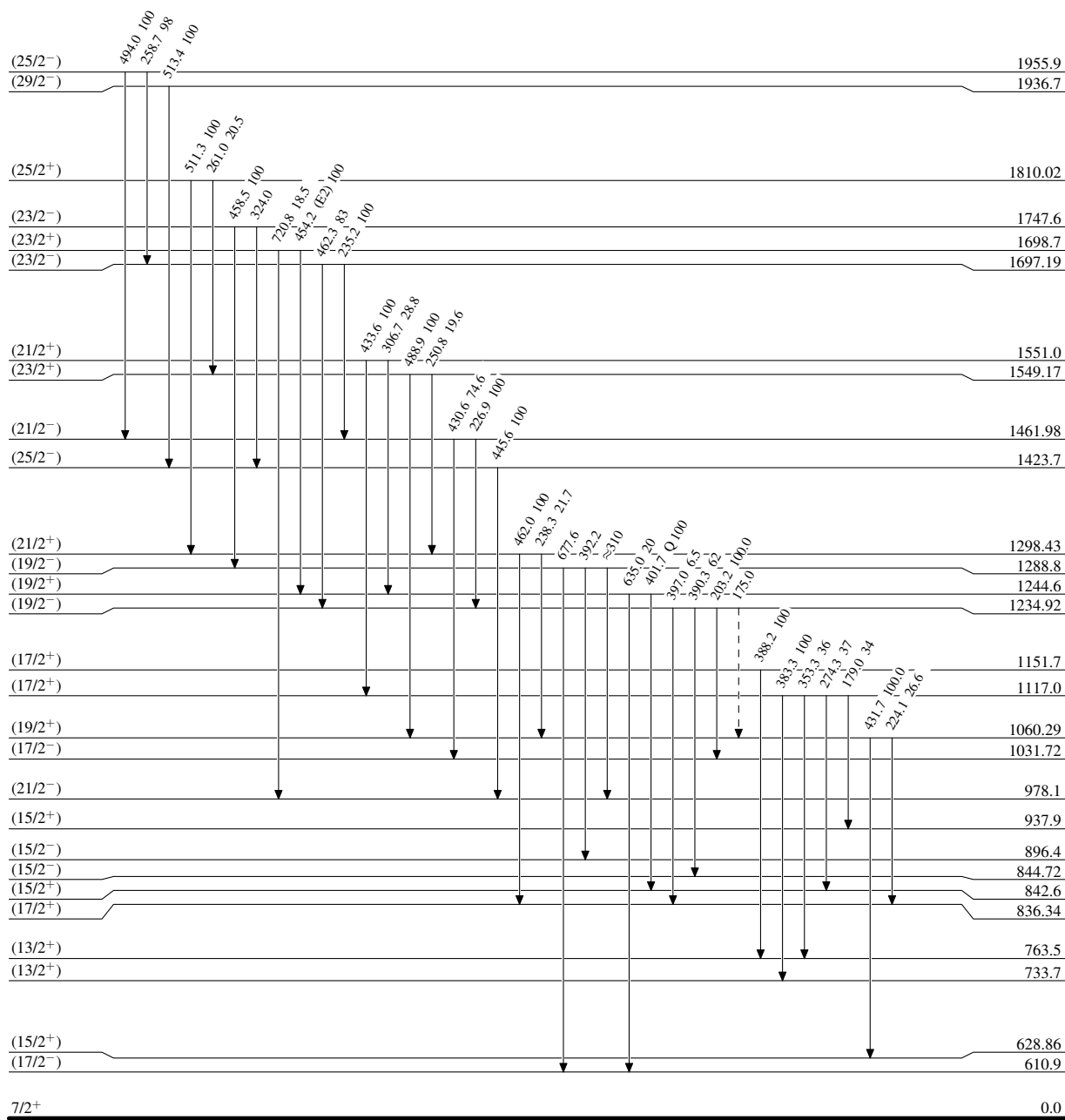
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

-----► γ Decay (Uncertain)

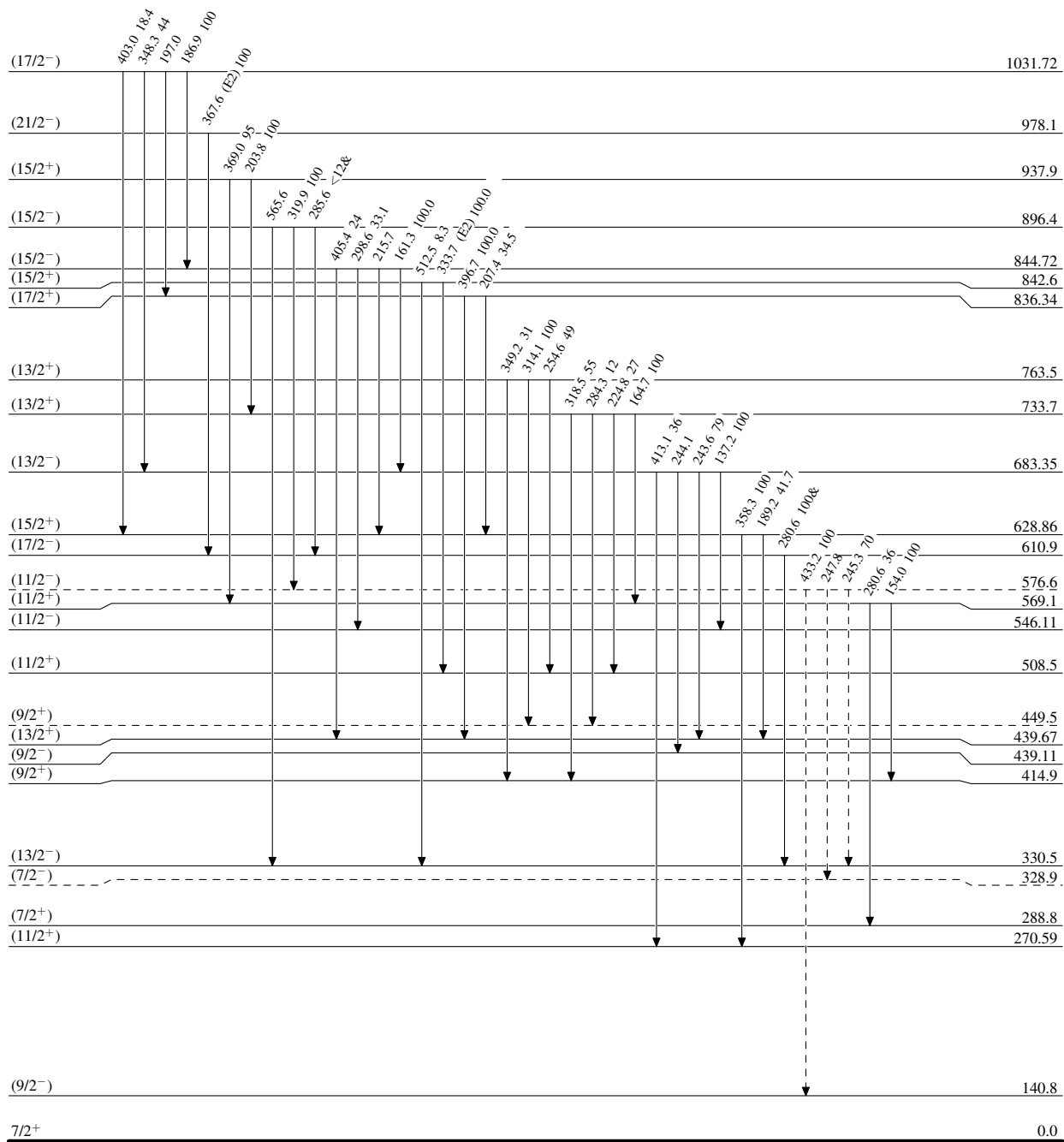


Adopted Levels, Gammas

Legend

Level Scheme (continued)

 Intensities: Relative photon branching from each level
 & Multiply placed: undivided intensity given

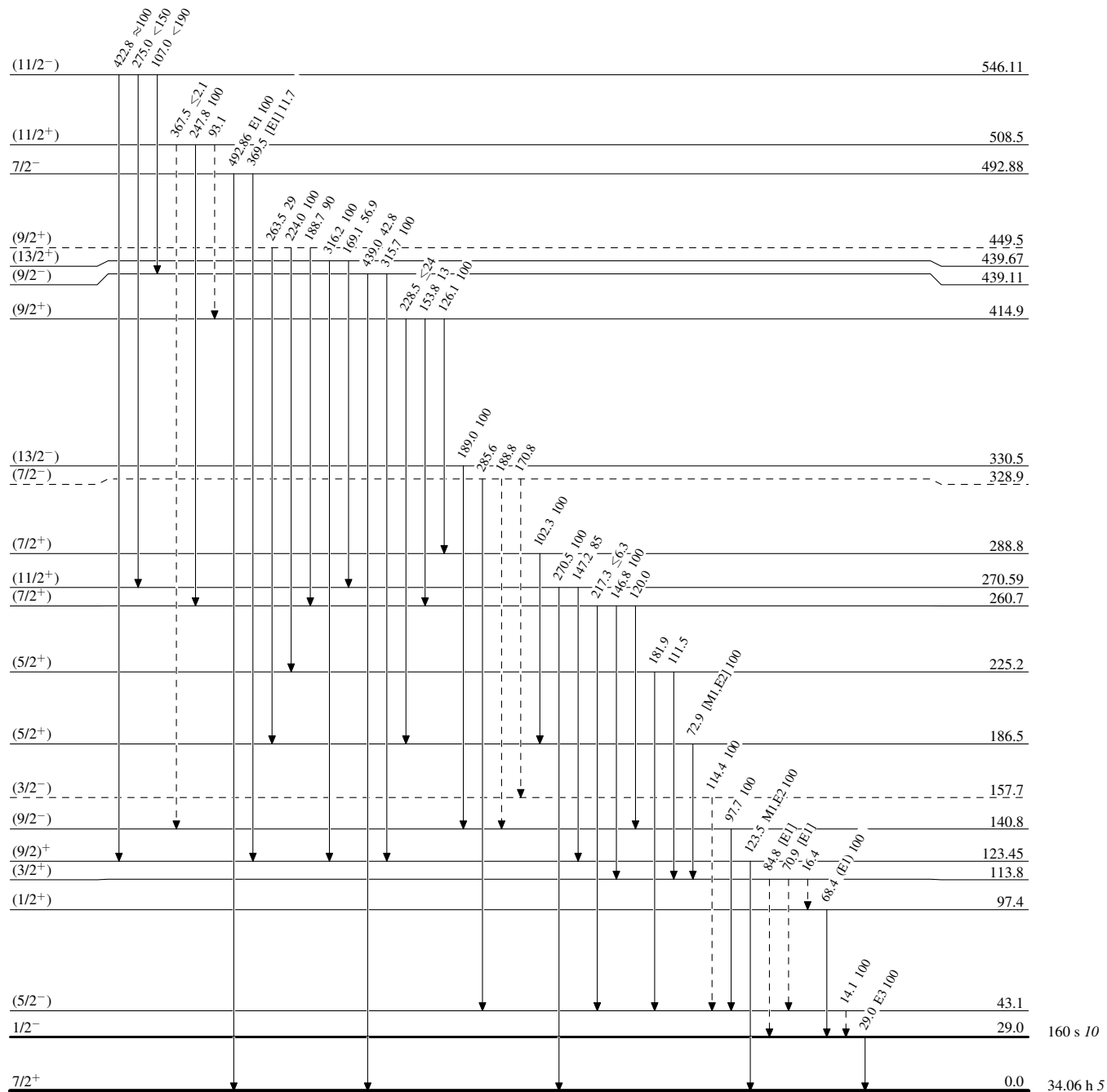
 -----► γ Decay (Uncertain)


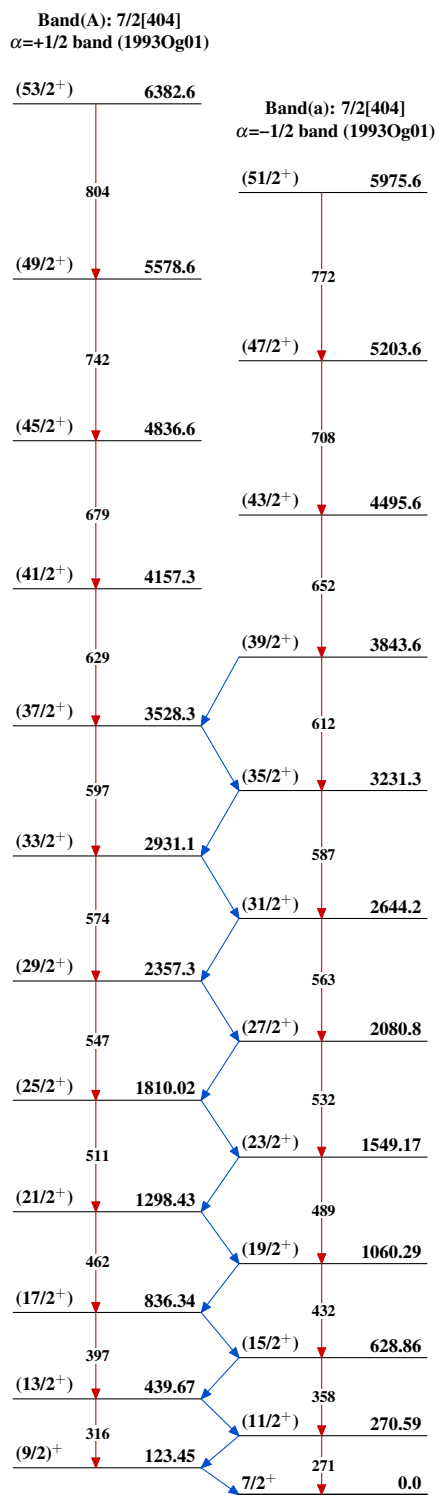
Adopted Levels, Gammas

Legend

Level Scheme (continued)

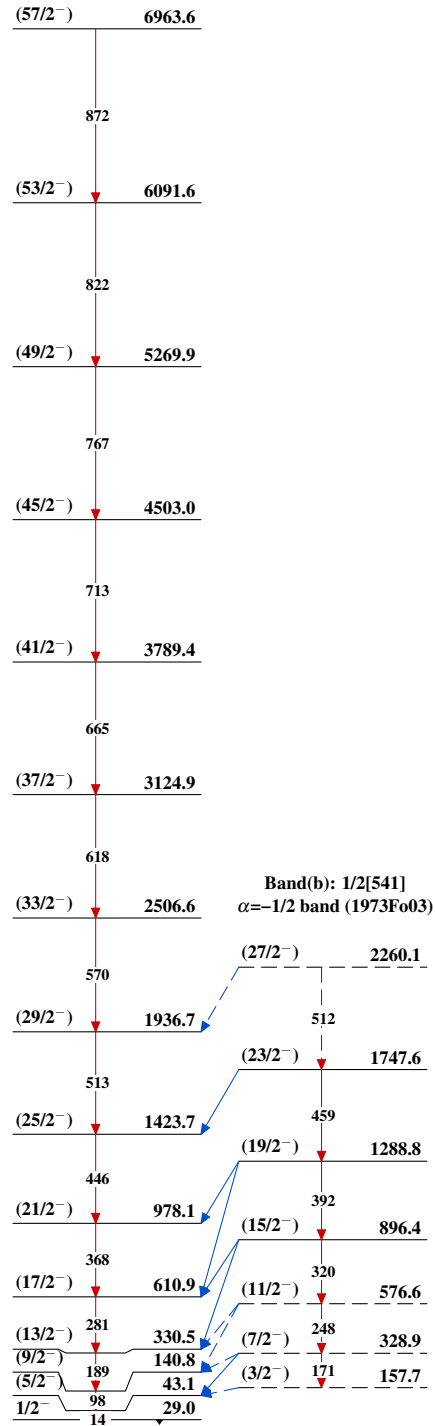
 Intensities: Relative photon branching from each level
 & Multiply placed: undivided intensity given

 -----► γ Decay (Uncertain)

 $^{169}_{71}\text{Lu}_{98}$

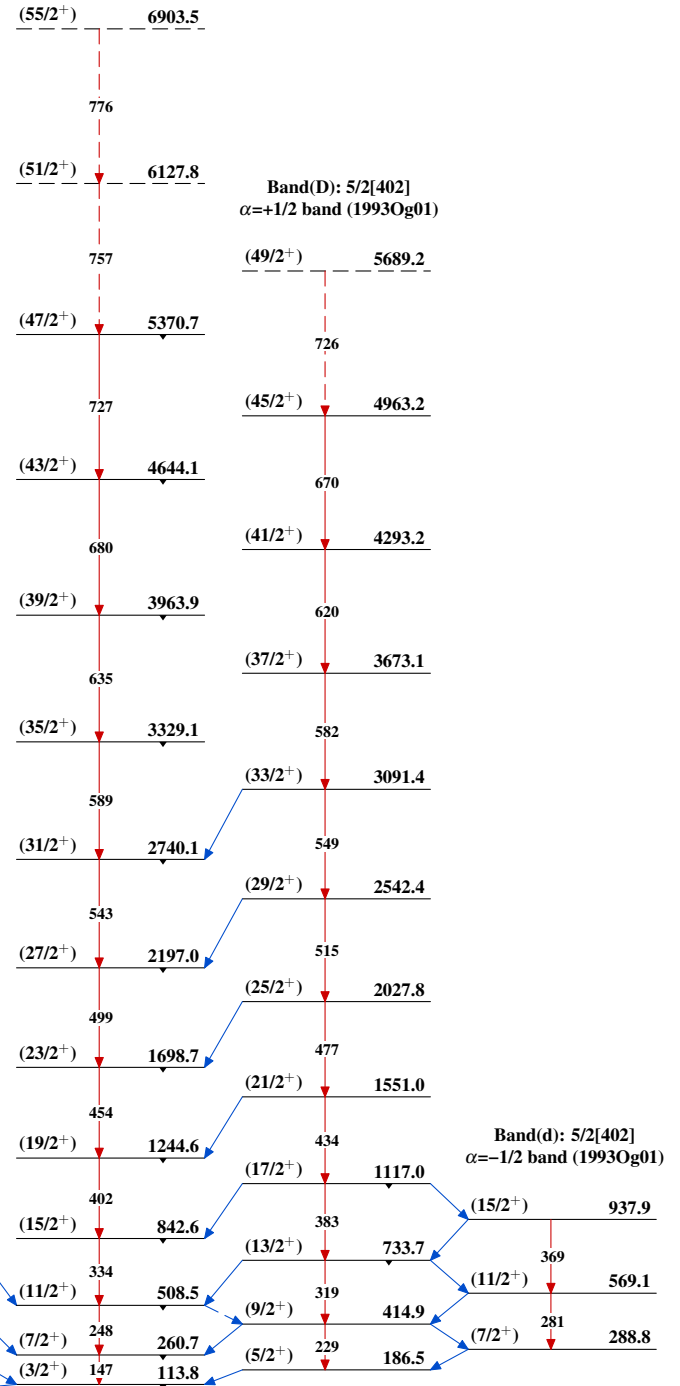
Adopted Levels, Gammas $^{169}_{71}\text{Lu}_{98}$

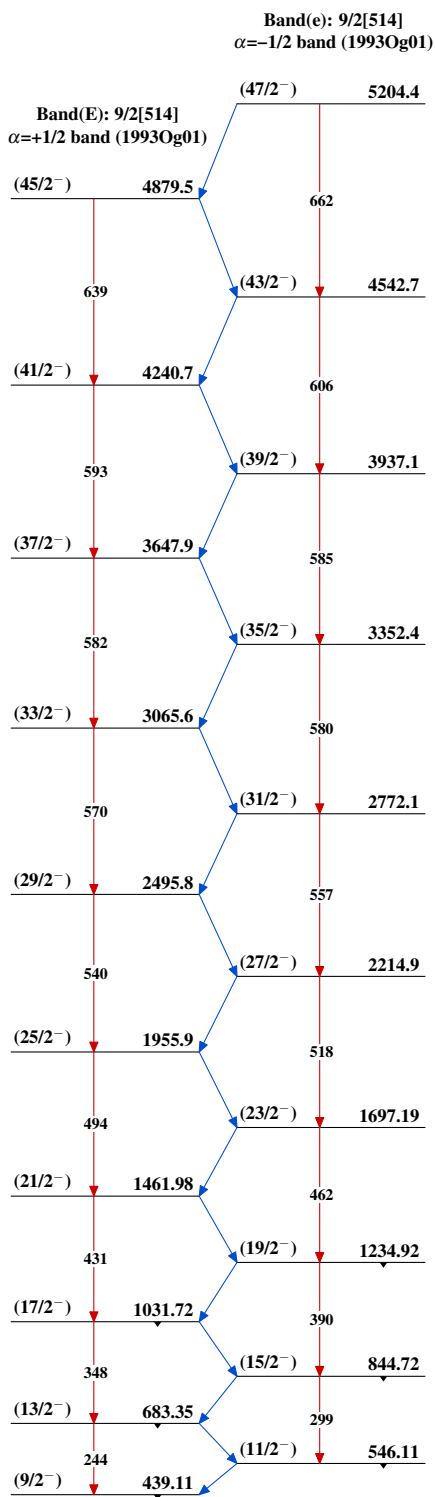
Adopted Levels, Gammas (continued)

Band(B): 1/2[541]
 $\alpha=+1/2$ band (1993Og01)



Band(c): 1/2[411]
 $\alpha=-1/2$ band (1993Og01)



Adopted Levels, Gammas (continued) $^{169}_{71}\text{Lu}_{98}$

^{169}Hf $\varepsilon+\beta^+$ decay (3.24 min) 1973Me09,1973FoYE

Parent: ^{169}Hf : $E=0.0$; $J^\pi=5/2^-$; $T_{1/2}=3.24$ min 5; $Q(\varepsilon)=3366$ 28; $\% \varepsilon+\% \beta^+$ decay=100.0

^{169}Hf - $J^\pi, T_{1/2}$: from ^{169}Hf Adopted Levels.

^{169}Hf - $Q(\varepsilon)$: from 2021Wa16.

1973Me09: sources from $^{170}\text{Yb}({}^3\text{He}, 4n)$; Yb oxide targets enriched to 67% in ^{170}Yb ; measured E_γ , I_γ (Compton-suppressed Ge(Li) (FWHM=1.9 keV at 1332 keV), surface-barrier Ge(Li) (FWHM=0.8 keV at 122 keV)), Ice (Si(Li)), half-life of ^{169}Hf .

1973FoYE: sources from $^{168}\text{Yb}(\alpha, 3n)$ and $^{170}\text{Yb}(\alpha, 5n)$; measured E_γ , I_γ (Ge(Li), FWHM=1.4 keV at 100 keV, 2.3 keV at 1 MeV); measured E_γ , I_γ $\gamma\gamma$ coin; placed 72.9 γ and 68.4 γ .

1969Ar23: Hf sources from ^{169}Ta parent decay; measured E_γ , I_γ , $\gamma(t)$, $\gamma\gamma$ coin using coaxial Ge(Li) and NaI(Tl) detectors, and β^+ data using a 2 cm x 2 cm anthracene crystal (14% energy resolution for 624-keV ce line from ^{137}Cs), also $I(\gamma^\pm)$.

1970At01: Measured E_γ , I_γ and half-life of ^{169}Hf .

1970Ch17: Measured E_γ , I_γ , $I(\gamma^\pm)$, and half-life of ^{169}Hf .

1975Gr44: Measured E_γ , I_γ and half-life of ^{169}Hf .

The decay scheme is tentative and incomplete. The measured $I(K \times \text{ray})$ cannot be corrected for K conversion of possible 71 γ and 85 γ because their intensities are unknown; if significant, this would lower $\varepsilon K/\beta^+$ and, hence, the calculated $\varepsilon+\beta^+$ feeding to the 493 level. However, a very large change in feeding to the 493 level would be required to invalidate the conclusion that this is an allowed, unhindered transition. Feeding to the (5/2 $^-$) 43 level may be significant, but is unknown. There may also exist feeding to levels with $E>493$ that are as yet unknown.

 ^{169}Lu Levels

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$T_{1/2}^\ddagger$	Comments
0.0	7/2 $^+$	34.06 h 5	
29.0 5	1/2 $^-$	160 s 10	
42.9 6	(5/2 $^-$)		
97.4 5	(1/2 $^+$)		$\log f^{A_{\text{ft}}}>8.5$ implies $\% \varepsilon+\% \beta^+$ feeding<0.4 to this level.
113.8 6	(3/2 $^+$)		$\log ft>5.9$ implies $\% \varepsilon+\% \beta^+$ <5 to this level.
123.49 15	(9/2 $^+$)		$\log f^{A_{\text{ft}}}>8.5$ implies $\% \varepsilon+\% \beta^+$ feeding<0.4 to this level, consistent with intensity balance at this level.
186.7 6	(5/2 $^+$)		
492.89 10	7/2 $^-$		

† From least-squares fit to E_γ .

‡ From Adopted Levels.

 ε, β^+ radiations

$E(\text{decay})$	$E(\text{level})$	$I\beta^+^\dagger$	$I\varepsilon^\dagger$	$\text{Log } ft$	$I(\varepsilon+\beta^+)^\dagger$	Comments
(2873 28)	492.89	>12.1	>75.9	<4.6	>88	$E(\text{decay})$: 2872 200 from measured $E\beta^+=1850$ 200 (1969Ar23). $I(\varepsilon+\beta^+)$: estimated in 1973Me09 from $I(K \times \text{ray})=86$ 5 and $I(\gamma^\pm)=33.0$ 15, relative to $I_\gamma=100$ for 492.9 γ (1973Me09).
(3179 28)	186.7	<1.0	<4.0	>5.9	<5	$I(\varepsilon+\beta^+)$: 6.8 from intensity imbalance; however, uncertainty may be large (1973FoYE do not state uncertainty in $I(73\gamma)$). <5% feeding is expected based on $\log ft>5.9$ for first-forbidden transition.
(3323 ‡ 28)	42.9					
(3366 ‡ 28)	0.0	<1.2	<3.7	>6.0	<5	$I(\varepsilon+\beta^+)$: from $\log ft>5.9$ for first-forbidden transition.

† Absolute intensity per 100 decays.

‡ Existence of this branch is questionable.

¹⁶⁹Hf $\varepsilon+\beta^+$ decay (3.24 min) 1973Me09,1973FoYE (continued) $\gamma(^{169}\text{Lu})$

I_γ normalization: from $\Sigma I(\gamma+ce)$ 94 6 from 492.9 keV level, based on the estimated total of >88% to satisfy $K/\beta=5.2$ 14-4 from measured $I(K \text{ x ray})=86$ 5 and $I(\gamma^\pm)=33.0$ 15 relative to $I(493\gamma)=100$ (1973Me09). This normalization should be considered to be highly tentative. Other $I(\gamma^\pm)=27$ (1969Ar23), 82 20 relative to $I(493\gamma)=100$ (1970Ch17).

$I_\gamma(K \text{ x ray})=86$ 5, $I(\gamma^\pm)=33.0$ 15, relative to $I_\gamma=100$ for 492.9 γ (1973Me09).

$E_\gamma^\dagger$	$I_\gamma^{\dagger\&}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ‡	α^a	$I_{(\gamma+ce)}^\&$	Comments
(14.1 @)		42.9	(5/2 ⁻)	29.0	1/2 ⁻				
(16.4 @)		113.8	(3/2 ⁺)	97.4	(1/2 ⁺)			≈ 3.7	$I_{(\gamma+ce)}$: since negligible $\varepsilon+\beta^+$ feeding of the 97 level is expected ($\Delta J^\pi=2$, no), the level scheme implies $I(\gamma+ce)(16\gamma)\approx I(\gamma+ce)(68\gamma)=3.7$.
(29.0 5)		29.0	1/2 ⁻	0.0	7/2 ⁺	E3	9.4×10^4 10		E_γ , Mult.: from Adopted Gammas.
68.4 @ 1	1.9 #	97.4	(1/2 ⁺)	29.0	1/2 ⁻	(E1) @	0.931 13		
(70.9 @ 2)		113.8	(3/2 ⁺)	42.9	(5/2 ⁻)	[E1]	0.852 13		
72.9 @ 2	0.7 #	186.7	(5/2 ⁺)	113.8	(3/2 ⁺)	[M1,E2]	10.6 15		
(84.8 @ 2)		113.8	(3/2 ⁺)	29.0	1/2 ⁻	[E1]	0.538 8		
123.6 2	5.0 5	123.49	(9/2 ⁺)	0.0	7/2 ⁺	M1,E2	1.76 25		E_γ : others: 123.2 (1970At01), 123 (1970Ch17), 123 (1975Gr44).
									I_γ : weighted average of 4.6 5 (1973Me09) and 5.6 6 (1970Ch17). Others: 8 (1970At01), 7 (1975Gr44).
									Mult.: from $1.16<\alpha(\text{exp})<5.0$ (1973Me09 – scaled from $1.17<\alpha(\text{exp})<5.1$) with $\alpha_1=0.0814(\text{Brice})/0.0823(1973Me09)$ for the 198.84 keV 3 4 ⁺ to 2 ⁺ transition in 168Yb.
369.5 2	11.7 8	492.89	7/2 ⁻	123.49	(9/2 ⁺)	[E1]	0.01253 18		E_γ : others: 369.3 (1970At01), 368 (1970Ch17), 369 (1975Gr44).
									I_γ : weighted average of 11.6 10 (1973Me09) and 11.9 12 (1970Ch17). Others: 11 (1970At01), 13 (1975Gr44).
492.86 10	100	492.89	7/2 ⁻	0.0	7/2 ⁺	E1	0.00651 9		E_γ : others: 492.3 (1970At01), 491 (1970Ch17).
									I_γ : same value in 1970At01, 1970Ch17, and 1975Gr44.
									$\alpha(K)\text{exp}=0.004$ 1 (1973Me09).

† From 1973Me09, except as noted.

‡ From $\alpha(K)\text{exp}$, as deduced from simultaneous measurement of I_{ce} and I_γ , except where noted (detector calibration assumes $\alpha(L)=0.0814$ (E2 theory) for 198.8 γ in ¹⁶⁸Yb) (1973Me09). Same in the adopted dataset.

From 1973FoYE; uncertainty unstated by authors.

@ From Adopted Gammas.

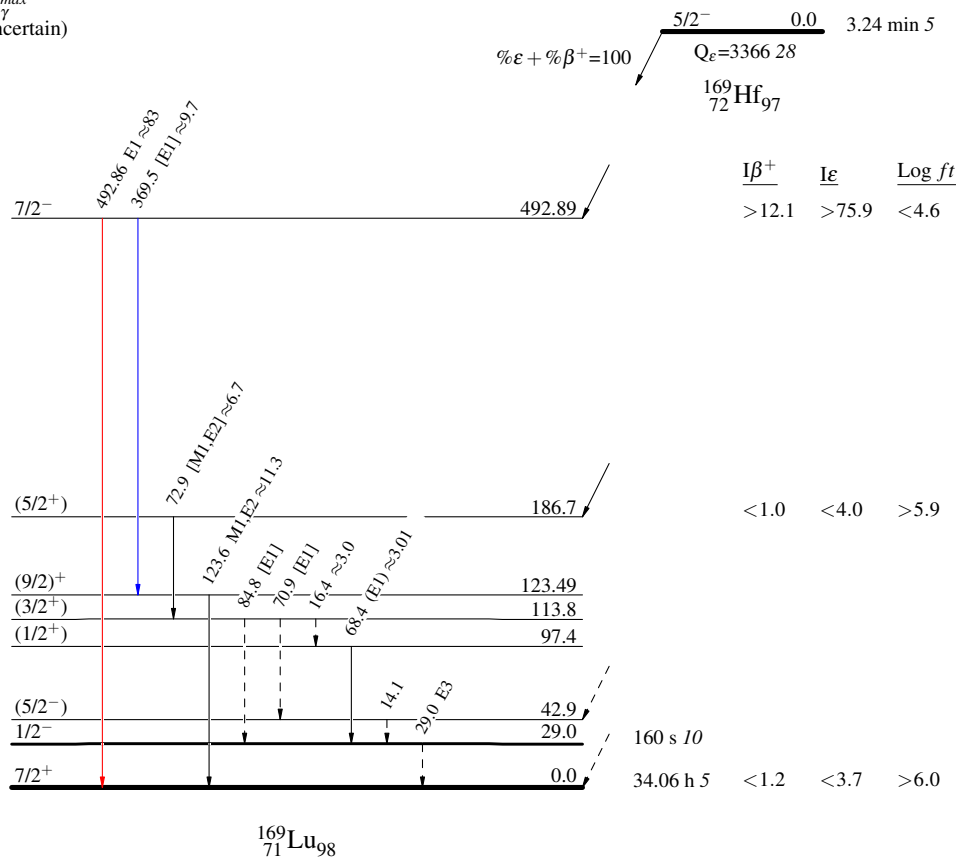
& For absolute intensity per 100 decays, multiply by ≈ 0.82 .

^a Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with “Frozen Orbitals” approximation based on γ -ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

^{169}Hf $\varepsilon+\beta^+$ decay (3.24 min) 1973Me09,1973FoYEDecay Scheme

Legend

- $I_\gamma < 2\% \times I_\gamma^{\max}$
 —————→ $I_\gamma < 10\% \times I_\gamma^{\max}$
 —————→ $I_\gamma > 10\% \times I_\gamma^{\max}$
 - - - - -→ γ Decay (Uncertain)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays

^{169}Lu IT decay (160 s) [1965Bj01](#)

Parent: ^{169}Lu : $E=29.0$ 5; $J^\pi=1/2^-$; $T_{1/2}=160$ s 10; %IT decay=100.0

Isomer identified using excitation-function data for $\text{Yb}(p,xn)$ ([1965Bj01](#)).

The decay scheme and all data are from [1965Bj01](#). Sources from $^{170}\text{Yb}(p,2n)$, $E(p)=13$ MeV (pulsed beam); Yb metal targets enriched to 85% in ^{170}Yb . Measured $E(\text{ce})$, Ice (magnetic spectrometer).

 ^{169}Lu Levels

<u>$E(\text{level})$</u>	<u>J^π[†]</u>	<u>$T_{1/2}$[†]</u>	<u>Comments</u>
0.0	$7/2^+$	34.06 h 5	
29.0 5	$1/2^-$	160 s 10	%IT=100 $T_{1/2}$: from ce(t) (1965Bj01).

[†] From Adopted Levels, except as noted.

 $\gamma(^{169}\text{Lu})$

I_γ normalization: from $I(\gamma+\text{ce})(29.0\gamma)=100\%$.

<u>E_γ</u>	<u>I_γ^{†‡}</u>	<u>$E_i(\text{level})$</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.</u>	<u>α[#]</u>	<u>$I_{(\gamma+\text{ce})}$[‡]</u>	<u>Comments</u>
29.0 5	0.00106 11	29.0	$1/2^-$	0.0	$7/2^+$	E3	9.4×10^4 10	100	0.5 < (L1+L2)/L3 ≤ 0.8. Mult.: (L1+L2)/L3 is consistent with E2 or E3. The lifetime, compared to the Weisskopf estimate, corresponds to a retardation of 1×10^9 times for E2 and about 1×10^3 times for E3, and thus strongly favors E3 (1965Bj01).

[†] Deduced from $I(\gamma+\text{ce})$ and α .

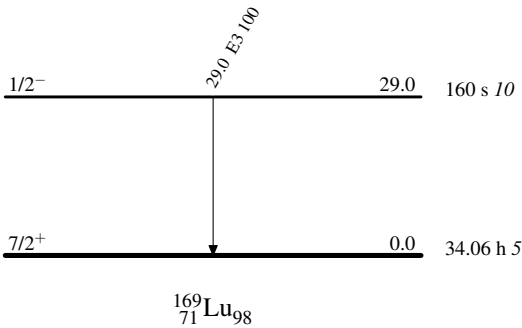
[‡] Absolute intensity per 100 decays.

[#] Total theoretical internal conversion coefficients, calculated using the BrIcc code ([2008Ki07](#)) with “Frozen Orbitals” approximation based on γ -ray energies, assigned multiplicities, and mixing ratios, unless otherwise specified.

¹⁶⁹Lu IT decay (160 s) 1965Bj01

Decay Scheme

Intensities: I_(γ+ce) per 100 parent decays
%IT=100.0



$^{154}\text{Sm}(^{19}\text{F}, 4n\gamma)$ **1993Og01**

No significant changes compared to that in the previous evaluation ([2008Ba31](#)) by C.M. Baglin.

$E(^{19}\text{F})=85$ MeV; 98.67% ^{154}Sm targets, stacked foils or Pb-backed foils; NORDBALL detector array (15 Ge-BGO spectrometers and 10 BaF₂ multiplicity-filter detectors); measured $E\gamma$, $I\gamma$, $\gamma\gamma$ coin, DCO ratios ($\theta=37^\circ$ (or 143°) and 79° (or 101°)), $T_{1/2}$ from DSAM; particle rotor calculations. See [1993Ko09](#) for further discussion of these data.

The level scheme is taken from [1993Og01](#). The authors report two additional coupled bands which apparently belong to either ^{169}Lu or ^{168}Lu . The energies of all but two of the 52 transitions in those bands match those in bands subsequently assigned to ^{168}Lu by [1998Ha17](#), [1999Ka17](#) and/or [2002Ha33](#), so the evaluator concludes that those additional bands reported by [1993Og01](#) actually belong to ^{168}Lu .

 ^{169}Lu Levels

E(level) [†]	J π [#]	E(level) [†]	J π [#]	E(level) [†]	J π [#]	E(level) [†]	J π [#]
0.0 ^b	7/2 ⁺	843.3 ^f 9	15/2 ⁺	2080.1 ^b 14	27/2 ⁺	4156.6 ^a 20	(41/2 ⁺)
43.1 ^{‡c} 6	5/2 ⁻	844.4 ^{&} 8	15/2 ⁻	2198.1 ^f 13	27/2 ⁺	4239.9 [@] 18	41/2 ⁻
114.7 ^f 11	3/2 ⁺	896.1 ^d 12	(15/2 ⁻)	2214.1 ^{&} 13	27/2 ⁻	4294.3 ^g 21	(41/2 ⁺)
123.2 ^a 7	9/2 ⁺	938.4 ^h 10	15/2 ⁺	2356.5 ^a 14	29/2 ⁺	4494.9 ^b 20	(43/2 ⁺)
141.2 ^c 8	9/2 ⁻	978.7 ^c 12	21/2 ⁻	2495.0 [@] 14	29/2 ⁻	4504.2 ^c 20	45/2 ⁻
187.1 ^g 11	5/2 ⁺	1031.4 [@] 8	17/2 ⁻	2507.8 ^c 16	33/2 ⁻	4542.0 ^{&} 18	43/2 ⁻
226.2 ^e 12	5/2 ⁺	1059.9 ^b 10	19/2 ⁺	2543.4 ^g 13	29/2 ⁺	4645.3 ^f 19	43/2 ⁺
261.4 ^f 8	7/2 ⁺	1117.7 ^g 9	17/2 ⁺	2643.5 ^b 15	31/2 ⁺	4835.9 ^a 22	(45/2 ⁺)
270.4 ^b 7	11/2 ⁺	1152.4 ^e 14	17/2 ⁺	2741.3 ^f 14	31/2 ⁺	4878.8 [@] 19	45/2 ⁻
289.6 ^h 11	7/2 ⁺	1233.8 ^{&} 9	19/2 ⁻	2771.4 ^{&} 14	31/2 ⁻	4964.3 ^g 23	(45/2 ⁺)
330.5 ^c 9	13/2 ⁻	1245.7 ^f 10	19/2 ⁺	2930.4 ^a 16	33/2 ⁺	5202.9 ^b 23	(47/2 ⁺)
415.3 ^g 9	9/2 ⁺	1288.5 ^d 12	(19/2 ⁻)	3064.8 [@] 15	33/2 ⁻	5203.7 ^{&} 19	47/2 ⁻
439.1 ^a 8	13/2 ⁺	1297.8 ^a 11	21/2 ⁺	3092.5 ^g 15	33/2 ⁺	5271.1 ^c 23	(49/2 ⁻)
439.2 [@] 7	9/2 ⁻	1424.7 ^c 13	25/2 ⁻	3126.1 ^c 18	37/2 ⁻	5371.9 ^f 20	47/2 ⁺
450.3 ^e 9	9/2 ⁺	1461.3 [@] 10	21/2 ⁻	3230.6 ^b 16	35/2 ⁺	5577.9 ^a 24	(49/2 ⁺)
509.4 ^f 8	11/2 ⁺	1548.6 ^b 12	23/2 ⁺	3330.3 ^f 16	35/2 ⁺	5690.3 ^g 25	(49/2 ⁺)
546.2 ^{&} 7	11/2 ⁻	1551.9 ^g 10	21/2 ⁺	3351.6 ^{&} 16	35/2 ⁻	5974.9 ^b 25	(51/2 ⁺)
569.2 ^h 10	11/2 ⁺	1696.4 ^{&} 11	23/2 ⁻	3527.6 ^a 17	37/2 ⁺	6092.8 ^c 25	(53/2 ⁻)
610.9 ^c 10	17/2 ⁻	1699.5 ^f 11	23/2 ⁺	3647.2 [@] 16	37/2 ⁻	6129.0 ^f 23	(51/2 ⁺)
628.6 ^b 8	15/2 ⁺	1747.0 ^d 16	(23/2 ⁻)	3674.2 ^g 18	(37/2 ⁺)	6382 ^a 3	(53/2 ⁺)
683.2 [@] 7	13/2 ⁻	1809.2 ^a 13	25/2 ⁺	3790.7 ^c 19	41/2 ⁻	6904.7 ^f 25	(55/2 ⁺)
734.4 ^g 9	13/2 ⁺	1938.1 ^c 15	29/2 ⁻	3842.9 ^b 18	39/2 ⁺	6965 ^c 3	(57/2 ⁻)
764.4 ^e 9	13/2 ⁺	1955.2 [@] 12	25/2 ⁻	3936.4 ^{&} 17	39/2 ⁻		
835.7 ^a 9	17/2 ⁺	2028.7 ^g 12	25/2 ⁺	3965.2 ^f 18	39/2 ⁺		

[†] From least-squares fit to $E\gamma$, assigning 1 keV uncertainty to all $E\gamma$ data and assuming $E=43.1$ 6 (from Adopted Levels) for the 5/2⁻ 1/2[541] state.

[‡] From Adopted Levels; held fixed in least-squares level-energy adjustment.

[#] Authors' values, based on deduced band structure, analogy to neighboring nuclides, and alignment gains, band crossing frequencies and B(M1)/B(E2) ratios for intraband transitions, when available. All values are consistent with adopted values, but use of parentheses differs.

@ Band(A): 9/2[514] $\alpha=+1/2$ band. First band crossing at $\hbar\omega\approx 0.27$ MeV, alignment gain $\geq 6.2\hbar$.

& Band(a): 9/2[514] $\alpha=-1/2$ band. See comment on signature partner band.

^a Band(B): 7/2[404] $\alpha=+1/2$ band. First band crossing at $\hbar\omega\approx 0.28$ MeV, alignment gain $\approx 6.2\hbar$. Band assignment supported by observed B(M1)/B(E2) ratios for intraband transitions.

$^{154}\text{Sm}(^{19}\text{F},4n\gamma)$ **1993Og01 (continued)** ^{169}Lu Levels (continued)

^b Band(b): 7/2[404] $\alpha=-1/2$ band. See comment on signature partner band.

^c Band(C): 1/2[541] $\alpha=+1/2$ band. First band crossing at $\hbar\omega\approx 0.32$ MeV, alignment gain $\approx 3.5\hbar$. Average $Q(\text{transition})=7.5$ b 10 for J=33/2 through 57/2 band members.

^d Band(c): 1/2[541] $\alpha=-1/2$ band.

^e Band(D): 1/2[411] $\alpha=+1/2$ band. Strongly mixed with 5/2[402] $\alpha=+1/2$ band.

^f Band(d): 1/2[411] $\alpha=-1/2$ band. First band crossing at $\hbar\omega\approx 0.28$ MeV, alignment gain $\geq 7.9\hbar$.

^g Band(E): 5/2[402] $\alpha=+1/2$ band. Strongly mixed with 1/2[411] $\alpha=+1/2$ band. First band crossing at $\hbar\omega\approx 0.26$ MeV, alignment gain $\approx 6.1\hbar$.

^h Band(e): 5/2[402] $\alpha=-1/2$ band.

 $\gamma(^{169}\text{Lu})$

1993Og01 provide their data in a series of tables and figures. Most data are taken from the summary of measured properties given in table 1a for in-band transitions and, for interband transitions, in table 1b (1/2[411] to 1/2[541] transitions and gated intensities for 1/2[411] $\Delta J=2$ in-band transitions), table 1c (9/2[514] to 7/2[404]), table 1d (5/2[402] to 1/2[411]) and table 1e (between 5/2[402] and 1/2[411]). However, some information was also taken from the gated spectra in fig. 2a-d, the proposed level scheme in fig. 3 (parts I and II), as indicated.

E_γ [†]	I_γ [‡]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
97.7	22.3 6	141.2	9/2 ⁻	43.1	5/2 ⁻	E_γ : from fig. 2b (coincidence spectra gated by 593 γ or 137 γ) and fig. 3 (part I); absent in table 1a.
102.2	6.2 5	289.6	7/2 ⁺	187.1	5/2 ⁺	
107.0		546.2	11/2 ⁻	439.2	9/2 ⁻	
111.5	1.1 2	226.2	5/2 ⁺	114.7	3/2 ⁺	DCO=1.17 10.
123.5	31.8 10	123.2	9/2 ⁺	0.0	7/2 ⁺	
126.1	4.5 6	415.3	9/2 ⁺	289.6	7/2 ⁺	
137.1	17.6 8	683.2	13/2 ⁻	546.2	11/2 ⁻	DCO=1.00 5.
146.8	12.4 9	261.4	7/2 ⁺	114.7	3/2 ⁺	
147.2	25.5 15	270.4	11/2 ⁺	123.2	9/2 ⁺	
153.8	0.6 2	415.3	9/2 ⁺	261.4	7/2 ⁺	DCO=1.10 7.
153.9	11.0 25	569.2	11/2 ⁺	415.3	9/2 ⁺	
161.4	28.7 7	844.4	15/2 ⁻	683.2	13/2 ⁻	
164.7	18.8 13	734.4	13/2 ⁺	569.2	11/2 ⁺	DCO=1.08 10. DCO=0.91 5.
169.0	21.1 10	439.1	13/2 ⁺	270.4	11/2 ⁺	
175.0 [@]		1233.8	19/2 ⁻	1059.9	19/2 ⁺	
179.0	3.2 3	1117.7	17/2 ⁺	938.4	15/2 ⁺	DCO=1.18 10.
186.8	17.4 6	1031.4	17/2 ⁻	844.4	15/2 ⁻	
188.7	1.9 3	450.3	9/2 ⁺	261.4	7/2 ⁺	
189.0	100.0	330.5	13/2 ⁻	141.2	9/2 ⁻	DCO=1.01 8.
189.4	16.1 10	628.6	15/2 ⁺	439.1	13/2 ⁺	
197.0		1031.4	17/2 ⁻	835.7	17/2 ⁺	
203.2	20.1 4	1233.8	19/2 ⁻	1031.4	17/2 ⁻	DCO=1.18 10.
203.8	6.3 4	938.4	15/2 ⁺	734.4	13/2 ⁺	
207.2	14.5 10	835.7	17/2 ⁺	628.6	15/2 ⁺	
215.7		844.4	15/2 ⁻	628.6	15/2 ⁺	DCO=1.01 8.
218.0	≤ 0.78	261.4	7/2 ⁺	43.1	5/2 ⁻	
224.0	2.1 3	450.3	9/2 ⁺	226.2	5/2 ⁺	
224.1	11.5 6	1059.9	19/2 ⁺	835.7	17/2 ⁺	DCO=1.18 10.
224.8	5.0 6	734.4	13/2 ⁺	509.4	11/2 ⁺	
227.1	14.2 10	1461.3	21/2 ⁻	1233.8	19/2 ⁻	
228.3	≤ 1.1	415.3	9/2 ⁺	187.1	5/2 ⁺	DCO=1.18 10.
235.2	15.4 8	1696.4	23/2 ⁻	1461.3	21/2 ⁻	
237.9	9.3 5	1297.8	21/2 ⁺	1059.9	19/2 ⁺	

Continued on next page (footnotes at end of table)

$^{154}\text{Sm}(^{19}\text{F}, 4n\gamma)$ **1993Og01 (continued)** $\gamma(^{169}\text{Lu})$ (continued)

E_γ †	I_γ ‡	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. #	Comments
244.1		683.2	13/2 ⁻	439.2	9/2 ⁻		E_γ is for doublet. I_γ for this component is not stated in 1993Og01 ; authors assume it will be such that B(M1)/B(E2) for the intraband $\Delta J=1$ and $\Delta J=2$ transitions from the 683 level will be consistent with expected value of ≈ 1.5 .
244.1	13.9 20	683.2	13/2 ⁻	439.1	13/2 ⁺		
247.9	11.1 5	509.4	11/2 ⁺	261.4	7/2 ⁺		
251.0	6.9 2	1548.6	23/2 ⁺	1297.8	21/2 ⁺		
255.0	1.7 2	764.4	13/2 ⁺	509.4	11/2 ⁺		
258.7	11.8 10	1955.2	25/2 ⁻	1696.4	23/2 ⁻		DCO=1.01 7.
258.9	12.8 13	2214.1	27/2 ⁻	1955.2	25/2 ⁻		
260.7	7.0 6	1809.2	25/2 ⁺	1548.6	23/2 ⁺		
263.5	0.6 2	450.3	9/2 ⁺	187.1	5/2 ⁺		
270.7	30.0 14	270.4	11/2 ⁺	0.0	7/2 ⁺		
270.7	4.9 4	2080.1	27/2 ⁺	1809.2	25/2 ⁺		
274.3	3.5 3	1117.7	17/2 ⁺	843.3	15/2 ⁺		
276.0		546.2	11/2 ⁻	270.4	11/2 ⁺		
276.4	5.5 4	2356.5	29/2 ⁺	2080.1	27/2 ⁺		
276.5	15.1 10	2771.4	31/2 ⁻	2495.0	29/2 ⁻	D+Q	Mult.: DCO=1.55 10.
279.0	4.0 10	569.2	11/2 ⁺	289.6	7/2 ⁺		
280.6	102.0 15	610.9	17/2 ⁻	330.5	13/2 ⁻		DCO=1.14 15.
281.0	11.6 16	2495.0	29/2 ⁻	2214.1	27/2 ⁻	D+Q	Mult.: DCO=1.20 6.
284.3	2.2 6	734.4	13/2 ⁺	450.3	9/2 ⁺		
286.5	5.3 12	2930.4	33/2 ⁺	2643.5	31/2 ⁺		
286.8	12.6 5	3351.6	35/2 ⁻	3064.8	33/2 ⁻	D+Q	Mult.: DCO=1.47 9.
286.9	7.5 5	2643.5	31/2 ⁺	2356.5	29/2 ⁺		
289.3	7.3 7	3936.4	39/2 ⁻	3647.2	37/2 ⁻		
293.5	15.2 20	3064.8	33/2 ⁻	2771.4	31/2 ⁻		DCO=1.9 3 for contaminated γ .
295.5	12.6 12	3647.2	37/2 ⁻	3351.6	35/2 ⁻		
297.0	2.3 6	3527.6	37/2 ⁺	3230.6	35/2 ⁺		
298.5	9.5 6	844.4	15/2 ⁻	546.2	11/2 ⁻		
300.0	4.8 10	3230.6	35/2 ⁺	2930.4	33/2 ⁺		
302.0	7.9 16	4542.0	43/2 ⁻	4239.9	41/2 ⁻		
303.5	8.0 8	4239.9	41/2 ⁻	3936.4	39/2 ⁻		DCO=1.98 25 for contaminated γ .
306.7	3.4 3	1551.9	21/2 ⁺	1245.7	19/2 ⁺		
314.0	3.5 3	764.4	13/2 ⁺	450.3	9/2 ⁺		
315.3		3842.9	39/2 ⁺	3527.6	37/2 ⁺		from fig. 3 (part I); absent in table 1a.
316.0	37.1 12	439.1	13/2 ⁺	123.2	9/2 ⁺		
316.0	68 3	439.2	9/2 ⁻	123.2	9/2 ⁺		
319.2	10.3 5	734.4	13/2 ⁺	415.3	9/2 ⁺		DCO=1.32 18.
325.0	5 3	5203.7	47/2 ⁻	4878.8	45/2 ⁻		
329.4	1.60 15	2028.7	25/2 ⁺	1699.5	23/2 ⁺		
333.8	13.9 3	843.3	15/2 ⁺	509.4	11/2 ⁺	Q	I_γ : from gated spectra (table 1b of 1993Og01); 13.9 5 in table 1a. Mult.: DCO=0.97 5.
337.0	4.0 20	4878.8	45/2 ⁻	4542.0	43/2 ⁻		
345.3	1.1 2	2543.4	29/2 ⁺	2198.1	27/2 ⁺		
348.2	7.6 8	1031.4	17/2 ⁻	683.2	13/2 ⁻		
349.2	1.1 2	764.4	13/2 ⁺	415.3	9/2 ⁺		
351.2	1.5 4	3092.5	33/2 ⁺	2741.3	31/2 ⁺		
353.3	3.4 3	1117.7	17/2 ⁺	764.4	13/2 ⁺		
358.4	38.6 18	628.6	15/2 ⁺	270.4	11/2 ⁺		
367.6	101.0 10	978.7	21/2 ⁻	610.9	17/2 ⁻	(Q)	Mult.: DCO=0.99 10.
368.0	≤ 0.23	509.4	11/2 ⁺	141.2	9/2 ⁻		
369.0	6.0 3	938.4	15/2 ⁺	569.2	11/2 ⁺		
383.3	9.5 6	1117.7	17/2 ⁺	734.4	13/2 ⁺		DCO=1.12 19.

Continued on next page (footnotes at end of table)

¹⁵⁴Sm(¹⁹F,4nγ) **1993Og01 (continued)**
^γ(¹⁶⁹Lu) (continued)

E_γ †	I_γ ‡	E_i (level)	J_i^π	E_f	J_f^π	Mult. #	Comments
388.0	3.3 3	1152.4	17/2 ⁺	764.4	13/2 ⁺		
390.2	12.5 8	1233.8	19/2 ⁻	843.3	15/2 ⁺		
392.3 @		1288.5?	(19/2 ⁻)	896.1?	(15/2 ⁻)		E_γ : from fig. 3 (Part II); absent in table 1a.
396.8	42.0 9	835.7	17/2 ⁺	439.1	13/2 ⁺		
397.0	1.3 3	1233.8	19/2 ⁻	835.7	17/2 ⁺		
401.7	9.9 3	1245.7	19/2 ⁺	844.4	15/2 ⁻	Q	I_γ : from gated spectra (table 1b of 1993Og01); 9.9 5 in table 1a. Mult.: DCO=0.87 6.
403.0	3.2 4	1031.4	17/2 ⁻	628.6	15/2 ⁺		
405.4	7.0 9	844.4	15/2 ⁻	439.1	13/2 ⁺		
412.7	6.4 6	683.2	13/2 ⁻	270.4	11/2 ⁺		
423.0	7.0 4	546.2	11/2 ⁻	123.2	9/2 ⁺		
430.5	10.6 3	1461.3	21/2 ⁻	1031.4	17/2 ⁻		
431.3	43.2 10	1059.9	19/2 ⁺	628.6	15/2 ⁺		
433.6	11.8 10	1551.9	21/2 ⁺	1117.7	17/2 ⁺		
439.4	29.1 10	439.2	9/2 ⁻	0.0	7/2 ⁺		
445.7	88.0 13	1424.7	25/2 ⁻	978.7	21/2 ⁻		DCO=1.09 15.
454.0	8.1 4	1699.5	23/2 ⁺	1245.7	19/2 ⁺	Q	Mult.: DCO=0.88 5.
458.5 @		1747.0?	(23/2 ⁻)	1288.5?	(19/2 ⁻)		E_γ : from fig. 3 (Part II); absent in table 1a.
462.0	42.8 20	1297.8	21/2 ⁺	835.7	17/2 ⁺		
462.3	12.8 10	1696.4	23/2 ⁻	1233.8	19/2 ⁻		
476.8	9.0 5	2028.7	25/2 ⁺	1551.9	21/2 ⁺		
488.8	35.3 10	1548.6	23/2 ⁺	1059.9	19/2 ⁺		
494.1	12.0 6	1955.2	25/2 ⁻	1461.3	21/2 ⁻		
498.8	4.9 3	2198.1	27/2 ⁺	1699.5	23/2 ⁺		I_γ : from gated spectra (table 1b of 1993Og01); 7.9 3 in table 1a appears to be a typographical error. DCO=1.09 5.
511.3	34.2 15	1809.2	25/2 ⁺	1297.8	21/2 ⁺		
512.5	1.16 25	843.3	15/2 ⁺	330.5	13/2 ⁻		
513.4	99 3	1938.1	29/2 ⁻	1424.7	25/2 ⁻		
514.8	9.0 10	2543.4	29/2 ⁺	2028.7	25/2 ⁺		
517.7	15.0 15	2214.1	27/2 ⁻	1696.4	23/2 ⁻		
531.5	29.4 7	2080.1	27/2 ⁺	1548.6	23/2 ⁺		
539.8	14.6 14	2495.0	29/2 ⁻	1955.2	25/2 ⁻		
543.2	4.3 3	2741.3	31/2 ⁺	2198.1	27/2 ⁺		I_γ : from gated spectra (table 1b of 1993Og01); 4.3 12 in table 1a. DCO=0.88 20.
547.4	33.2 15	2356.5	29/2 ⁺	1809.2	25/2 ⁺		
549.1	8.7 15	3092.5	33/2 ⁺	2543.4	29/2 ⁺		
557.2	19.0 6	2771.4	31/2 ⁻	2214.1	27/2 ⁻		
563.2	33.0 20	2643.5	31/2 ⁺	2080.1	27/2 ⁺		
565.6 @		896.1?	(15/2 ⁻)	330.5	13/2 ⁻		E_γ : from fig. 3 (Part II); absent in table 1. Note that labels for 565.6γ and 677.6γ were mistakenly interchanged on level scheme. DCO=1.10 10.
569.8	45.9 7	2507.8	33/2 ⁻	1938.1	29/2 ⁻		
569.8	14.8 14	3064.8	33/2 ⁻	2495.0	29/2 ⁻		
574.1	36.9 6	2930.4	33/2 ⁺	2356.5	29/2 ⁺		
580.2	14.1 7	3351.6	35/2 ⁻	2771.4	31/2 ⁻		
581.7	8.5 15	3674.2	(37/2 ⁺)	3092.5	33/2 ⁺		
582.3	14.4 10	3647.2	37/2 ⁻	3064.8	33/2 ⁻		
584.8	9.1 10	3936.4	39/2 ⁻	3351.6	35/2 ⁻		
587.3	32.1 20	3230.6	35/2 ⁺	2643.5	31/2 ⁺		
589.0	2.6 2	3330.3	35/2 ⁺	2741.3	31/2 ⁺		I_γ : from gated spectra (table 1b of 1993Og01); 2.6 3 in table 1a. DCO=1.25 12.

Continued on next page (footnotes at end of table)

$^{154}\text{Sm}(^{19}\text{F}, 4n\gamma)$ **1993Og01 (continued)** $\gamma(^{169}\text{Lu})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^\ddagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
592.7	7.4 12	4239.9	41/2 ⁻	3647.2	37/2 ⁻	
597.2	15.9 10	3527.6	37/2 ⁺	2930.4	33/2 ⁺	
605.7	11.1 15	4542.0	43/2 ⁻	3936.4	39/2 ⁻	
612.3	6.0 4	3842.9	39/2 ⁺	3230.6	35/2 ⁺	
618.4	40.1 6	3126.1	37/2 ⁻	2507.8	33/2 ⁻	DCO=0.9 3.
620.1	8.0 10	4294.3	(41/2 ⁺)	3674.2	(37/2 ⁺)	
629.0	3.1 5	4156.6	(41/2 ⁺)	3527.6	37/2 ⁺	
634.7	1.7 3	3965.2	39/2 ⁺	3330.3	35/2 ⁺	I_γ : from gated spectra (table 1b of 1993Og01); 1.7 5 in table 1a. DCO=1.07 20.
635.0	2.0 4	1245.7	19/2 ⁺	610.9	17/2 ⁻	
638.8	4.1 15	4878.8	45/2 ⁻	4239.9	41/2 ⁻	
652.0	5.8 7	4494.9	(43/2 ⁺)	3842.9	39/2 ⁺	
661.6	6.7 23	5203.7	47/2 ⁻	4542.0	43/2 ⁻	
664.7	16.9 12	3790.7	41/2 ⁻	3126.1	37/2 ⁻	DCO=0.9 3.
670.0	2.0 3	4964.3	(45/2 ⁺)	4294.3	(41/2 ⁺)	
677.6 [@]		1288.5?	(19/2 ⁻)	610.9	17/2 ⁻	E_γ : from fig. 3 (Part II); absent in table 1. See also comment on 565.6 γ .
679.3	3.0 3	4835.9	(45/2 ⁺)	4156.6	(41/2 ⁺)	
680.0	0.95 15	4645.3	43/2 ⁺	3965.2	39/2 ⁺	I_γ : from gated spectra (table 1b of 1993Og01); 0.9 3 in table 1a. DCO=0.95 25.
708.0	4.8 5	5202.9	(47/2 ⁺)	4494.9	(43/2 ⁺)	
713.4	6.0 8	4504.2	45/2 ⁻	3790.7	41/2 ⁻	
720.8	1.5 2	1699.5	23/2 ⁺	978.7	21/2 ⁻	
726.0 [@]	1.2 4	5690.3?	(49/2 ⁺)	4964.3	(45/2 ⁺)	
726.7	0.62 15	5371.9	47/2 ⁺	4645.3	43/2 ⁺	I_γ : from gated spectra (table 1b of 1993Og01); 0.6 3 in table 1a.
742.0	1.5 2	5577.9	(49/2 ⁺)	4835.9	(45/2 ⁺)	
757.1 [@]	0.5 2	6129.0?	(51/2 ⁺)	5371.9	47/2 ⁺	
766.9	2.0 3	5271.1	(49/2 ⁻)	4504.2	45/2 ⁻	
772.0	2.6 3	5974.9	(51/2 ⁺)	5202.9	(47/2 ⁺)	
773.1	1.5 2	2198.1	27/2 ⁺	1424.7	25/2 ⁻	
775.7 [@]	0.5 1	6904.7?	(55/2 ⁺)	6129.0?	(51/2 ⁺)	DCO=1.4 3.
803.2	1.16 20	2741.3	31/2 ⁺	1938.1	29/2 ⁻	
804.0	1.5 3	6382	(53/2 ⁺)	5577.9	(49/2 ⁺)	
821.7	1.6 3	6092.8	(53/2 ⁻)	5271.1	(49/2 ⁻)	
822.4	0.42 10	3330.3	35/2 ⁺	2507.8	33/2 ⁻	
839.0	0.43 14	3965.2	39/2 ⁺	3126.1	37/2 ⁻	
855.0	0.24 5	4645.3	43/2 ⁺	3790.7	41/2 ⁻	
867.6	≤ 0.11	5371.9	47/2 ⁺	4504.2	45/2 ⁻	
872.0	1.0 2	6965	(57/2 ⁻)	6092.8	(53/2 ⁻)	

[†] [1993Og01](#) do not state uncertainty in E_γ .[‡] Photon intensity relative to $I(189.0\gamma)=100.0$.[#] Based on DCO ratio measured with stretched Q transition in gate. Expected ratios are 1.0 for stretched Q (or D, $\Delta J=0$) transitions, 1 to 1.8 for stretched D transitions (depending on spin alignment); the proximity of values for $\Delta J=2$ and $\Delta J=1$ transitions makes it difficult to obtain definitive multipolarity assignments.[@] Placement of transition in the level scheme is uncertain.

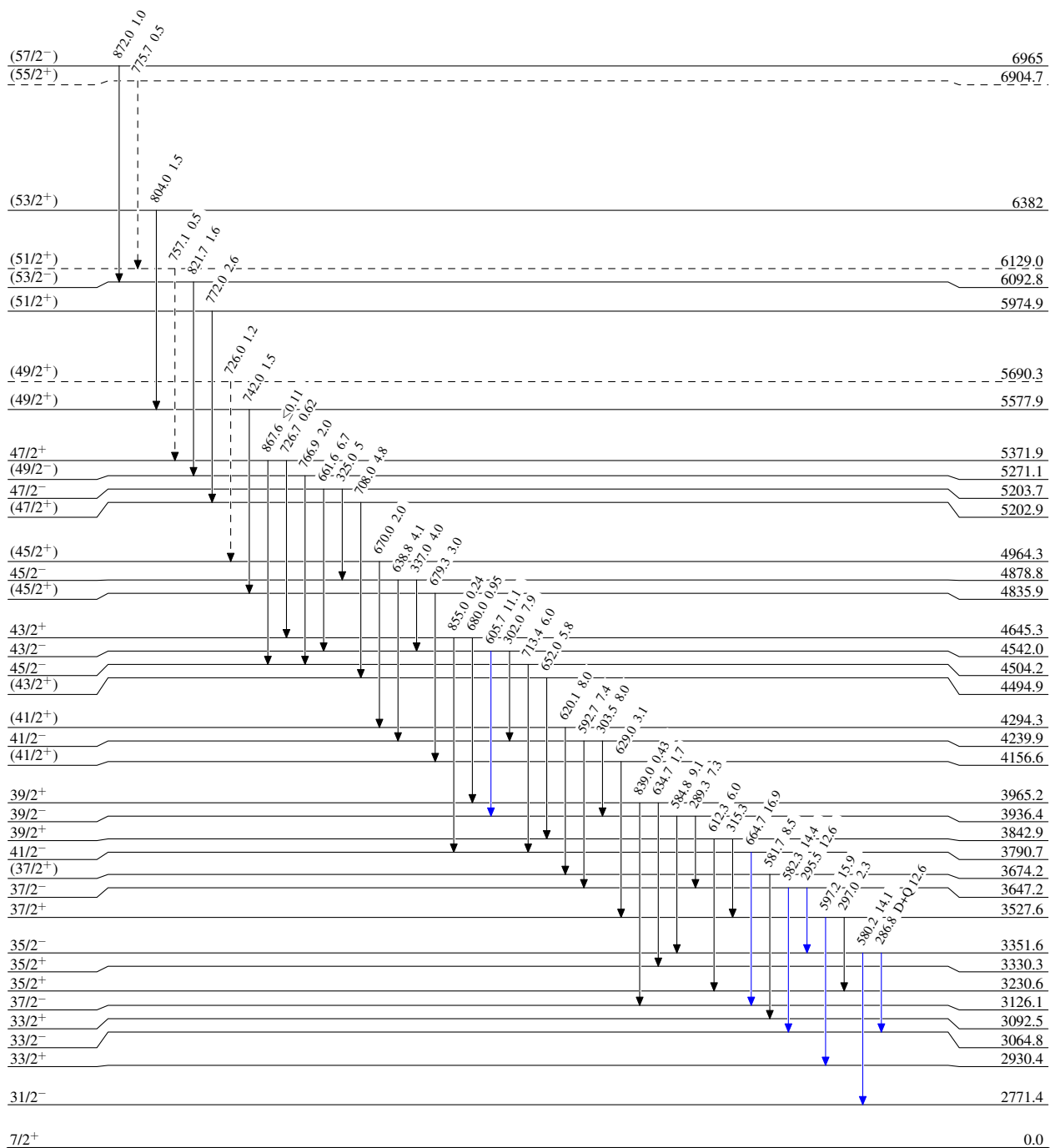
$^{154}\text{Sm}(^{19}\text{F},4n\gamma)$ **1993Og01**

Legend

Level Scheme

 Intensities: Relative I_γ

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$
- - - γ Decay (Uncertain)


 $^{169}_{71}\text{Lu}_{98}$

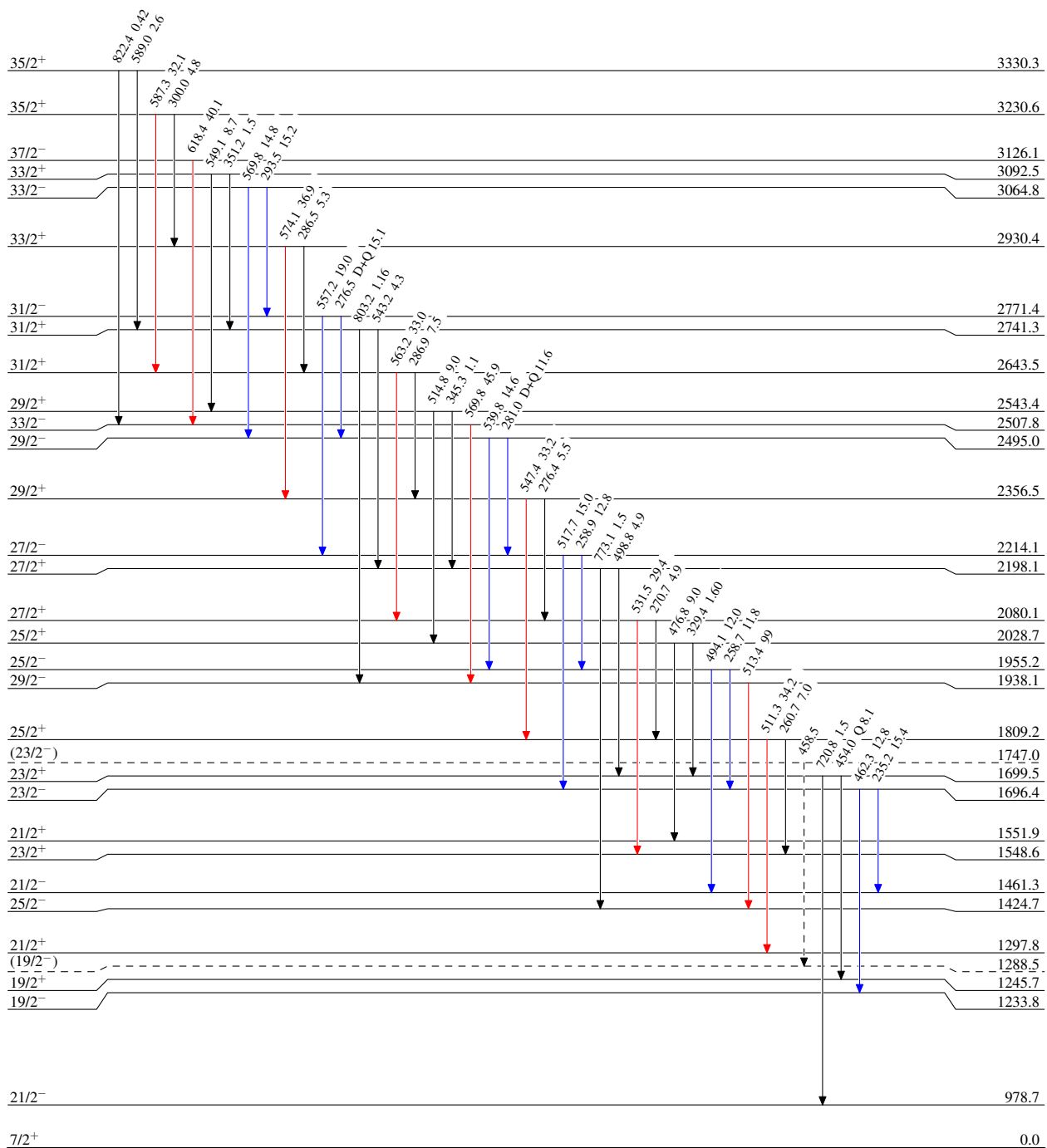
$^{154}\text{Sm}(^{19}\text{F},4n\gamma)$ 1993Og01

Legend

Level Scheme (continued)

 Intensities: Relative I_γ

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$
- - - - -→ γ Decay (Uncertain)


 $^{169}_{71}\text{Lu}_{98}$

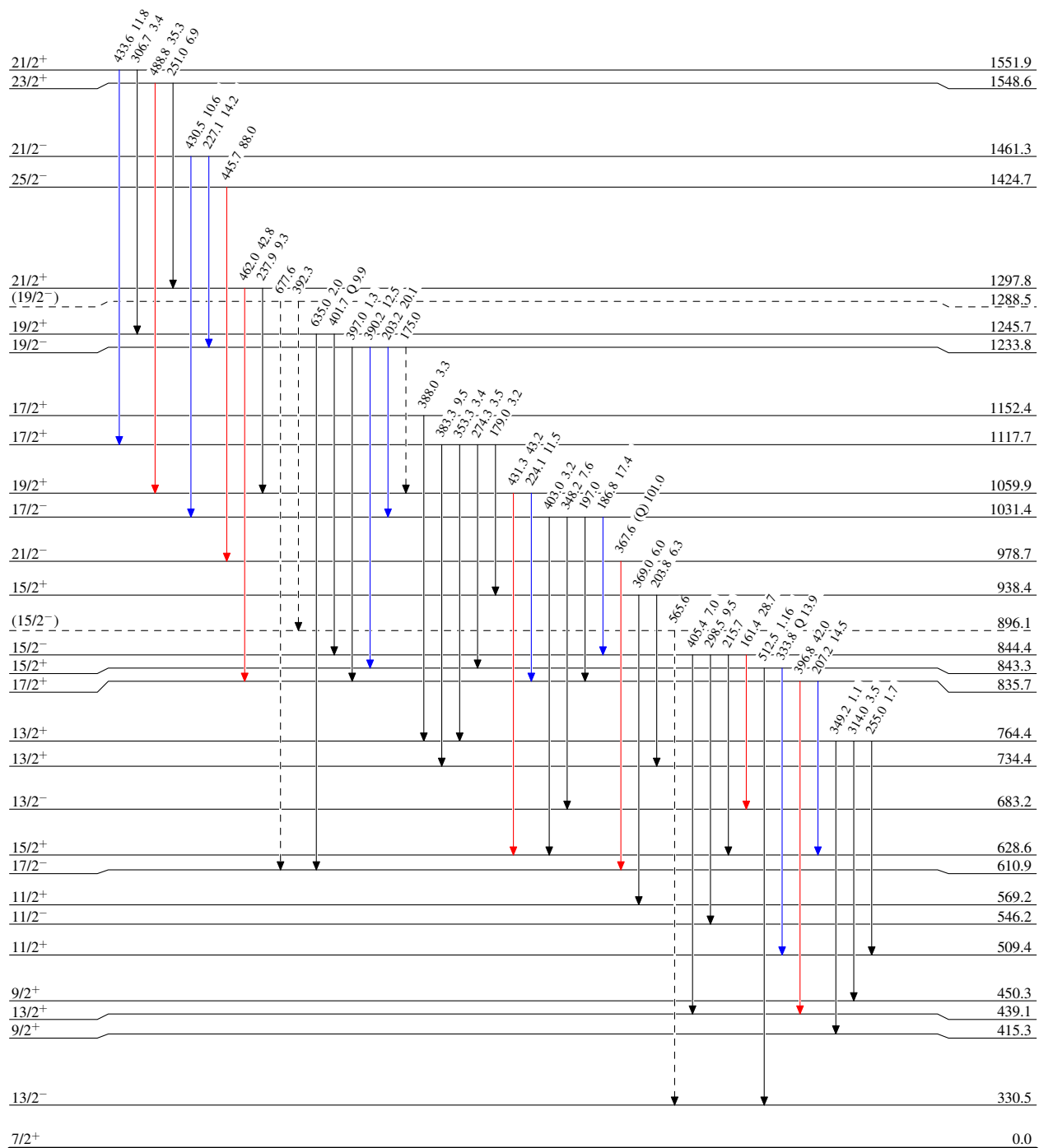
$^{154}\text{Sm}(^{19}\text{F},4n\gamma)$ 1993Og01

Legend

Level Scheme (continued)

Intensities: Relative I_γ

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\cdots$ γ Decay (Uncertain)



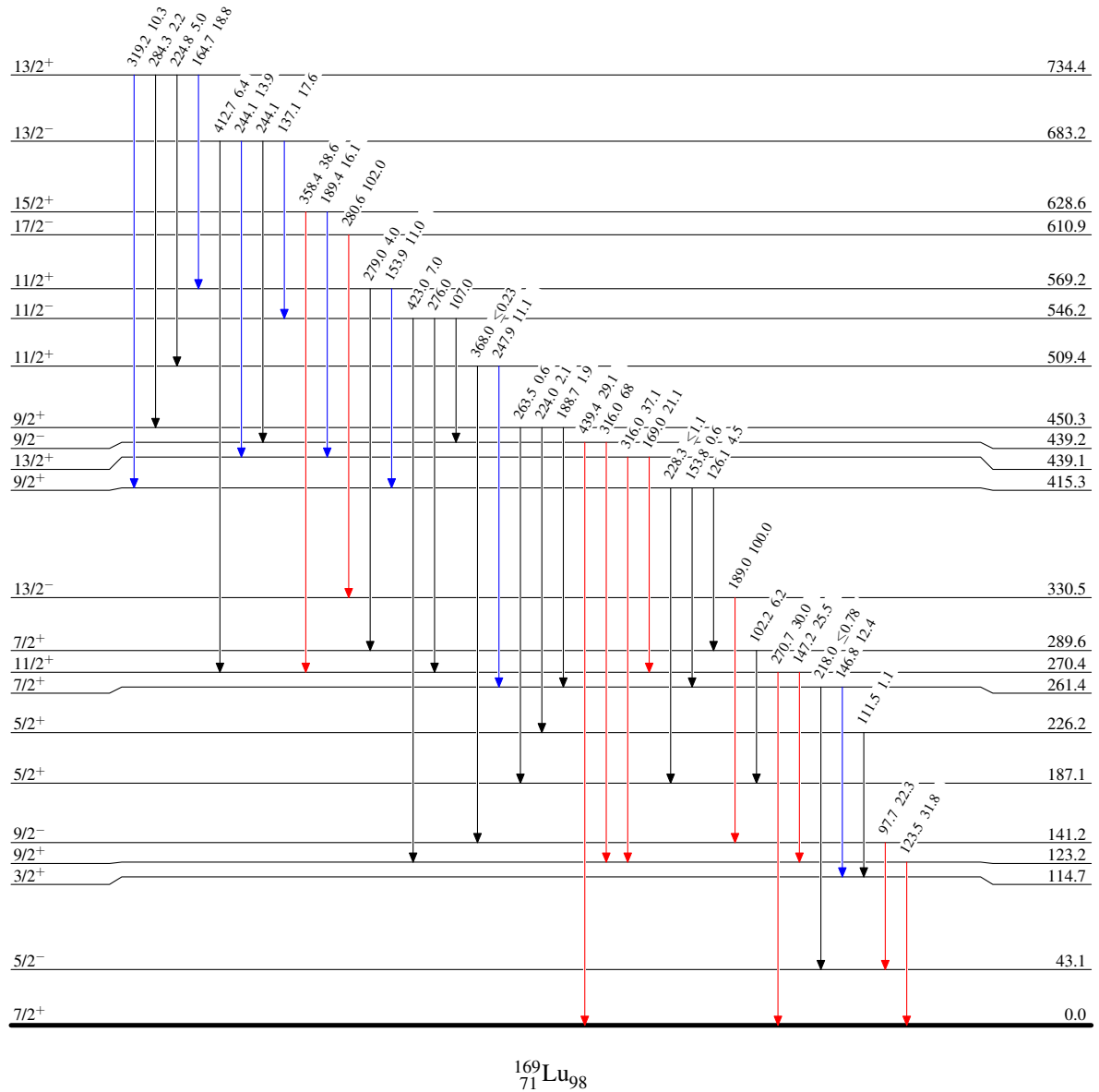
$^{154}\text{Sm}(^{19}\text{F},4n\gamma)$ 1993Og01

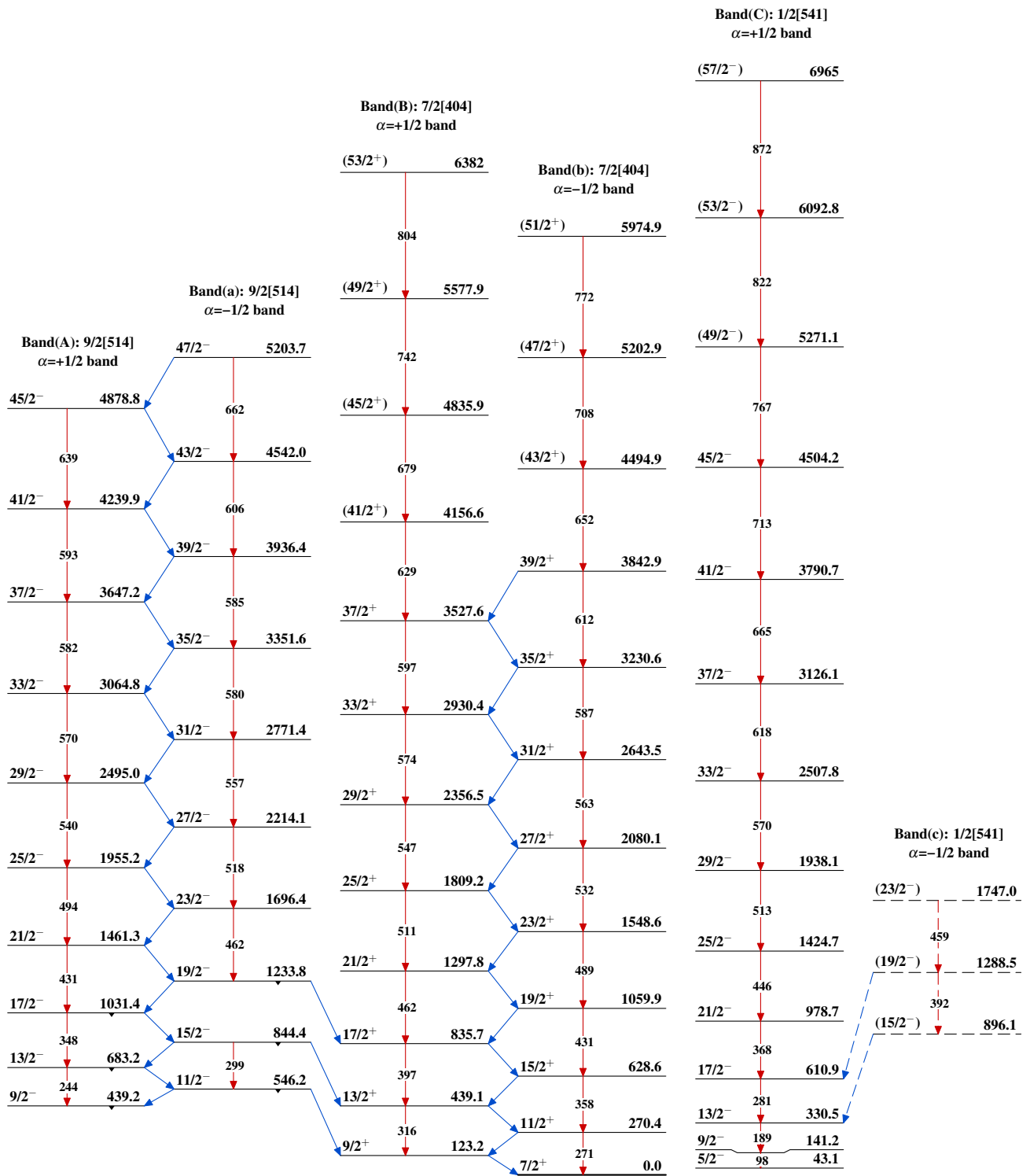
Level Scheme (continued)

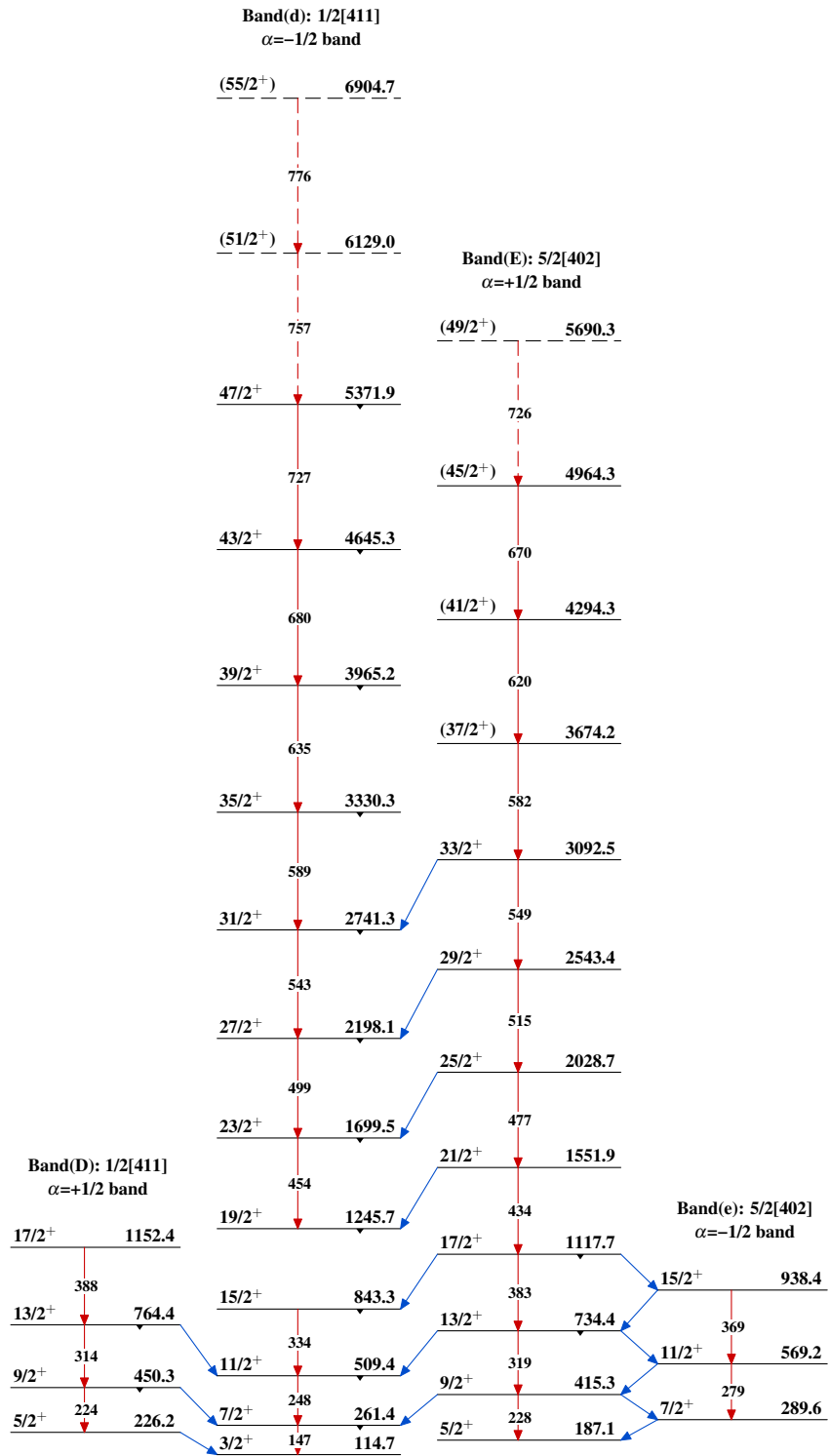
Intensities: Relative I_γ

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$

 $^{169}_{71}\text{Lu}_{98}$

$^{154}\text{Sm}(^{19}\text{F},4n\gamma)$ 1993Og01 $^{169}_{71}\text{Lu}_{98}$

$^{154}\text{Sm}(^{19}\text{F},4n\gamma)$ 1993Og01 (continued) $^{169}_{71}\text{Lu}_{98}$

¹⁶⁹Tm(α ,4n γ), ¹⁷¹Yb(p,3n γ) **1973Fo03**

E(α)=50 MeV, E(p)=30 MeV; metallic targets; measured E γ , I γ (Ge(Li)), $\gamma\gamma$ coin; used classical rotor model to interpret level structure.

¹⁶⁹Lu Levels

E(level) [†]	J π [‡]	E(level) [†]	J π [‡]	E(level) [†]	J π [‡]	E(level) [†]	J π [‡]
0.0 [#]	7/2 ⁺	329.4 [@] 6	13/2 ⁻	836.4 [#] 2	17/2 ⁺	1461.9 ^b 3	21/2 ⁻
29.0 [@] 5	1/2 ⁻	415.1 ^a 6	9/2 ⁺	842.1 ^{&} 7	15/2 ⁺	1549.3 [#] 3	23/2 ⁺
43.1 [@] 6	5/2 ⁻	439.10 ^b 16	9/2 ⁻	844.65 ^b 22	15/2 ⁻	1697.1 ^b 3	23/2 ⁻
97.4 ^{&} 5	1/2 ⁺	439.70 [#] 14	13/2 ⁺	895.2 [@] 7	15/2 ⁻	1698.0 ^{&} 8	23/2 ⁺
113.7 ^{&} 6	3/2 ⁺	449.2? ^{&} 6	9/2 ⁺	937.0? ^a 7	15/2 ⁺	1746.4 [@] 8	23/2 ⁻
123.46 [#] 9	9/2 ⁺	508.4 ^b 6	11/2 ⁺	977.3 [@] 7	21/2 ⁻	1810.5 [#] 6	25/2 ⁺
140.7 [@] 6	9/2 ⁻	546.08 ^b 17	11/2 ⁻	1031.55 ^b 25	17/2 ⁻	1934.7 [@] 8	29/2 ⁻
157.5? [@] 6	3/2 ⁻	569.2 ^a 7	11/2 ⁺	1060.40 [#] 24	19/2 ⁺	1955.8 ^b 4	25/2 ⁻
186.6 ^a 6	5/2 ⁺	574.3? [@] 7	11/2 ⁻	1151.3? ^{&} 8	17/2 ⁺	2080.9 [#] 5	27/2 ⁺
225.1 ^{&} 6	5/2 ⁺	609.9 [@] 7	17/2 ⁻	1235.0 ^b 3	19/2 ⁻	2196.5 ^{&} 9	27/2 ⁺
260.5 ^{&} 6	7/2 ⁺	628.91 [#] 18	15/2 ⁺	1243.8 ^{&} 8	19/2 ⁺	2258.5? [@] 8	27/2 ⁻
270.61 [#] 13	11/2 ⁺	683.31 ^b 18	13/2 ⁻	1287.7 [@] 7	19/2 ⁻	2357.9 [#] 7	29/2 ⁺
288.9 ^a 6	7/2 ⁺	733.8 ^a 7	13/2 ⁺	1298.5 [#] 3	21/2 ⁺	2504.6 [@] 9	33/2 ⁻
328.7? [@] 7	7/2 ⁻	763.1? ^{&} 7	13/2 ⁺	1422.8 [@] 7	25/2 ⁻		

[†] From least-squares fit to E γ .

[‡] Authors' values from relative excitation yields, E(p)/E(α) yield ratios, and rotational structure. These values are consistent with adopted values, but many adopted values are given in parentheses.

Band(A): 7/2[404] band.

@ Band(B): 1/2[541] band.

& Band(C): 1/2[411] band.

^a Band(D): 5/2[402] band.

^b Band(E): 9/2[514] band.

 $\gamma(^{169}\text{Lu})$

Reported γ intensity ratios (given in comments) are for (p,3n γ) and (α ,4n γ), each at $\theta=90^\circ$, and normalized to 1.00 for the 123.5 γ .

E γ	I γ [#]	E _i (level)	J π _i	E _f	J π _f	Mult.	Comments
(13.9 [†] 4)		43.1	5/2 ⁻	29.0	1/2 ⁻		
(16.4 [†] 3)		113.7	3/2 ⁺	97.4	1/2 ⁺		
(29.0 5)		29.0	1/2 ⁻	0.0	7/2 ⁺		E γ : from Adopted Gammas.
^x 63.2 [‡] 2							
68.4 1	23.6	97.4	1/2 ⁺	29.0	1/2 ⁻	(E1)	I γ (E(p)=30 MeV)/I γ (E(α)=50 MeV)=1.92. Mult.: E1 from strong intensity and retardation (T _{1/2} ≥100 ns; value attributed to B. Skanberg in private communication to 1973Fo03). Multipolarities other than E1 would require 68.4 γ to be at least four times more intense than any other transition.
70.9 ^{‡c} 2	<1.2 [@]	113.7	3/2 ⁺	43.1	5/2 ⁻		
72.9 ^{‡c} 2	2.6	186.6	5/2 ⁺	113.7	3/2 ⁺		I γ (E(p)=30 MeV)/I γ (E(α)=50 MeV)=1.04.
^x 75.2 [‡] 2	<2.3 [@]						I γ (E(p)=30 MeV)/I γ (E(α)=50 MeV)=0.66.

Continued on next page (footnotes at end of table)

$^{169}\text{Tm}(\alpha,4n\gamma), ^{171}\text{Yb}(p,3n\gamma)$ **1973Fo03 (continued)** $\gamma(^{169}\text{Lu})$ (continued)

E_γ	$I_\gamma^\#$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
84.8 ^{±c} 2	<5.0 [@]	113.7	3/2 ⁺	29.0	1/2 ⁻	$I_\gamma=5.0$ and $I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=2.23$ for 84.8 γ and 84.3 $\gamma(^{170}\text{Yb})$ combined.
93.1 ^c		508.4	11/2 ⁺	415.1	9/2 ⁺	E_γ : from level scheme in fig. 3 of 1973Fo03 only.
97.7 1	24.6	140.7	9/2 ⁻	43.1	5/2 ⁻	$I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=0.91$.
102.3 1	3.7	288.9	7/2 ⁺	186.6	5/2 ⁺	$I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=1.54$.
107.0 2	<9.7 [@]	546.08	11/2 ⁻	439.10	9/2 ⁻	I_γ : for 107.0 γ and unplaced 107.8 γ combined. $I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=0.94$ (for 107.0 γ and unplaced 107.8 γ combined).
^x 107.8 2	<9.7 [@]					See comments with 107.0 γ .
^x 109.8 2						$I_\gamma \approx 7$ at 90°.
111.5 2		225.1	5/2 ⁺	113.7	3/2 ⁺	I_γ : ≈ 9 at 90° and $I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=1.12$ for contaminated line.
^x 112.7 [±] 2	8.8					
114.4 ^c 2	2.2	157.5?	3/2 ⁻	43.1	5/2 ⁻	$I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=2.68$.
120.0 [±] 2	<4.2 [@]	260.5	7/2 ⁺	140.7	9/2 ⁻	I_γ : 4.2, $I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=0.78$ for line with large contribution from ^{170}Lu .
123.5 1	48.7	123.46	9/2 ⁺	0.0	7/2 ⁺	$I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=1.00$ (intensity ratio normalization).
126.1 1	8.9	415.1	9/2 ⁺	288.9	7/2 ⁺	$I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=1.65$.
^x 132.1 [±] 2	1.5					$I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=1.32$.
^x 135.2 [±] 2	0.8					
137.2 1	<11.0 [@]	683.31	13/2 ⁻	546.08	11/2 ⁻	$I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=0.87$.
^x 144.3 [±] 2	3.7					
146.8 2	<18	260.5	7/2 ⁺	113.7	3/2 ⁺	See comments with 147.2 γ .
147.2 2	≈ 25	270.61	11/2 ⁺	123.46	9/2 ⁺	$I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=1.06$ (for 146.8 γ and 147.2 γ combined). I_γ : deduced from $I_\gamma < 42.8$ (for 146.8 γ and 147.2 γ combined), $I_\gamma(270.5\gamma)/I_\gamma(147.2\gamma) \approx 1.24$, and $I_\gamma(270.5\gamma)=31.0$.
154.0 ^{ac} 2	&	415.1	9/2 ⁺	260.5	7/2 ⁺	
154.0 ^a 2	7.8	569.2	11/2 ⁺	415.1	9/2 ⁺	$I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=1.52$.
161.3 2	<14.8	844.65	15/2 ⁻	683.31	13/2 ⁻	I_γ : 14.8 for 161.3 γ and unplaced 162.6 γ combined. $I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=0.65$ (for 161.3 γ and unplaced 162.6 γ combined).
^x 162.6 2	<14.8					See comments with 161.3 γ .
164.7 [±] 1	11.7 [@]	733.8	13/2 ⁺	569.2	11/2 ⁺	$I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=1.01$.
169.1 1	≤ 23.1 [@]	439.70	13/2 ⁺	270.61	11/2 ⁺	$I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=0.80$. I_γ : for 169.1 γ and 170.8 γ combined.
170.8 ^c 3	≤ 23.1 [@]	328.7?	7/2 ⁻	157.5?	3/2 ⁻	I_γ : 23.1, $I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=2.42$ for γ arising largely from ^{171}Lu . I_γ : see comment with 169.1 γ .
^x 179.3 [±] 2						$I_\gamma \approx 4$ at 90°.
181.9 [±] 2		225.1	5/2 ⁺	43.1	5/2 ⁻	$I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV}) > 1$.
186.9 2	12.9	1031.55	17/2 ⁻	844.65	15/2 ⁻	
188.8 ^{ac} 2	&	328.7?	7/2 ⁻	140.7	9/2 ⁻	
188.8 ^a 2	≈ 90	329.4	13/2 ⁻	140.7	9/2 ⁻	$I_\gamma(E(p)=30\text{ MeV})/I_\gamma(E(\alpha)=50\text{ MeV})=0.65$ (for 188.8 γ and 189.2 γ combined). I_γ : deduced from $I_\gamma=100.0$ (for 188.8 γ and 189.2 γ combined), $I_\gamma(358.3\gamma)/I_\gamma(189.2\gamma) \approx 3.49$, and $I_\gamma(358.3\gamma)=34.9$.
188.8 ^{ac} 2	&	449.2?	9/2 ⁺	260.5	7/2 ⁺	
189.2 2	≈ 10	628.91	15/2 ⁺	439.70	13/2 ⁺	See comments with 188.8 γ .

Continued on next page (footnotes at end of table)

$^{169}\text{Tm}(\alpha,4n\gamma), ^{171}\text{Yb}(p,3n\gamma)$ **1973Fo03 (continued)** $\gamma(^{169}\text{Lu})$ (continued)

E_γ	$I_\gamma^\#$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
$^x197.0$ 2	≈ 19.1 @					
$^x198.6$ 2	≈ 18.1 @					$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.11$.
203.4 ^{ac} 2	&	937.0?	15/2 ⁺	733.8	13/2 ⁺	
203.4 ^a 2	13.5	1235.0	19/2 ⁻	1031.55	17/2 ⁻	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.26$.
207.4 2	9.2	836.4	17/2 ⁺	628.91	15/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.19$.
217.3 $\ddagger$ 3		260.5	7/2 ⁺	43.1	5/2 ⁻	$I_\gamma \approx 1$ at 90° for 217.3 γ +218.8 γ doublet.
224.0 ^{ac} 2	&	449.2?	9/2 ⁺	225.1	5/2 ⁺	
224.0 ^a 2	14.9	1060.40	19/2 ⁺	836.4	17/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.75$.
226.9 2	10.4	1461.9	21/2 ⁻	1235.0	19/2 ⁻	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.51$.
228.5 2	7.0	415.1	9/2 ⁺	186.6	5/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.47$.
235.2 $\ddagger$ 2	4.6	1697.1	23/2 ⁻	1461.9	21/2 ⁻	
238.3 $\ddagger$ 3	4.2	1298.5	21/2 ⁺	1060.40	19/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.27$.
243.6 $\ddagger$ 4	16.3	683.31	13/2 ⁻	439.70	13/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.82$. May also feed 9/2 ⁻ 439.1 level.
245.3 $\ddagger$ ^c 3	7.6	574.3?	11/2 ⁻	329.4	13/2 ⁻	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=1.41$.
247.8 ^a 1	23.2	508.4	11/2 ⁺	260.5	7/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=1.05$.
247.8 ^{ac} 1	&	574.3?	11/2 ⁻	328.7?	7/2 ⁻	
$^x249.9$ $\ddagger$ 3	7.1					I_γ : for 249.9 γ and 250.8 γ combined.
250.8 $\ddagger$ 3	<7.1	1549.3	23/2 ⁺	1298.5	21/2 ⁺	I_γ : see comment with 249.9 γ .
$^x252.2$ $\ddagger$ 3	4.3					$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.46$.
254.6 $\ddagger$ ^c 3	3.3	763.1?	13/2 ⁺	508.4	11/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.71$.
258.7 $\ddagger$ 3	7.9	1955.8	25/2 ⁻	1697.1	23/2 ⁻	
261.0 $\ddagger$ ^c 3	4.2	1810.5	25/2 ⁺	1549.3	23/2 ⁺	
270.5 ^a 2	31.0	270.61	11/2 ⁺	0.0	7/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.68$. Entire I_γ is shown with this placement because alternative placement in uncertain.
270.5 ^{ac} 2	&	2080.9	27/2 ⁺	1810.5	25/2 ⁺	Placement from 2080.9 level uncertain.
275.0 $\ddagger$ 3	<7.4	546.08	11/2 ⁻	270.61	11/2 ⁺	I_γ : for 275.0 γ and unplaced 276.3 γ combined. $I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=1.45$ (for 275.0 γ and unplaced 276.3 γ combined).
$^x276.3$ $\ddagger$ 3	<7.4					See comments with 275.0 γ .
280.6 ^b 2	87.7 ^b	569.2	11/2 ⁺	288.9	7/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.32$.
280.6 ^b 2	87.7 ^b	609.9	17/2 ⁻	329.4	13/2 ⁻	See comment on 280.6 γ from 569 level.
285.6 ^b $\ddagger$ 3	<1 ^b	328.7?	7/2 ⁻	43.1	5/2 ⁻	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV}) \approx 1.00$.
285.6 ^b $\ddagger$ ^c 3	<1 ^b	895.2	15/2 ⁻	609.9	17/2 ⁻	
$^x287.4$ $\ddagger$ 3	≈ 1					$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV}) \approx 3.00$.
298.6 2	9.9	844.65	15/2 ⁻	546.08	11/2 ⁻	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.26$.
$^x306.9$ $\ddagger$ 4						$I_\gamma \approx 1.5$ at 90°.
≈ 310		1287.7	19/2 ⁻	977.3	21/2 ⁻	Observed only in $\gamma\gamma$ coin spectrum.
314.1 $\ddagger$ ^c 3	6.7	763.1?	13/2 ⁺	449.2?	9/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.72$.
315.7 2	<46.3	439.10	9/2 ⁻	123.46	9/2 ⁺	I_γ : for 315.7 γ and 316.2 γ combined. $I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.76$ (for 315.7 γ and 316.2 γ combined).
316.2 2	<46.3	439.70	13/2 ⁺	123.46	9/2 ⁺	See comments with 315.7 γ .
318.5 $\ddagger$ 3	≈ 8	733.8	13/2 ⁺	415.1	9/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=1.15$.
319.9 $\ddagger$ ^c 3	8.2	895.2	15/2 ⁻	574.3?	11/2 ⁻	
324.0 $\ddagger$ 5		1746.4	23/2 ⁻	1422.8	25/2 ⁻	$I_\gamma \approx 1.5$ at 90°.
324.0 $\ddagger$ ^c 5		2258.5?	27/2 ⁻	1934.7	29/2 ⁻	$I_\gamma \approx 1.5$ at 90°.
333.7 3	15.6	842.1	15/2 ⁺	508.4	11/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.89$.

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$^{169}\text{Tm}(\alpha,4n\gamma), ^{171}\text{Yb}(p,3n\gamma)$ **1973Fo03 (continued)** $\gamma(^{169}\text{Lu})$ (continued)

E_γ	I_γ #	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
$^{x340.0}_{\pm 5}$						$I_\gamma \approx 2$ at 90° .
348.3 3	17.3	1031.55	17/2 ⁻	683.31	13/2 ⁻	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.76$.
358.3 2	34.9	628.91	15/2 ⁺	270.61	11/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.42$.
$^{367.5}_{ac} 2$	&	508.4	11/2 ⁺	140.7	9/2 ⁻	
$^{367.5}_{ac} 2$	&	937.0?	15/2 ⁺	569.2	11/2 ⁺	
$^{367.5}_a 2$	70.5	977.3	21/2 ⁻	609.9	17/2 ⁻	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.14$.
$^{x378.7}_{\pm 4}$	2.5					
$^{x382.8}_{\pm 3}$	≈ 7					I_γ : for 382.8 γ and 384.2 γ combined. $I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.36$ (for 382.8 γ and 384.2 γ combined).
$^{x384.2}_{\pm 3}$	≈ 7					See comments with 382.8 γ .
$^{388.2}_{\pm c} 4$	3.8	1151.3?	17/2 ⁺	763.1?	13/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.51$.
$^{390.3}_{\pm 3}$	$<16.7^@$	1235.0	19/2 ⁻	844.65	15/2 ⁻	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.26$.
$^{392.2}_{\pm 4}$	1.2	1287.7	19/2 ⁻	895.2	15/2 ⁻	
$^{396.7}_2 2$	30.2	836.4	17/2 ⁺	439.70	13/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.27$.
$^{x398.7}_{\pm 3}$	<1.8					$I_\gamma=1.8$ and $I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.68$ (for 398.7 γ and 400.5 γ combined).
$^{x400.5}_{\pm 3}$	<1.8					See comments with 398.7 γ .
$^{401.7}_3 3$	10.9	1243.8	19/2 ⁺	842.1	15/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.31$.
$^{x406.2}_{\pm 4}$	≈ 2					
$^{413.1}_{\pm 4}$	≈ 4	683.31	13/2 ⁻	270.61	11/2 ⁺	
$^{x416.3}_{\pm 4}$	≈ 6					
$^{422.8}_{\pm 3}$	≈ 5	546.08	11/2 ⁻	123.46	9/2 ⁺	
$^{430.6}_3 3$	<33.8	1461.9	21/2 ⁻	1031.55	17/2 ⁻	I_γ : 33.8 for 430.6 γ and 431.7 γ combined. $I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.16$ (for 430.6 γ and 431.7 γ combined).
$^{431.7}_3 3$	<33.8	1060.40	19/2 ⁺	628.91	15/2 ⁺	See comments with 430.6 γ .
$^{433.2}_{\pm c} 3$	10.9	574.3?	11/2 ⁻	140.7	9/2 ⁻	
$^{439.0}_3 3$	6.7	439.10	9/2 ⁻	0.0	7/2 ⁺	
$^{x440.4}_3 3$	13.5					
$^{445.6}_2 2$	53.5	1422.8	25/2 ⁻	977.3	21/2 ⁻	
$^{454.2}_{\pm 3}$	10.6	1698.0	23/2 ⁺	1243.8	19/2 ⁺	
$^{458.5}_{\pm 3}$	7.1	1746.4	23/2 ⁻	1287.7	19/2 ⁻	
$^{462.0}_b 2$	$^{37.1}_b$	1298.5	21/2 ⁺	836.4	17/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.08$.
$^{462.0}_b 2$	$^{37.1}_b$	1697.1	23/2 ⁻	1235.0	19/2 ⁻	
$^{x469.0}_{\pm 3}$	5.9					
$^{x476.5}_{\pm 3}$	9.2					$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.50$.
$^{x479.3}_{\pm 4}$						$I_\gamma \approx 6$ at 90° .
$^{488.9}_2 2$	26.5	1549.3	23/2 ⁺	1060.40	19/2 ⁺	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=0.08$.
$^{494.0}_{\pm 4}$	7.4	1955.8	25/2 ⁻	1461.9	21/2 ⁻	
$^{498.5}_{\pm 3}$		2196.5	27/2 ⁺	1698.0	23/2 ⁺	$I_\gamma \approx 9.0$ at 90° .
$^{512.0}_{b\pm} 5$	$<148^b@$	1810.5	25/2 ⁺	1298.5	21/2 ⁺	
$^{512.0}_{b\pm} 5$	$<148^b@$	1934.7	29/2 ⁻	1422.8	25/2 ⁻	
$^{512.0}_{ac} 5$	&	2258.5?	27/2 ⁻	1746.4	23/2 ⁻	
$^{x516.8}_{\pm 3}$	≈ 12					
$^{531.6}_{\pm 3}$	14.2	2080.9	27/2 ⁺	1549.3	23/2 ⁺	
$^{x539.5}_{\pm 4}$	3.9					

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$^{169}\text{Tm}(\alpha,4n\gamma), ^{171}\text{Yb}(p,3n\gamma)$ **1973Fo03 (continued)** $\gamma(^{169}\text{Lu})$ (continued)

E_γ	$I_\gamma^\#$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
$^{x543.7}_{\ddagger} 4$	10.5					
$^{547.4}_{\ddagger} 4$	16.9	2357.9	$29/2^+$	1810.5	$25/2^+$	
$^{x557.1}_{\ddagger} 4$	9.7					
$^{x562.9}_{\ddagger} 4$	13.5					
$^{565.6}_{\ddagger} 4$		895.2	$15/2^-$	329.4	$13/2^-$	$I_\gamma(E(p)=30 \text{ MeV})/I_\gamma(E(\alpha)=50 \text{ MeV})=1.00$. $I_\gamma \approx 6$ at 90° .
$^{569.9}_{\ddagger} 4$	23.0	2504.6	$33/2^-$	1934.7	$29/2^-$	
$^{x574.0}_{\ddagger} 4$	3.5					
$^{x582.1}_{\ddagger} 5$	≈ 3					
$^{x588.8}_{\ddagger} 5$	≈ 2					
$^{x597.4}_{\ddagger} 4$	12.8					
$^{x601.9}_{\ddagger} 5$						$I_\gamma \approx 5.4$ at 90° .
$^{x610.4}_{\ddagger} 5$						$I_\gamma \approx 6.0$ at 90° .
$^{x618.3}_{\ddagger} 4$	16.0					
$^{x634.7}_{\ddagger} 5$						$I_\gamma \approx 7.4$ at 90° .
$^{x665.0}_{\ddagger} 5$						$I_\gamma \approx 3.0$ at 90° .
$^{677.6}_{\ddagger} 5$		1287.7	$19/2^-$	609.9	$17/2^-$	$I_\gamma \approx 5.7$ at 90° .

† **1973Fo03** deduced energies for unobserved transitions from $5/2^-$ $1/2[541]$ to $1/2^-$ $1/2[541]$ (given as x by authors) and from $3/2^+$ $1/2[411]$ to $1/2^+$ $1/2[411]$ (given as y by authors) as follows. From fits of the $J(J+1)$ expansions, both x and y are ≈ 15 keV. The 97.7γ - 120.0γ - 247.8γ coincidence requires $y=x+2.5$ keV. With 84.8γ then placed, x can be deduced from $146.8\gamma+84.8\gamma$ - 120.0γ - 97.7γ ($=13.9$ 4) and y, from 84.8γ - 68.4γ ($=16.4$ 3). **1973Fo03** report these energy values as tentative and somewhat uncertain.

‡ Assignment to ^{169}Lu uncertain.

$^\#$ Arbitrary units for $E(\alpha)=50 \text{ MeV}$, $\theta=125^\circ$. $\Delta I_\gamma \approx 10\%$ for strong, well-resolved peaks, and up to 50% for others. See **1973Fo03** for additional intensity data.

$^\textcircled{a}$ Includes possible component from contaminant. See **1973Fo03** for source.

$^\&$ No intensity attributed for the uncertain placement or for placement from an uncertain level or for an additional placement.

^{a} Multiply placed.

^{b} Multiply placed with undivided intensity.

^{c} Placement of transition in the level scheme is uncertain.

^{x} γ ray not placed in level scheme.

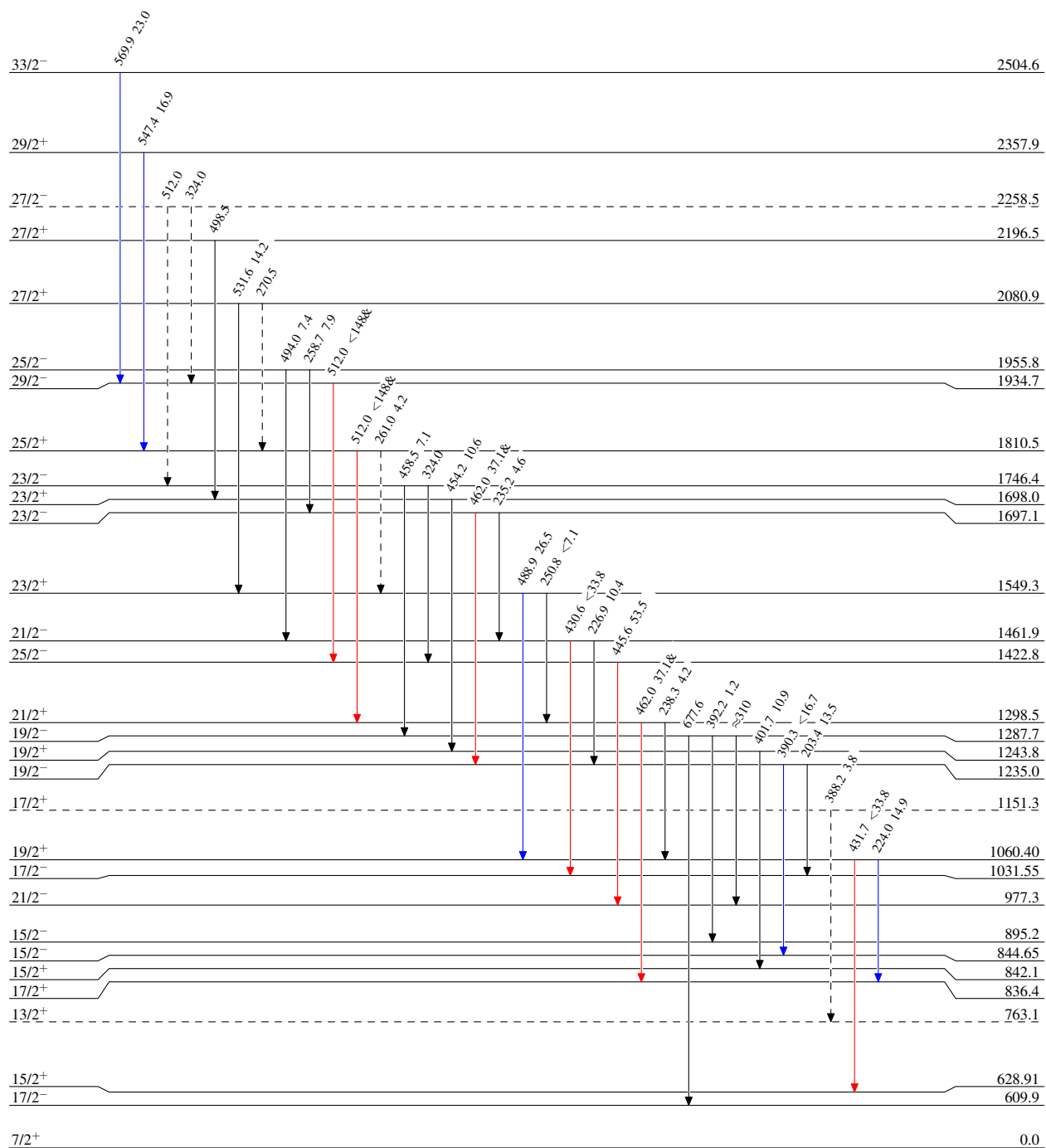
$^{169}\text{Tm}(\alpha,4n\gamma), ^{171}\text{Yb}(\text{p},3n\gamma)$ 1973Fo03

Level Scheme

Intensities: relative I_γ for $E(\alpha)=50$ MeV, $\theta=125^\circ$
 & Multiply placed: undivided intensity given

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\text{max}}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\text{max}}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\text{max}}$
 $\cdots\cdots\cdots\longrightarrow$ γ Decay (Uncertain)

 $^{169}_{71}\text{Lu}_{98}$

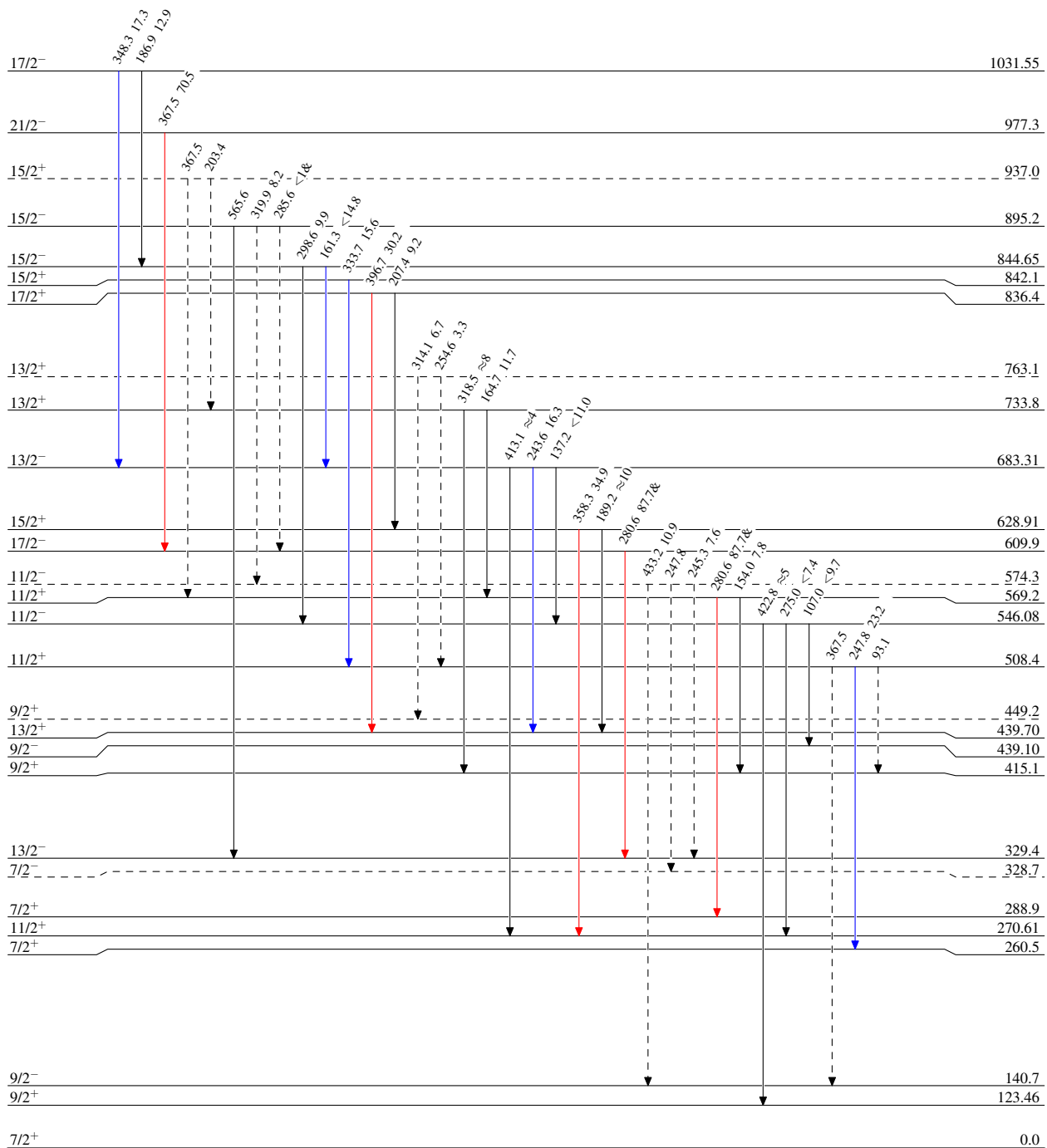
$^{169}\text{Tm}(\alpha,4n\gamma), ^{171}\text{Yb}(p,3n\gamma)$ 1973Fo03

Level Scheme (continued)

Intensities: relative I_γ for $E(\alpha)=50$ MeV, $\theta=125^\circ$
& Multiply placed: undivided intensity given

Legend

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$
- - - - -→ γ Decay (Uncertain)



$^{169}_{71}\text{Lu}_{98}$

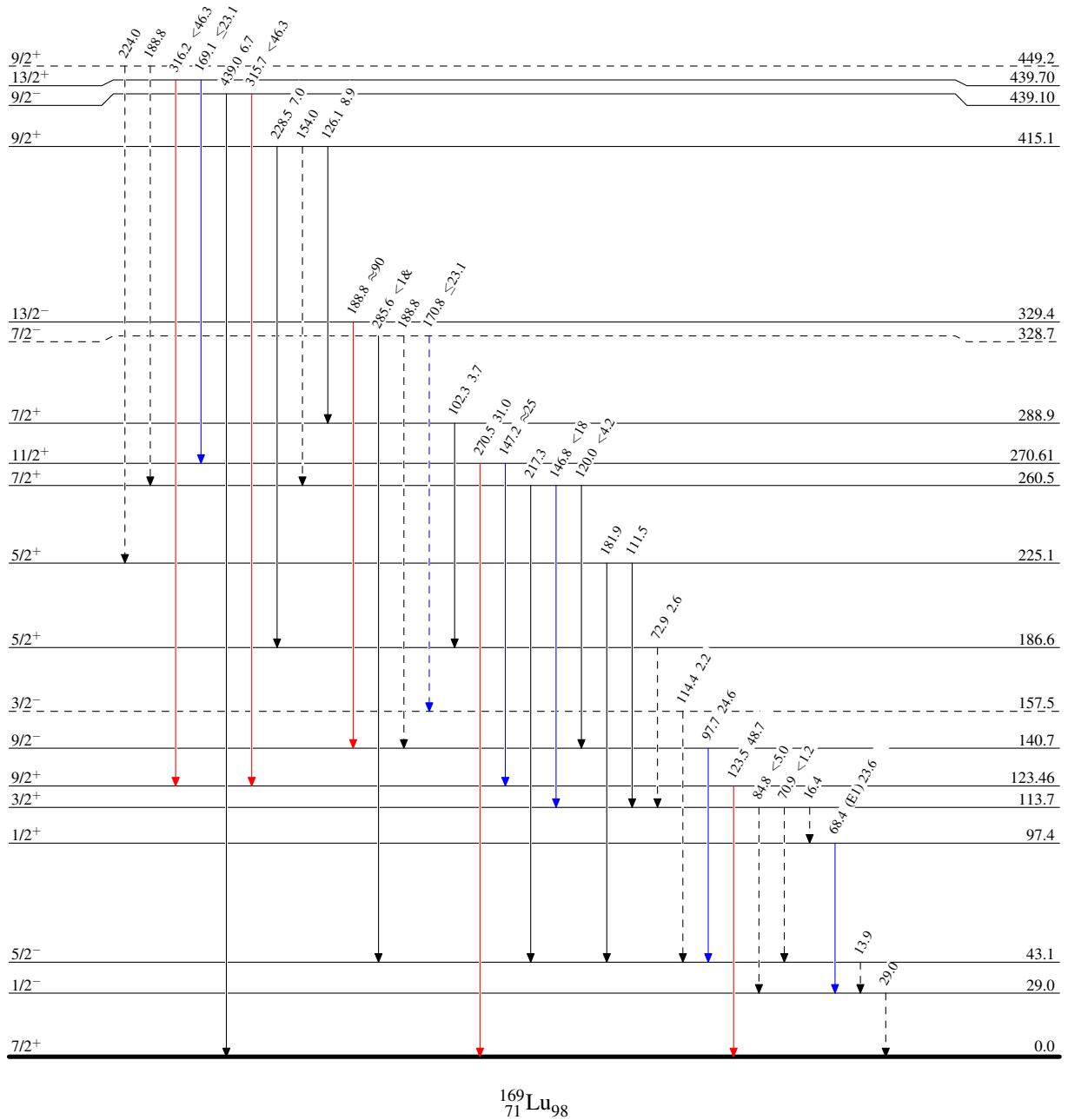
$^{169}\text{Tm}(\alpha,4n\gamma), ^{171}\text{Yb}(\text{p},3n\gamma)$ 1973Fo03

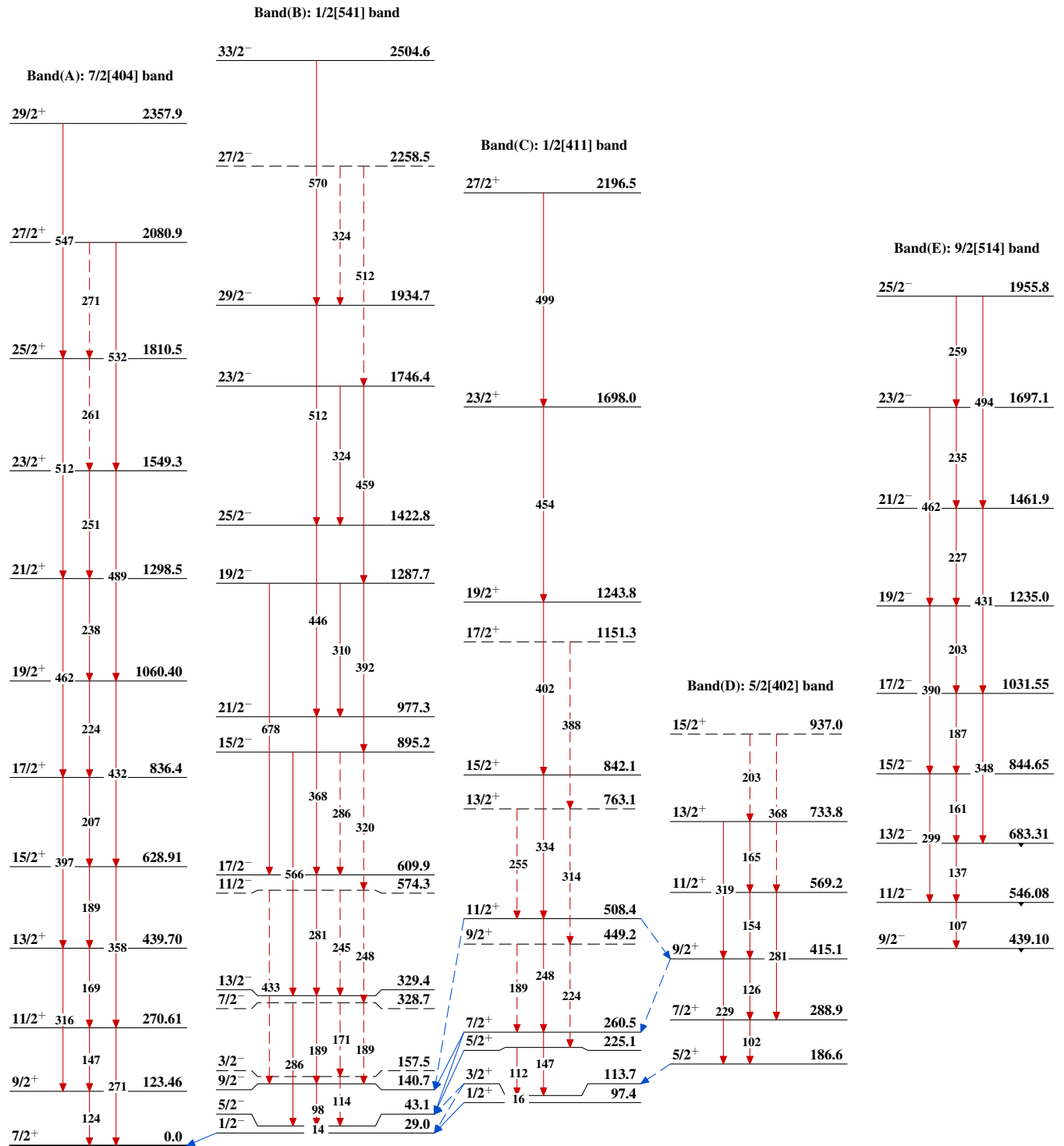
Level Scheme (continued)

Intensities: relative I_γ for $E(\alpha)=50$ MeV, $\theta=125^\circ$
 & Multiply placed: undivided intensity given

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\text{max}}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\text{max}}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\text{max}}$
 $\longrightarrow$ γ Decay (Uncertain)



$^{169}\text{Tm}(\alpha,4n\gamma), ^{171}\text{Yb}(p,3n\gamma)$ 1973Fo03 $^{169}_{71}\text{Lu}_{98}$

¹⁶⁸Yb(p,p) IAR [1970Wh05](#)

E(p)=10-13 MeV; measured excitation functions at $\theta=90^\circ$, 125° , 141° , 160° (Si(Li), FWHM=30-35 keV).

¹⁶⁹Lu Levels

<u>E(level)</u>	<u>Comments</u>
14065 20	$\Gamma_p=5.9$ keV, $\Gamma=53$ keV. E(level): deduced from E(res)=10273 20 and S(p)=3792 3 (2021Wa16). Analog of 1/2 ⁻ 24.2 level in ¹⁶⁹ Yb.

Adopted Levels, Gammas

$Q(\beta^-) = -4430$ 40; $S(n) = 7.43 \times 10^3$ 4; $S(p) = 4.93 \times 10^3$ 5; $Q(\alpha) = 3.15 \times 10^3$ 4 2021Wa16
Other reactions.

$^{160}\text{Gd}(^{16}\text{O}, 7n\gamma)$, $E = 110\text{--}134$ MeV (1982Pe10 and 1983Pe21): γ -ray multiplicities for high-spin state deexcitation; Ge(Li) and 12 NaI detectors.

$^{164}\text{Dy}(^{12}\text{C}, 7n\gamma)$, $E = 118$ MeV (1981Hj01): γ -ray multiplicities for high-spin state deexcitation; Ge(Li) and 8 scin detectors; 9 transitions in 5/2[642] band and 5 transitions in 5/2[523] band.

$^{174}\text{Yb}(\alpha, 9n\gamma)$, $^{176}\text{Hf}(\alpha, 11n\gamma)$ (1983Ma32): neutron multiplicities at high excitation.

Activities of 1.87 h 3 (1951Wi08) and 1.5 h (1961Me05) were assigned to ^{169}Hf , but not found in subsequent experiments (1966Ha23, 1969Ar23, 1970Ch17).

 ^{169}Hf Levels

Band structure is adopted from 2001Sc49. The orbitals involved in the band labels are as follows: 5/2[642] (A,B); 3/2[651] (C,D); 5/2[523] (E,F); 5/2[512] (G,H); 1/2[521] (M,N).

Cross Reference (XREF) Flags

- A ^{169}Ta ε decay (4.9 min)
 B $^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$
 C $^{130}\text{Te}(^{44}\text{Ca}, 5n\gamma)$, $^{124}\text{Sn}(^{50}\text{Ti}, 5n\gamma)$
 D $^{159}\text{Tb}(^{14}\text{N}, 4n\gamma)$

E(level) [†]	J^π [‡]	$T_{1/2}$ [#]	XREF	Comments
0.0 [@]	5/2 ⁻	3.24 min 5	ABCD	$\% \varepsilon + \% \beta^+ = 100$ J^π : $\log ft < 4.6$ to 7/2 ⁻ at 492.9 keV in ^{169}Lu ; systematics of N=97 nuclei support assignment of 5/2[523] Nilsson orbital to ^{169}Hf (g.s.) and 7/2[523] to 492.9 keV level (^{169}Lu). $T_{1/2}$: weighted average of 3.2 min 1 (1969Ar23), 3.3 min 3 (1970At01), 3.26 min 5 (1970Ch17), 3.2 min 1 (1973FoYE), 3.25 min 10 (1973Me09). The uncertainty is the lowest value from 1970Ch17.
28.80 ^b 4	(7/2) ⁺	82 ns +40–15	ABCD	J^π : E1 γ to 5/2 ⁻ . Coincidence data (prompt and delayed) support assignment of 28.8, 36.7, and 38.2 levels as 7/2 ⁺ , 9/2 ⁺ , and 5/2 ⁺ members, respectively, of the expected 5/2[642] band. The inverted spin sequence and proximity of the levels can be explained by Coriolis effects. $T_{1/2}$: from $\gamma\gamma(t)$ in $^{159}\text{Tb}(^{14}\text{N}, 4n\gamma)$ (1975Re05).
36.70 ^a 28	(9/2) ⁺		BCD	J^π : see comment with 28.8 level.
38.18 ^a 4	(5/2) ⁺		A D	E(level): the level has been proposed as a tentative member of the 5/2[642] band in 1975Re05 ($^{14}\text{N}, 4n\gamma$).
59.16 ^c 8	(5/2) ⁻		B D	J^π : (E1) γ to 5/2 ⁻ ; see comment in 28.8 level. J^π : 5/2 ⁻ 5/2[512] consistent with position of level and structure of higher members of band (mixing ratios and g factors fit 5/2[512] better than 3/2[521]) (1975Re05 – ($^{14}\text{N}, 4n\gamma$)).
77.76 ^{&} 8	(7/2) ⁻		ABCD	
104.00 ^b 27	(11/2) ⁺		BCD	
144.74 ^a 26	(13/2) ⁺		BCD	
158.79 ^d 8	(7/2) ⁻		B D	
177.14 [@] 7	(9/2) ⁻		ABCD	
288.73 ^c 10	(9/2) ⁻		B D	
302.67 ^{&} 11	(11/2) ⁻		BCD	
311.17 ^b 26	(15/2) ⁺		BCD	

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Adopted Levels, Gammas (continued) ^{169}Hf Levels (continued)

E(level) [†]	J ^π [‡]	XREF	E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF
363.40 ^a 26	(17/2 ⁺)	BCD	2914.14 ^c 34	(33/2 ⁻)		B
442.87 ^d 11	(11/2 ⁻)	B D	2969.5 ⁱ 4	(33/2 ⁻)		B
444.20 [@] 11	(13/2 ⁻)	BCD	3065.68 ^{&} 29	(35/2 ⁻)		BC
613.83 ^{&} 13	(15/2 ⁻)	BCD	3107.3 ^e 6	(29/2 ⁺)		B
622.17 ^c 13	(13/2 ⁻)	B D	3134.4 ^h 6	(31/2 ⁻)		B
641.96 ^b 26	(19/2 ⁺)	BCD	3180.1 ^d 4	(35/2 ⁻)		B
689.67 ^a 26	(21/2 ⁺)	BCD	3220.53 [@] 34	(37/2 ⁻)		BC
790.40 [@] 14	(17/2 ⁻)	BCD	3395.6 ^f 6	(31/2 ⁺)		B
820.47 ^d 13	(15/2 ⁻)	B D	3425.2 ^g 6	(33/2 ⁻)		B
997.97 ^{&} 16	(19/2 ⁻)	BCD	3453.6 ^a 4	(41/2 ⁺)		BCD
1028.5 ^c 4	(17/2 ⁻)	B	3471.7 ⁱ 6	(37/2 ⁻)		B
1079.93 ^b 26	(23/2 ⁺)	BCD	3514.9 ^c 4	(37/2 ⁻)		B
1113.03 ^a 27	(25/2 ⁺)	BCD	3588.4 ^b 4	(39/2 ⁺)	0.29 ps 19	BC
1201.58 [@] 16	(21/2 ⁻)	BCD	3672.19 ^{&} 35	(39/2 ⁻)		BC
1443.13 ^{&} 17	(23/2 ⁻)	BCD	3700.1 ^e 7	(33/2 ⁺)		B
1472.5 ^c 4	(21/2 ⁻)	B	3728.9 ^h 7	(35/2 ⁻)		B
1608.00 ^b 27	(27/2 ⁺)	BCD	3768.69 ^d 35	(39/2 ⁻)		B
1618.40 ^a 28	(29/2 ⁺)	BCD	3832.8 [@] 4	(41/2 ⁻)		BC
1662.12 [@] 17	(25/2 ⁻)	BCD	4020.3 ^f 7	(35/2 ⁺)		B
1734.29 ^f 28	(15/2 ⁺)	B	4041.4 ^j 4	(41/2 ⁺)		B
1867.2 ^e 4	(17/2 ⁺)	B	4041.5 ^g 7	(37/2 ⁻)		B
1908.64 ^c 32	(25/2 ⁻)	B	4053.4 ⁱ 7	(41/2 ⁻)		B
1940.78 ^{&} 20	(27/2 ⁻)	BCD	4141.2 ^a 4	(45/2 ⁺)	0.29 ps 5	BCD
1953.2 ^g 4	(21/2 ⁻)	B	4155.8 ^c 4	(41/2 ⁻)		B
2012.8 ^f 4	(19/2 ⁺)	B	4320.6 ^{&} 4	(43/2 ⁻)	0.20 ps +11-7	BC
2127.2 ⁱ 4	(25/2 ⁻)	B	4343.2 ^b 4	(43/2 ⁺)	0.20 ps +13-9	BC
2141.1 ^h 5	(23/2 ⁻)	B	4350.5 ^e 7	(37/2 ⁺)		B
2153.63 [@] 23	(29/2 ⁻)	BCD	4361.1 ^h 7	(39/2 ⁻)		B
2188.20 ^a 30	(33/2 ⁺)	BCD	4442.0 ^d 4	(43/2 ⁻)		B
2191.6 ^e 5	(21/2 ⁺)	B	4510.4 [@] 5	(45/2 ⁻)	0.23 ps 4	BC
2210.88 ^b 29	(31/2 ⁺)	BCD	4685.4 ^f 7	(39/2 ⁺)		B
2357.7 ^g 5	(25/2 ⁻)	B	4688.1 ^g 7	(41/2 ⁻)		B
2380.23 ^c 31	(29/2 ⁻)	B	4706.1 ⁱ 8	(45/2 ⁻)		B
2384.3 ^f 5	(23/2 ⁺)	B	4730.0 ^j 4	(45/2 ⁺)		B
2484.21 ^{&} 23	(31/2 ⁻)	BCD	4827.5 ^c 6	(45/2 ⁻)		B
2525.4 ⁱ 4	(29/2 ⁻)	B	4882.4 ^a 5	(49/2 ⁺)	0.18 ps 4	BC
2597.7 ^h 5	(27/2 ⁻)	B	5021.0 ^h 7	(43/2 ⁻)		B
2597.8 ^e 5	(25/2 ⁺)	B	5027.4 ^e 7	(41/2 ⁺)		B
2667.26 [@] 29	(33/2 ⁻)	BC	5034.9 ^{&} 5	(47/2 ⁻)	0.21 ps +10-14	BC
2684.1 ^d 4	(31/2 ⁻)	B	5131.8 ^b 5	(47/2 ⁺)	0.15 ps 5	BC
2803.74 ^a 34	(37/2 ⁺)	BCD	5174.2 ^d 5	(47/2 ⁻)		B
2840.6 ^f 6	(27/2 ⁺)	B	5250.4 [@] 5	(49/2 ⁻)	0.13 ps +5-4	BC
2857.2 ^g 6	(29/2 ⁻)	B	5361.7 ^g 8	(45/2 ⁻)		B
2874.39 ^b 32	(35/2 ⁺)	BCD	5371.3 ^f 8	(43/2 ⁺)		B

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Adopted Levels, Gammas (continued) ^{169}Hf Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF	Comments
5424.7 ⁱ 9	(49/2 ⁻)		B	
5495.9 ^j 5	(49/2 ⁺)		B	
5544.3 ^c 7	(49/2 ⁻)		B	
5689.1 ^a 5	(53/2 ⁺)	0.055 ps 21	BC	
5711.7 ^h 8	(47/2 ⁻)		B	
5817.7 ^{&} 5	(51/2 ⁻)	0.11 ps 3	BC	
5956.2 ^d 6	(51/2 ⁻)		B	
5957.5 ^b 5	(51/2 ⁺)	0.14 ps 10	BC	
6045.9 [@] 5	(53/2 ⁻)	0.049 ps 21	BC	
6077.5 ^g 8	(49/2 ⁻)		B	
6097.9 ^f 9	(47/2 ⁺)		B	
6212.8 ⁱ 10	(53/2 ⁻)		B	
6309.5 ^j 5	(53/2 ⁺)		B	
6326.3 ^c 8	(53/2 ⁻)		B	
6455.4 ^h 8	(51/2 ⁻)		B	
6565.4 ^a 5	(57/2 ⁺)	0.11 ps +4-6	BC	
6667.6 ^{&} 5	(55/2 ⁻)		BC	
6790.2 ^d 7	(55/2 ⁻)		B	
6830.0 ^b 6	(55/2 ⁺)		BC	
6854.3 ^g 9	(53/2 ⁻)		B	
6895.1 [@] 6	(57/2 ⁻)	0.09 ps 4	BC	
7076.4 ⁱ 11	(57/2 ⁻)		B	
7170.8 ^j 6	(57/2 ⁺)		B	
7179.8 ^c 9	(57/2 ⁻)		B	
7509.3 ^a 6	(61/2 ⁺)	0.09 ps 3	BC	
7581.4 ^{&} 6	(59/2 ⁻)		BC	
7677.2 ^d 9	(59/2 ⁻)		B	
7751.4 ^b 7	(59/2 ⁺)		BC	
7806.4 [@] 6	(61/2 ⁻)	0.11 ps 6	BC	
8009.9 ⁱ 11	(61/2 ⁻)		B	
8088.9 ^j 7	(61/2 ⁺)		B	
8099.1 ^c 10	(61/2 ⁻)		B	
8514.7 ^a 6	(65/2 ⁺)		BC	
8539.2 ^{&} 6	(63/2 ⁻)		BC	
8569.0 ^d 9	(63/2 ⁻)		B	
8717.5 ^b 8	(63/2 ⁺)		B	
8784.9 [@] 6	(65/2 ⁻)		BC	
8996.9 ⁱ 12	(65/2 ⁻)		B	
9054.3 ^j 8	(65/2 ⁺)		B	
9405.3 ^{&} 7	(67/2 ⁻)		B	E(level): in $^{130}\text{Te}(^{44}\text{Ca}, 5\text{n}\gamma)$, (67/2 ⁻) state is located at 7545.1 keV due to a different placement of 1004.8 2 gamma.
9574.9 ^a 6	(69/2 ⁺)		BC	
9719.1 ^b 9	(67/2 ⁺)		B	
9826.8 [@] 7	(69/2 ⁻)		BC	
9995.6 ⁱ 13	(69/2 ⁻)		B	
10294.6 ^{&} 8	(71/2 ⁻)		B	

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Adopted Levels, Gammas (continued) ^{169}Hf Levels (continued)

E(level) [†]	J ^π [‡]	XREF	E(level) [†]	J ^π [‡]	XREF	E(level) [†]	J ^π [‡]	XREF
10676.9 ^a 7	(73/2 ⁺)	BC	12034.8 [@] 8	(77/2 ⁻)	B	14115.9 ^a 10	(85/2 ⁺)	B
10917.5 [?] 7	(73/2 ⁻)	BC	12221.4 ^{&} 10	(79/2 ⁻)	B	14277.8 [@] 16	(85/2 ⁻)	B
11005.7 ⁱ 13	(73/2 ⁻)	B	12955.8 ^a 9	(81/2 ⁺)	BC	14385.1 ^{&} 12	(87/2 ⁻)	B
11232.0 ^{&} 9	(75/2 ⁻)	B	13140.8 [@] 13	(81/2 ⁻)	B	15294.7 ^a 10	(89/2 ⁺)	B
11807.6 ^a 8	(77/2 ⁺)	BC	13272.4 ^{&} 11	(83/2 ⁻)	B			

[†] From least-squares fit to $E\gamma$, assuming $\Delta E=1$ keV for $E\gamma$ without uncertainty. Unobserved $E\gamma$ was ignored in the least-squares fitting.

[‡] Based on coincidence data, rotational structure, and γ -ray multipolarities in $^{159}\text{Tb}(^{14}\text{N},4n\gamma)$, except where noted. Note that in many cases the evaluator has added parentheses to the assignments in the ($^{76}\text{Ge},3n\gamma$) (2001Sc49) data set.

From DSAM in ($^{44}\text{Ca},5n\gamma$), except as noted.

[@] Band(A): 5/2[523] $\alpha=+1/2$ band (2001Sc49). A=10.8, B=9.5 (5/2, 7/2, 9/2, 11/2 levels). E band; becomes EAB band at $\hbar\omega=260$ keV. A subsequent band crossing occurs at $\hbar\omega\approx 550$ keV; probably involves proton alignment, 1/2[541]⊗9/2[514] or 7/2[404]⊗1/2[660].

[&] Band(a): 5/2[523] $\alpha=-1/2$ band (2001Sc49). A=10.8, B=9.5 (5/2, 7/2, 9/2, 11/2 levels). F band; becomes FAB band at $\hbar\omega=270$ keV. A subsequent band crossing occurs at $\hbar\omega\approx 450$ keV; probably involves proton alignment, 1/2[541]⊗9/2[514] or 7/2[404]⊗1/2[660].

^a Band(B): 5/2[642] $\alpha=+1/2$ band (2001Sc49). A band; becomes ABC band at $\hbar\omega=310$ keV. Subsequent band crossing at $\hbar\omega\approx 565$ keV may involve an aligned proton pair (see 2001Sc49 for discussion of possible π orbitals).

^b Band(b): 5/2[642] $\alpha=-1/2$ band (2001Sc49). B band; becomes BAD band at $\hbar\omega=370$ keV.

^c Band(C): 5/2[512] $\alpha=+1/2$ band (2001Sc49). A=14.6, B=-8.4 (5/2, 7/2, 9/2, 11/2 levels). G band; becomes GAB band at $\hbar\omega=255$ keV. Band not observed in ($^{44}\text{Ca},5n\gamma$) (1991Ga18) or in ($^{50}\text{Ti},4n\gamma$) (1990IrZZ).

^d Band(c): 5/2[512] $\alpha=-1/2$ band (2001Sc49). H band; becomes HAB band at $\hbar\omega=255$ keV.

^e Band(D): $\pi=+$, $\alpha=+1/2$ 3-quasiparticle band (2001Sc49). Strongly-coupled band; lowest-energy level may not be bandhead. A configuration of (ν 5/2[642])⊗(π 5/2[402])⊗(π 1/2[411]) with $K^\pi=1/2^+$ is very tentatively suggested in 2001Sc49.

^f Band(d): $\pi=+$, $\alpha=-1/2$ 3-quasiparticle band (2001Sc49). See comment on signature partner band.

^g Band(E): $\pi=-$, $\alpha=+1/2$ 3-quasiparticle band (2001Sc49). Strongly-coupled band; lowest-energy level may not be bandhead. Possible configuration: (ν 5/2[642])⊗(π 9/2[514])⊗(π 1/2[411]) with $K^\pi=15/2^-$; this is consistent with observed B(M1)/B(E2) for intraband transitions from levels; however, see 2001Sc49 for other possibilities.

^h Band(e): $\pi=-$, $\alpha=-1/2$ 3-quasiparticle band (2001Sc49). See comment on signature partner band.

ⁱ Band(F): $\nu[(1/2[521])(5/2[642])^2]$, $\alpha=+1/2$ band (2001Sc49). MAB band. Participation of (ν 1/2[521]) supported by similarity of Routhian with that for 1/2[521] band in ^{171}Hf for $300<\hbar\omega<475$. Band crossing at $\hbar\omega=490$ keV may involve aligned proton pair.

^j Band(G): $\pi=+$, $\alpha=+1/2$ 3-quasineutron band (2001Sc49). Configuration: $\nu[(5/2[642])(1/2[521])(5/2[523])]$ (AMF band). In-band B(E2) values possibly enhanced by presence of coupling to 5/2[642] γ -vibration band.

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Hf})$									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\&$	E_f	J_f^π	Mult. ^b	δ^b	α^c	Comments
28.80	(7/2) ⁺	28.80 [‡] 4	100	0.0	5/2 ⁻	E1 [‡]		2.003 29	B(E1)(W.u.)=3.8×10 ⁻⁵ +9-11
36.70	(9/2 ⁺)	(6.4 5)	100	28.80	(7/2) ⁺				E _γ : γ not observed; deduced from the difference of E _γ =73.7 5 and E _γ =67.3 1 depopulating the 104 keV level.
38.18	(5/2 ⁺)	38.18 [‡] 4	100	0.0	5/2 ⁻	(E1) [‡]		0.922 13	
59.16	(5/2 ⁻)	59.1 1	100	0.0	5/2 ⁻				
77.76	(7/2) ⁻	77.8 1	100	0.0	5/2 ⁻				
104.00	(11/2 ⁺)	67.3 1	100 20	36.70	(9/2 ⁺)				
		73.7 5	57 13	28.80	(7/2) ⁺				E _γ : unweighted average of 74.1 2 from (⁴⁴ Ca,5nγ) and 73.2 2 from (¹⁴ N,4nγ).
144.74	(13/2 ⁺)	108.1 3	100	36.70	(9/2 ⁺)	(E2)		2.61 5	E _γ : unweighted average of 108.4 2 from (⁴⁴ Ca,5nγ) and 107.8 1 from (¹⁴ N,4nγ).
158.79	(7/2 ⁻)	99.6 1	100 12	59.16	(5/2 ⁻)	(M1+E2)		3.82 24	E _γ ,Mult.: for doublet dominated by this transition.
		158.9 1	≤56 ^a	0.0	5/2 ⁻				
177.14	(9/2) ⁻	99.2 [@] 2	7.8 [@] 11	77.76	(7/2) ⁻	[M1,E2]		3.87 24	
		148.4 1	33.0 [@] 22	28.80	(7/2) ⁺	(E1(+M2))		0.21 8	Mult.: D(+Q) from (¹⁴ N,4nγ); Δπ=(yes) from band structure.
		177.1 1	100.0 [@] 11	0.0	5/2 ⁻	(E2)		0.434 6	
288.73	(9/2 ⁻)	130.0 1	100 10	158.79	(7/2 ⁻)	(M1+E2)	-2 2	1.4 5	δ: -4.0≤δ≤-0.05 from γ(θ) in (¹⁴ N,4nγ). 0.35 10 based on branching and rotational model if K=5/2.
		229.3 3	60 6	59.16	(5/2 ⁻)	(E2)		0.1832 27	
		288.5 2	18 3	0.0	5/2 ⁻				
302.67	(11/2) ⁻	125.3 [@] 2	8.6 [@] 18	177.14	(9/2) ⁻				
		225.0 1	100 [@] 4	77.76	(7/2) ⁻				
311.17	(15/2 ⁺)	166.5 1	63 [@] 4	144.74	(13/2 ⁺)	(M1+E2)	-0.8 1	0.783 27	Other I _γ : 112 11 in (¹⁴ N,4nγ).
		207.1 1	100.0 [@] 8	104.00	(11/2 ⁺)	(E2)		0.256 4	
363.40	(17/2 ⁺)	218.6 1	100	144.74	(13/2 ⁺)	(E2)		0.2141 30	
442.87	(11/2 ⁻)	154.1 1	100 10	288.73	(9/2 ⁻)	(M1+E2)	-3 3	0.8 4	δ: -6.0≤δ≤-0.03 from γ(θ) in (¹⁴ N,4nγ). 0.22 7 based on branching and rotational model if K=5/2.
		284.1 1	57 9	158.79	(7/2 ⁻)	(E2)		0.0934 13	
444.20	(13/2) ⁻	141 [#]		302.67	(11/2) ⁻				
		267.1 1	100	177.14	(9/2) ⁻	(E2)		0.1129 16	
613.83	(15/2) ⁻	169.7 [@] 2	3.0 [@] 3	444.20	(13/2) ⁻				
		311.2 1	100 [@] 9	302.67	(11/2) ⁻	(E2)		0.0710 10	
622.17	(13/2 ⁻)	179.3 1	100 10	442.87	(11/2 ⁻)	(M1+E2)	≤0	0.764 11	δ: -10≤δ≤+0.02 from γ(θ) in (¹⁴ N,4nγ). 0.18 5 based on branching and rotational model if K=5/2.
		333.4 4	81 8	288.73	(9/2 ⁻)	(E2)		0.0580 8	
641.96	(19/2 ⁺)	278.5 1	39.2 [@] 17	363.40	(17/2 ⁺)	(M1+E2)	-1.0 5	0.16 4	

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Hf})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\&$	E_f	J_f^π	Mult. ^b	δ^b	α^c	Comments
641.96	(19/2 ⁺)	330.8 1	100.0 [@] 7	311.17 (15/2 ⁺)	(E2)			0.0593 8	
689.67	(21/2 ⁺)	326.3 1	100	363.40 (17/2 ⁺)	(E2)			0.0618 9	
790.40	(17/2) ⁻	176 [#]		613.83 (15/2) ⁻					
		346.2 1	100	444.20 (13/2) ⁻	(E2)			0.0520 7	
		479 [#]		311.17 (15/2 ⁺)					
820.47	(15/2) ⁻	198.3 1	$\leq 340^a$	622.17 (13/2) ⁻					
		377.6 1	100 10	442.87 (11/2) ⁻	(E2)			0.0407 6	
997.97	(19/2) ⁻	207.5 [@] 2	11.3 [@] 11	790.40 (17/2) ⁻					
		384.4 2	100.0 [@] 17	613.83 (15/2) ⁻	(E2)			0.0387 5	E_γ : weighted average of 384.3 2 from (⁴⁴ Ca,5n γ) and 384.5 2 from (¹⁴ N,4n γ).
		634 [#]		363.40 (17/2 ⁺)					
1028.5	(17/2) ⁻	406.2 [#] 4	100	622.17 (13/2) ⁻					
1079.93	(23/2 ⁺)	390.3 2	15.5 [@] 6	689.67 (21/2 ⁺)	(M1+E2)	-1.0 5		0.065 16	
		437.9 1	100 [@] 6	641.96 (19/2 ⁺)	(E2)			0.0272 4	
1113.03	(25/2 ⁺)	423.4 1	100	689.67 (21/2 ⁺)	(E2)			0.0298 4	
1201.58	(21/2) ⁻	411.2 1	100	790.40 (17/2) ⁻	(E2)			0.0322 5	
		560 [#]		641.96 (19/2 ⁺)					
1443.13	(23/2) ⁻	241.4 [@] 2	1.4 [@] 3	1201.58 (21/2) ⁻					
		445.2 1	100 [@] 9	997.97 (19/2) ⁻	(E2)			0.0261 4	
		752 [#]		689.67 (21/2 ⁺)					
1472.5	(21/2) ⁻	443.9 [#] 4	100	1028.5 (17/2) ⁻					
1608.00	(27/2 ⁺)	495.1 [@] 2	13 [@] 3	1113.03 (25/2 ⁺)					
		528.0 1	100.0 [@] 7	1079.93 (23/2 ⁺)	(E2)			0.01689 24	
1618.40	(29/2 ⁺)	505.4 1	100	1113.03 (25/2 ⁺)	(E2)			0.01883 26	
1662.12	(25/2) ⁻	460.6 1	100	1201.58 (21/2) ⁻	(E2)			0.02386 33	
		583 [#]		1079.93 (23/2 ⁺)					
1734.29	(15/2 ⁺)	1092.8 [#] 4	82 [#] 18	641.96 (19/2 ⁺)					
		1290.1 [#] 4	46 [#] 9	444.20 (13/2) ⁻					
		1370.5 [#] 4	≈ 9 [#]	363.40 (17/2 ⁺)					
		1423.0 [#] 4	100 [#] 18	311.17 (15/2 ⁺)					
1867.2	(17/2 ⁺)	132.9 [#] 4	100	1734.29 (15/2 ⁺)					
1908.64	(25/2) ⁻	436.0 [#] 4	100 [#] 33	1472.5 (21/2) ⁻					
		707.0 [#] 4	56 [#] 22	1201.58 (21/2) ⁻					
1940.78	(27/2) ⁻	278.9 [@] 2	6.7 [@] 7	1662.12 (25/2) ⁻					

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Hf})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\&$	E_f	J_f^π	Mult. ^b	α^c	Comments
1940.78	(27/2) ⁻	497.6 2	100 [@] 17	1443.13 (23/2) ⁻	(E2)	0.01958 27		
		825 [#]		1113.03 (25/2 ⁺)				E_γ : fits placement poorly; $E_\gamma=828$ expected from level energy difference.
1953.2	(21/2) ⁻	873.6 [#] 4	100 [#] 11	1079.93 (23/2 ⁺)	(D)			
		1310.9 [#] 4	19 [#] 7	641.96 (19/2 ⁺)				
2012.8	(19/2 ⁺)	145.6 [#] 4	90 [#] 20	1867.2 (17/2 ⁺)				
		278.5 [#] 4	100 [#] 20	1734.29 (15/2 ⁺)				
2127.2	(25/2) ⁻	1047.1 [#] 4	100	1079.93 (23/2 ⁺)				
2141.1	(23/2) ⁻	187.9 [#] 4	100	1953.2 (21/2) ⁻				
2153.63	(29/2) ⁻	491.6 [@] 2	100	1662.12 (25/2) ⁻	(E2)	0.02019 28		Other E_γ : 490.2 5 in (¹⁴ N,4n γ).
		546 [#]		1608.00 (27/2 ⁺)				
2188.20	(33/2 ⁺)	569.7 2	100	1618.40 (29/2 ⁺)	(E2)	0.01404 20		
2191.6	(21/2 ⁺)	178.8 4	100 13	2012.8 (19/2 ⁺)				
		324.4 4	31 6	1867.2 (17/2 ⁺)				
2210.88	(31/2 ⁺)	592.9 [@] 2	12.0 [@] 24	1618.40 (29/2 ⁺)				
		602.7 2	100 [@] 3	1608.00 (27/2 ⁺)	(E2)	0.01228 17		
2357.7	(25/2) ⁻	216.6 [#] 4	100 [#] 7	2141.1 (23/2) ⁻				
		404.5 [#] 4	42 [#] 7	1953.2 (21/2) ⁻				
2380.23	(29/2) ⁻	471.4 [#] 4	100 [#] 25	1908.64 (25/2) ⁻				
		718.0 [#] 4	67 [#] 25	1662.12 (25/2) ⁻				
2384.3	(23/2 ⁺)	192.7 [#] 4	100 [#] 18	2191.6 (21/2 ⁺)				
		371.5 [#] 4	46 [#] 9	2012.8 (19/2 ⁺)				
2484.21	(31/2) ⁻	330.6 [@] 2	23 [@] 5	2153.63 (29/2) ⁻				
		543.5 2	100.0 [@] 24	1940.78 (27/2) ⁻	(E2)	0.01573 22		
		864 [#]		1618.40 (29/2 ⁺)				
2525.4	(29/2) ⁻	398.0 [#] 4	33 [#] 11	2127.2 (25/2) ⁻				
		917.3 [#] 4	100 [#] 11	1608.00 (27/2 ⁺)	D			
2597.7	(27/2) ⁻	240.0 [#] 4	100 [#] 8	2357.7 (25/2) ⁻				
		456.6 [#] 4	81 [#] 8	2141.1 (23/2) ⁻				
2597.8	(25/2 ⁺)	213.5 [#] 4	100 [#] 11	2384.3 (23/2 ⁺)				
		406.2 [#] 4	22 [#] 6	2191.6 (21/2 ⁺)				
2667.26	(33/2) ⁻	513.7 [@] 2	100	2153.63 (29/2) ⁻				
2684.1	(31/2) ⁻	1065.2 [#] 4	100	1618.40 (29/2 ⁺)				
2803.74	(37/2 ⁺)	615.6 2	100	2188.20 (33/2 ⁺)				

Adopted Levels, Gammas (continued)

						$\gamma(^{169}\text{Hf})$ (continued)			Comments
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\&$	E_f	J_f^π	Mult. ^b	α^c		
2840.6	(27/2 ⁺)	242.8 [#] 4	100 [#] 5	2597.8	(25/2 ⁺)				
		456.3 [#] 4	55 [#] 5	2384.3	(23/2 ⁺)				
2857.2	(29/2 ⁻)	259.5 [#] 4	100 [#] 9	2597.7	(27/2 ⁻)				
		499.5 [#] 4	27 [#] 9	2357.7	(25/2 ⁻)				
2874.39	(35/2 ⁺)	663.7 [@] 2	100 [@] 5	2210.88	(31/2 ⁺)				
		686.0 ^{@d} 2	22 [@] 7	2188.20	(33/2 ⁺)				
2914.14	(33/2 ⁻)	533.6 [#] 4	100 [#] 20	2380.23	(29/2 ⁻)				
		760.5 [#] 4	45 [#] 15	2153.63	(29/2 ⁻)				
2969.5	(33/2 ⁻)	443.9 [#] 4	100 [#] 10	2525.4	(29/2 ⁻)				
		758.8 [#] 4	53 [#] 5	2210.88	(31/2 ⁺)				
3065.68	(35/2 ⁻)	581.5 [@] 2	100	2484.21	(31/2 ⁻)				
3107.3	(29/2 ⁺)	266.7 [#] 4	100 [#] 11	2840.6	(27/2 ⁺)				
		509.5 [#] 4	61 [#] 11	2597.8	(25/2 ⁺)				
3134.4	(31/2 ⁻)	277.2 [#] 4	100 [#] 10	2857.2	(29/2 ⁻)				
		536.7 [#] 4	65 [#] 10	2597.7	(27/2 ⁻)				
3180.1	(35/2 ⁻)	495.5 [#] 4	100 [#] 38	2684.1	(31/2 ⁻)				
		992.0 [#] 4	88 [#] 38	2188.20	(33/2 ⁺)				
3220.53	(37/2 ⁻)	553.3 [@] 2	100	2667.26	(33/2 ⁻)				
3395.6	(31/2 ⁺)	288.3 [#] 4	100 [#] 7	3107.3	(29/2 ⁺)				
		555.1 [#] 4	67 [#] 20	2840.6	(27/2 ⁺)				
3425.2	(33/2 ⁻)	290.8 [#] 4	100 [#] 12	3134.4	(31/2 ⁻)				
		568.0 [#] 4	47 [#] 12	2857.2	(29/2 ⁻)				
3453.6	(41/2 ⁺)	650.0 2	100	2803.74	(37/2 ⁺)				E_γ : weighted average of 650.1 2 from (⁴⁴ Ca,5n γ) and 649.5 5 from (¹⁴ N,4n γ).
3471.7	(37/2 ⁻)	502.2 [#] 4	100	2969.5	(33/2 ⁻)				
3514.9	(37/2 ⁻)	600.4 [#] 4	100 [#] 11	2914.14	(33/2 ⁻)				
		847.8 [#] 4	26 [#] 11	2667.26	(33/2 ⁻)				
3588.4	(39/2 ⁺)	714.0 [@] 2	100	2874.39	(35/2 ⁺)	[E2]	0.00834 12	B(E2)(W.u.)=1.9×10 ² +22-8	
3672.19	(39/2 ⁻)	606.5 [@] 2	100	3065.68	(35/2 ⁻)				
3700.1	(33/2 ⁺)	304.5 [#] 4	100 [#] 14	3395.6	(31/2 ⁺)				
		592.8 [#] 4	86 [#] 14	3107.3	(29/2 ⁺)				
3728.9	(35/2 ⁻)	303.7 [#] 4	100 [#] 12	3425.2	(33/2 ⁻)				

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Hf})$ (continued)									
$E_i(\text{level})$	J_i^π	E_γ [†]	I_γ ^{&}	E_f	J_f^π	Mult. ^b	α ^c	Comments	
3728.9	(35/2 ⁻)	594.5 [#] 4	77 [#] 12	3134.4	(31/2 ⁻)				
3768.69	(39/2 ⁻)	588.3 [#] 4	93 [#] 22	3180.1	(35/2 ⁻)				
		703.1 [#] 4	57 [#] 22	3065.68	(35/2 ⁻)				
		964.9 [#] 4	100 [#] 29	2803.74	(37/2 ⁺)				
3832.8	(41/2 ⁻)	612.3 [@] 2	100	3220.53	(37/2 ⁻)				
4020.3	(35/2 ⁺)	320.2 [#] 4	100 [#] 8	3700.1	(33/2 ⁺)				
		624.6 [#] 4	77 [#] 23	3395.6	(31/2 ⁺)				
4041.4	(41/2 ⁺)	587.9 [#] 4	<50 [#]	3453.6	(41/2 ⁺)				
		1237.4 [#] 4	100 [#] 33	2803.74	(37/2 ⁺)				
4041.5	(37/2 ⁻)	312.6 [#] 4	100 [#] 12	3728.9	(35/2 ⁻)				
		616.3 [#] 4	77 [#] 12	3425.2	(33/2 ⁻)				
4053.4	(41/2 ⁻)	581.7 [#] 4	100	3471.7	(37/2 ⁻)				
4141.2	(45/2 ⁺)	687.8 [@] 2	100	3453.6	(41/2 ⁺)	[E2]	0.00906 13	B(E2)(W.u.)=226 +48-33	
4155.8	(41/2 ⁻)	640.9 [#] 4	100 [#] 17	3514.9	(37/2 ⁻)				
		935.4 [#] 4	24 [#] 10	3220.53	(37/2 ⁻)				
4320.6	(43/2 ⁻)	648.4 [@] 2	100	3672.19	(39/2 ⁻)	[E2]	0.01036 15	B(E2)(W.u.)=4.4×10 ² +24-16	
4343.2	(43/2 ⁺)	754.8 [@] 2	100	3588.4	(39/2 ⁺)	[E2]	0.00738 10	B(E2)(W.u.)=2.1×10 ² +17-8	
4350.5	(37/2 ⁺)	330.2 [#] 4	100 [#] 21	4020.3	(35/2 ⁺)				
		650.3 [#] 4	86 [#] 14	3700.1	(33/2 ⁺)				
4361.1	(39/2 ⁻)	319.6 [#] 4	100 [#] 17	4041.5	(37/2 ⁻)				
		632.2 [#] 4	92 [#] 17	3728.9	(35/2 ⁻)				
4442.0	(43/2 ⁻)	673.0 [#] 4	100 [#] 18	3768.69	(39/2 ⁻)				
		988.4 [#] 4	29 [#] 11	3453.6	(41/2 ⁺)				
4510.4	(45/2 ⁻)	677.6 [@] 2	100	3832.8	(41/2 ⁻)	[E2]	0.00938 13	B(E2)(W.u.)=3.1×10 ² +7-5	
4685.4	(39/2 ⁺)	334.9 [#] 4	100 [#] 10	4350.5	(37/2 ⁺)				
		665.1 [#] 4	80 [#] 30	4020.3	(35/2 ⁺)				
4688.1	(41/2 ⁻)	327.0 [#] 4	100 [#] 21	4361.1	(39/2 ⁻)				
		646.6 [#] 4	90 [#] 21	4041.5	(37/2 ⁻)				
4706.1	(45/2 ⁻)	652.7 [#] 4	100	4053.4	(41/2 ⁻)				
4730.0	(45/2 ⁺)	588.9 [#] 4	<38 [#]	4141.2	(45/2 ⁺)				
		688.2 [#] 4	100 [#] 38	4041.5	(37/2 ⁻)				
		1276.2 4	75 25	3453.6	(41/2 ⁺)				

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Hf})$ (continued)								
$E_i(\text{level})$	J_i^π	E_γ [†]	I_γ ^{&}	E_f	J_f^π	Mult. ^b	α ^c	Comments
4827.5	(45/2 ⁻)	671.7 [#] 4	100	4155.8	(41/2 ⁻)			
4882.4	(49/2 ⁺)	741.2 [@] 2	100	4141.2	(45/2 ⁺)	[E2]	0.00768 11	B(E2)(W.u.)=2.5×10 ² +7-5
5021.0	(43/2 ⁻)	332.9 [#] 4	100 [#] 13	4688.1	(41/2 ⁻)			
		659.9 [#] 4	93 [#] 20	4361.1	(39/2 ⁻)			
5027.4	(41/2 ⁺)	342.0 [#] 4	100 [#] 29	4685.4	(39/2 ⁺)			
		676.9 [#] 4	71 [#] 29	4350.5	(37/2 ⁺)			
5034.9	(47/2 ⁻)	714.3 [@] 2	100	4320.6	(43/2 ⁻)	[E2]	0.00833 12	B(E2)(W.u.)=2.6×10 ² +23-9
5131.8	(47/2 ⁺)	788.6 [@] 2	100	4343.2	(43/2 ⁺)	[E2]	0.00671 9	B(E2)(W.u.)=2.2×10 ² +11-6
5174.2	(47/2 ⁻)	732.0 [#] 4	100 [#] 15	4442.0	(43/2 ⁻)			
		1033.2 [#] 4	24 [#] 9	4141.2	(45/2 ⁺)			
5250.4	(49/2 ⁻)	740.0 [@] 2	100	4510.4	(45/2 ⁻)	[E2]	0.00770 11	B(E2)(W.u.)=3.5×10 ² +16-10
5361.7	(45/2 ⁻)	340.7 [#] 4	100 [#] 33	5021.0	(43/2 ⁻)			
		673.6 [#] 4	100 [#] 33	4688.1	(41/2 ⁻)			
5371.3	(43/2 ⁺)	343.9 [#] 4	100 [#] 33	5027.4	(41/2 ⁺)			
		685.9 [#] 4	83 [#] 33	4685.4	(39/2 ⁺)			
5424.7	(49/2 ⁻)	718.6 [#] 4	100	4706.1	(45/2 ⁻)			
5495.9	(49/2 ⁺)	765.7 [#] 4	100 [#] 31	4730.0	(45/2 ⁺)			
		1354.6 [#] 4	69 [#] 23	4141.2	(45/2 ⁺)			
5544.3	(49/2 ⁻)	716.8 [#] 4	100 [#]	4827.5	(45/2 ⁻)			
5689.1	(53/2 ⁺)	806.8 [@] 2	100	4882.4	(49/2 ⁺)	[E2]	0.00639 9	B(E2)(W.u.)=5.4×10 ² +33-15
5711.7	(47/2 ⁻)	350.0 4	100 22	5361.7	(45/2 ⁻)			
		690.7 4	89 22	5021.0	(43/2 ⁻)			
5817.7	(51/2 ⁻)	782.8 [@] 2	100	5034.9	(47/2 ⁻)	[E2]	0.00682 10	B(E2)(W.u.)=3.1×10 ² +12-7
5956.2	(51/2 ⁻)	782.0 [#] 4	100	5174.2	(47/2 ⁻)			
5957.5	(51/2 ⁺)	825.7 [@] 2	100	5131.8	(47/2 ⁺)	[E2]	0.00608 9	B(E2)(W.u.)=1.9×10 ² +22-8
6045.9	(53/2 ⁻)	795.5 [@] 2	100	5250.4	(49/2 ⁻)	[E2]	0.00658 9	B(E2)(W.u.)=6.5×10 ² +46-20
								B(E2)(W.u.)=6.5×10 ² +46-20 upper bound exceeds RUL=1000.
6077.5	(49/2 ⁻)	365.8 [#] 4	89 [#] 33	5711.7	(47/2 ⁻)			
		715.8 [#] 4	100 [#] 33	5361.7	(45/2 ⁻)			
6097.9	(47/2 ⁺)	726.6 [#] 4	100	5371.3	(43/2 ⁺)			
6212.8	(53/2 ⁻)	788.1 [#] 4	100	5424.7	(49/2 ⁻)			
6309.5	(53/2 ⁺)	813.3 [#] 4	100 [#] 24	5495.9	(49/2 ⁺)			
		1427.1 [#] 4	38 [#] 14	4882.4	(49/2 ⁺)			

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Hf})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\&$	E_f	J_f^π	Mult. ^b	α^c	Comments	
6326.3	(53/2 ⁻)	781.9 [#] 4	100	5544.3	(49/2 ⁻)				
6455.4	(51/2 ⁻)	377.9 [#] 4	100 [#] 33	6077.5	(49/2 ⁻)				
		743.7 [#] 4	83 [#] 33	5711.7	(47/2 ⁻)				
6565.4	(57/2 ⁺)	876.3 [@] 2	100	5689.1	(53/2 ⁺)	[E2]	0.00536 8	B(E2)(W.u.)=1.8×10 ² +13-5	
6667.6	(55/2 ⁻)	849.9 [@] 2	100	5817.7	(51/2 ⁻)				
6790.2	(55/2 ⁻)	834.0 [#] 4	100	5956.2	(51/2 ⁻)				
6830.0	(55/2 ⁺)	872.5 [@] 2	100	5957.5	(51/2 ⁺)				
6854.3	(53/2 ⁻)	398.9 [#] 4	80 [#] 40	6455.4	(51/2 ⁻)				
		776.8 [#] 4	100 [#] 40	6077.5	(49/2 ⁻)				
6895.1	(57/2 ⁻)	849.2 [@] 2	100	6045.9	(53/2 ⁻)	[E2]	0.00573 8	B(E2)(W.u.)=2.6×10 ² +19-8	
7076.4	(57/2 ⁻)	863.6 [#] 4	100	6212.8	(53/2 ⁻)				
7170.8	(57/2 ⁺)	860.9 [#] 4	100 [#] 20	6309.5	(53/2 ⁺)				
		1482.1 [#] 4	<20 [#]	5689.1	(53/2 ⁺)				
7179.8	(57/2 ⁻)	853.5 [#] 4	100	6326.3	(53/2 ⁻)				
7509.3	(61/2 ⁺)	943.9 [@] 2	100	6565.4	(57/2 ⁺)	[E2]	0.00460 6	B(E2)(W.u.)=1.5×10 ² +8-4	
7581.4	(59/2 ⁻)	913.8 2	100	6667.6	(55/2 ⁻)			E _γ : weighted average of 914.0 4 from (⁷⁶ Ge,3nγ) and 913.7 2 from (⁴⁴ Ca,5nγ).	
7677.2	(59/2 ⁻)	887.0 [#] 4	100	6790.2	(55/2 ⁻)				
7751.4	(59/2 ⁺)	921.4 [#] 4	100	6830.0	(55/2 ⁺)			E _γ : other: 917.4 2 in (⁴⁴ Ca,5nγ).	
7806.4	(61/2 ⁻)	911.3 [@] 2	100	6895.1	(57/2 ⁻)	[E2]	0.00494 7	B(E2)(W.u.)=1.5×10 ² +13-6	
8009.9	(61/2 ⁻)	933.5 [#] 4	100	7076.4	(57/2 ⁻)				
8088.9	(61/2 ⁺)	918.1 [#] 4	100	7170.8	(57/2 ⁺)				
8099.1	(61/2 ⁻)	919.3 [#] 4	100	7179.8	(57/2 ⁻)				
8514.7	(65/2 ⁺)	1005.4 [@] 2	100	7509.3	(61/2 ⁺)				
8539.2	(63/2 ⁻)	957.8 [@] 2	100	7581.4	(59/2 ⁻)				
8569.0	(63/2 ⁻)	891.8 [#] 4	100	7677.2	(59/2 ⁻)				
8717.5	(63/2 ⁺)	966.1 [#] 4	100	7751.4	(59/2 ⁺)				
8784.9	(65/2 ⁻)	978.4 [@] 2	100	7806.4	(61/2 ⁻)				
8996.9	(65/2 ⁻)	987.0 [#] 4	100	8009.9	(61/2 ⁻)				
9054.3	(65/2 ⁺)	965.4 [#] 4	100	8088.9	(61/2 ⁺)				
9405.3	(67/2 ⁻)	866.1 [#] 4	100	8539.2	(63/2 ⁻)			E _γ : note that, in ¹³⁰ Te(⁴⁴ Ca,5nγ), E _γ =1004.8 2 was proposed for this 67/2 to 63/2 transition.	
9574.9	(69/2 ⁺)	1060.2 [@] 2	100	8514.7	(65/2 ⁺)			E _γ : other: 1059.2 4 from (⁷⁶ Ge,3nγ).	

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Hf})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\&$	E_f	J_f^π	Comments
9719.1?	(67/2 ⁺)	1001.6 ^d 4	100	8717.5	(63/2 ⁺)	
9826.8	(69/2 ⁻)	1041.9 [@] 2	100	8784.9	(65/2 ⁻)	E_γ : other: 1040.8 4 from (⁷⁶ Ge,3n γ).
9995.6?	(69/2 ⁻)	998.7 ^{#d} 4	100	8996.9	(65/2 ⁻)	
10294.6	(71/2 ⁻)	889.3 [#] 4	100	9405.3	(67/2 ⁻)	
10676.9	(73/2 ⁺)	1102.0 [@] 2	100	9574.9	(69/2 ⁺)	Other E_γ : 1100.8 4 in (⁷⁶ Ge,3n γ).
10917.5?	(73/2 ⁻)	1090.7 ^{@d} 2	100	9826.8	(69/2 ⁻)	
11005.7?	(73/2 ⁻)	1010.1 ^{#d} 4	100	9995.6?	(69/2 ⁻)	
11232.0	(75/2 ⁻)	937.4 [#] 4	100	10294.6	(71/2 ⁻)	
11807.6	(77/2 ⁺)	1130.7 [#] 4	100	10676.9	(73/2 ⁺)	
12034.8	(77/2 ⁻)	1117.3 [#] 4	100	10917.5?	(73/2 ⁻)	
12221.4	(79/2 ⁻)	989.4 [#] 4	100	11232.0	(75/2 ⁻)	
12955.8	(81/2 ⁺)	1148.2 [#] 4	100	11807.6	(77/2 ⁺)	E_γ : other: 1146.0 2 in (⁴⁴ Ca,5n γ) (γ placed lower in cascade).
13140.8	(81/2 ⁻)	1106 [#] 1	100	12034.8	(77/2 ⁻)	
13272.4	(83/2 ⁻)	1051.0 [#] 4	100	12221.4	(79/2 ⁻)	
14115.9	(85/2 ⁺)	1160.1 [#] 4	100	12955.8	(81/2 ⁺)	
14277.8	(85/2 ⁻)	1137 [#] 1	100	13140.8	(81/2 ⁻)	
14385.1	(87/2 ⁻)	1112.7 [#] 4	100	13272.4	(83/2 ⁻)	
15294.7	(89/2 ⁺)	1178.8 [#] 4	100	14115.9	(85/2 ⁺)	E_γ : other: 1181.5 2 in (⁴⁴ Ca,5n γ) (γ placed lower in cascade).

[†] From ¹⁵⁹Tb(¹⁴N,4n γ), except where noted. A few E_γ in (⁷⁶Ge,3n γ) and (⁴⁴Ca,5n γ) differ by approximately 1 keV, the reason for this difference is not clear. In these cases, mostly the values from (⁴⁴Ca,5n γ) have been adopted for higher precision.

[‡] From ¹⁶⁹Ta ϵ decay.

[#] From ⁹⁶Zr(⁷⁶Ge,3n γ).

[@] From ¹³⁰Te(⁴⁴Ca,5n γ).

[&] Relative photon branching from each level; intensities are from ¹⁵⁹Tb(¹⁴N,4n γ), except as noted.

^a Reported as upper limit because observed γ included possible contribution from a contaminant.

^b From ¹⁵⁹Tb(¹⁴N,4n γ), except where noted. $\Delta\pi$ =(no) has been assigned to intraband Q and D(+Q) transitions.

^c Total theoretical internal conversion coefficients, calculated using the BrIcc code ([2008Ki07](#)) with "Frozen Orbitals" approximation based on γ -ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

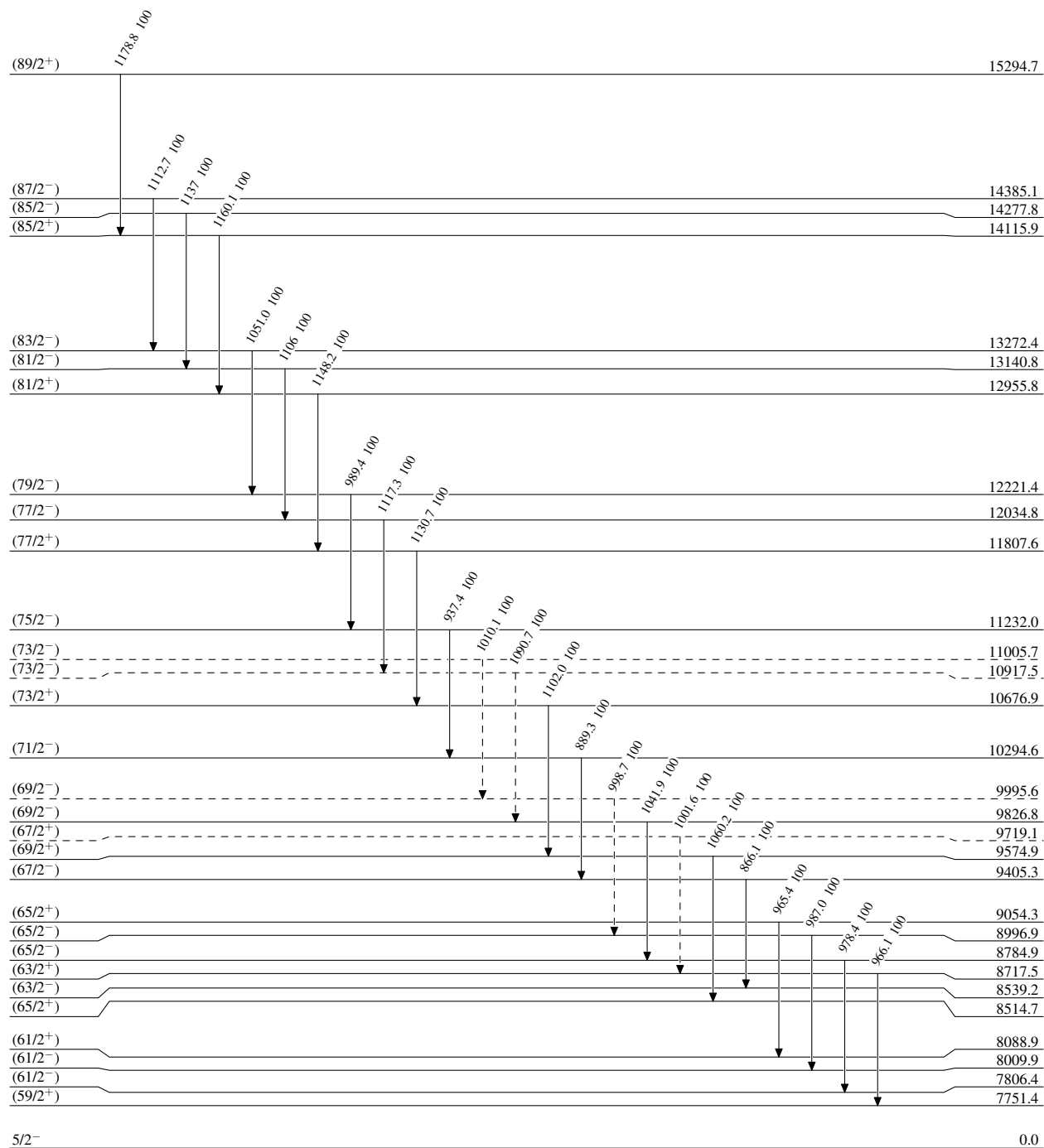
^d Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

 - - - - - $\rightarrow$ γ Decay (Uncertain)


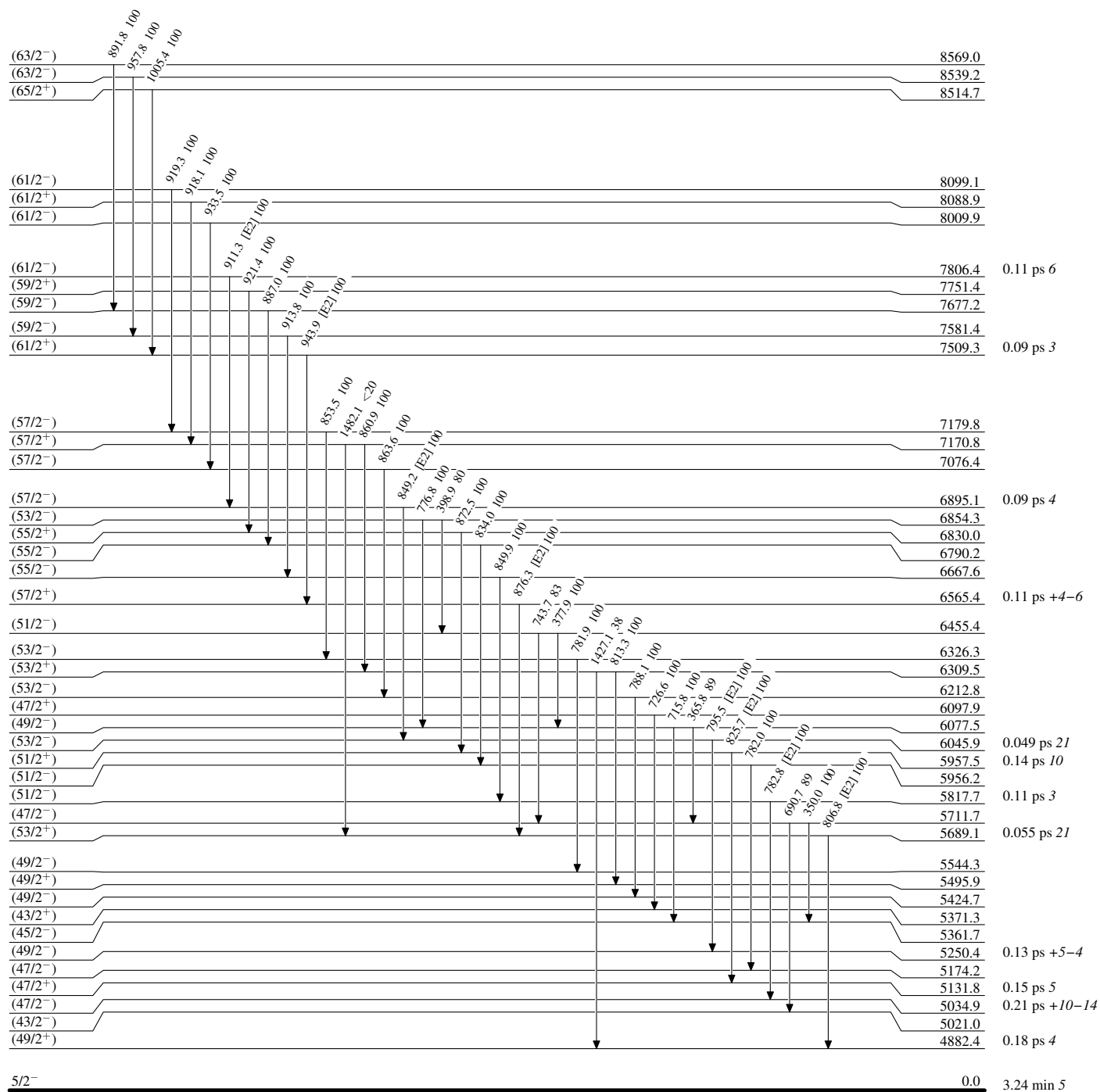
0.11 ps 6

3.24 min 5

Adopted Levels, Gammas

Level Scheme (continued)

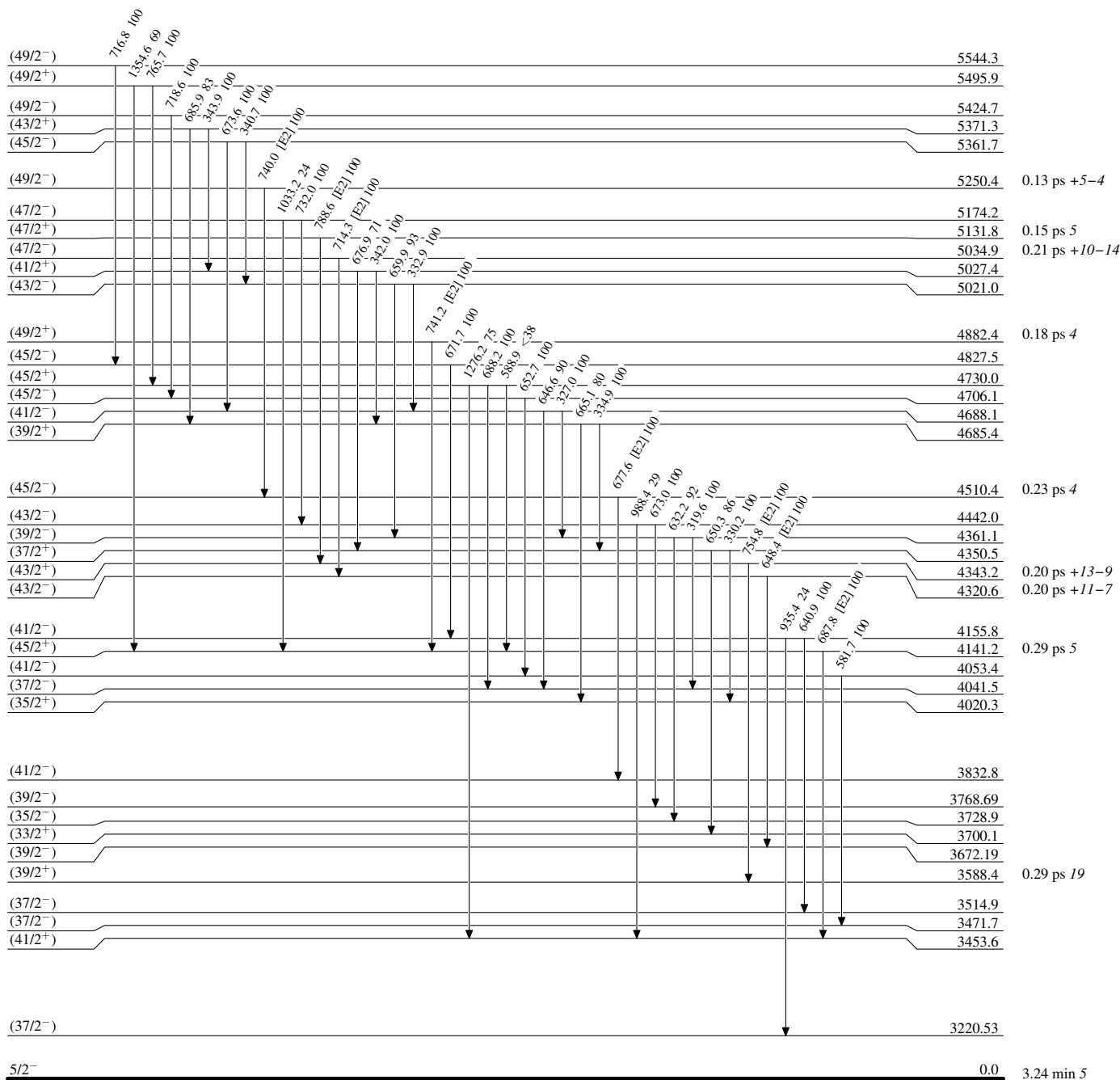
Intensities: Relative photon branching from each level



Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level



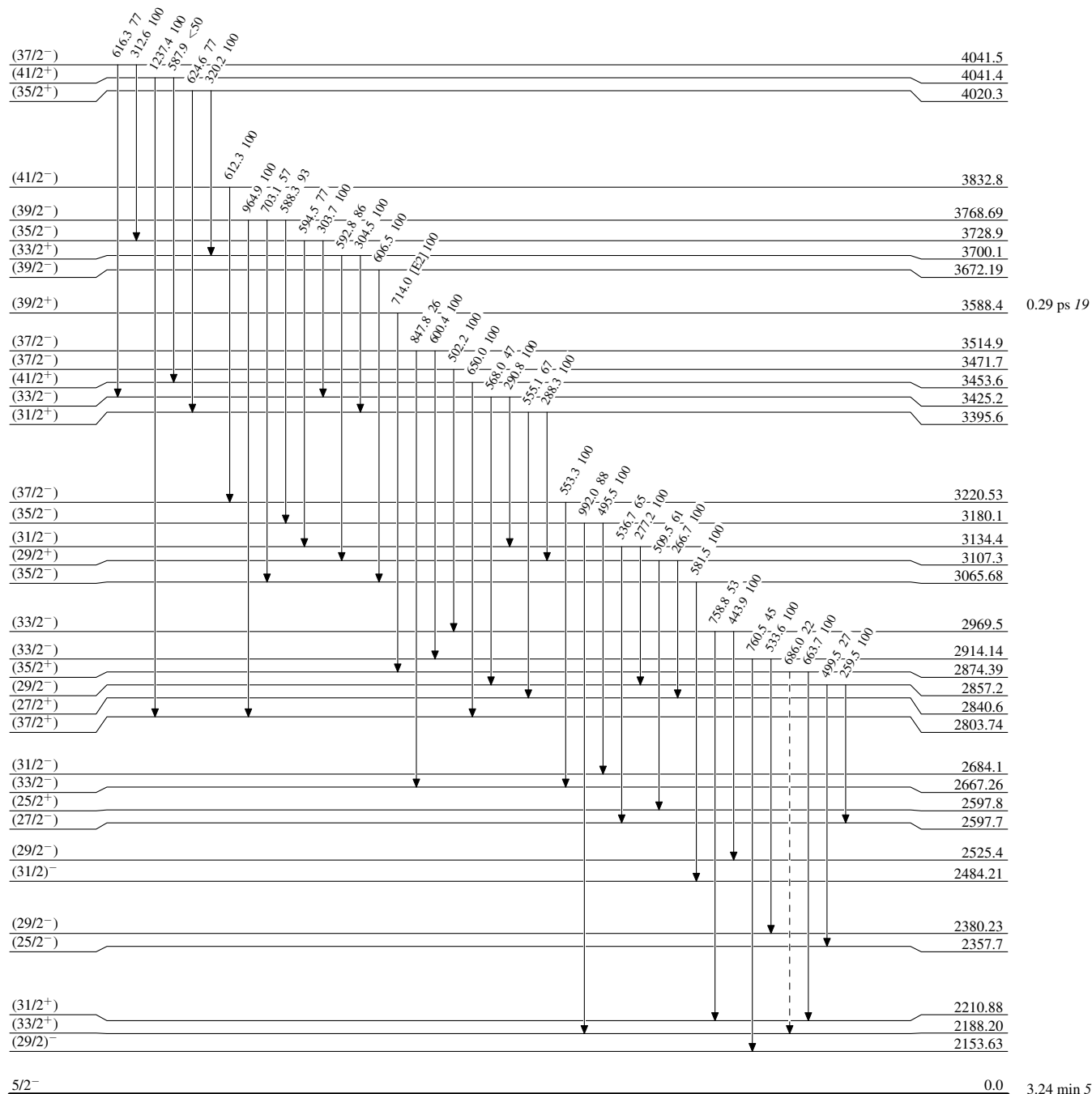
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

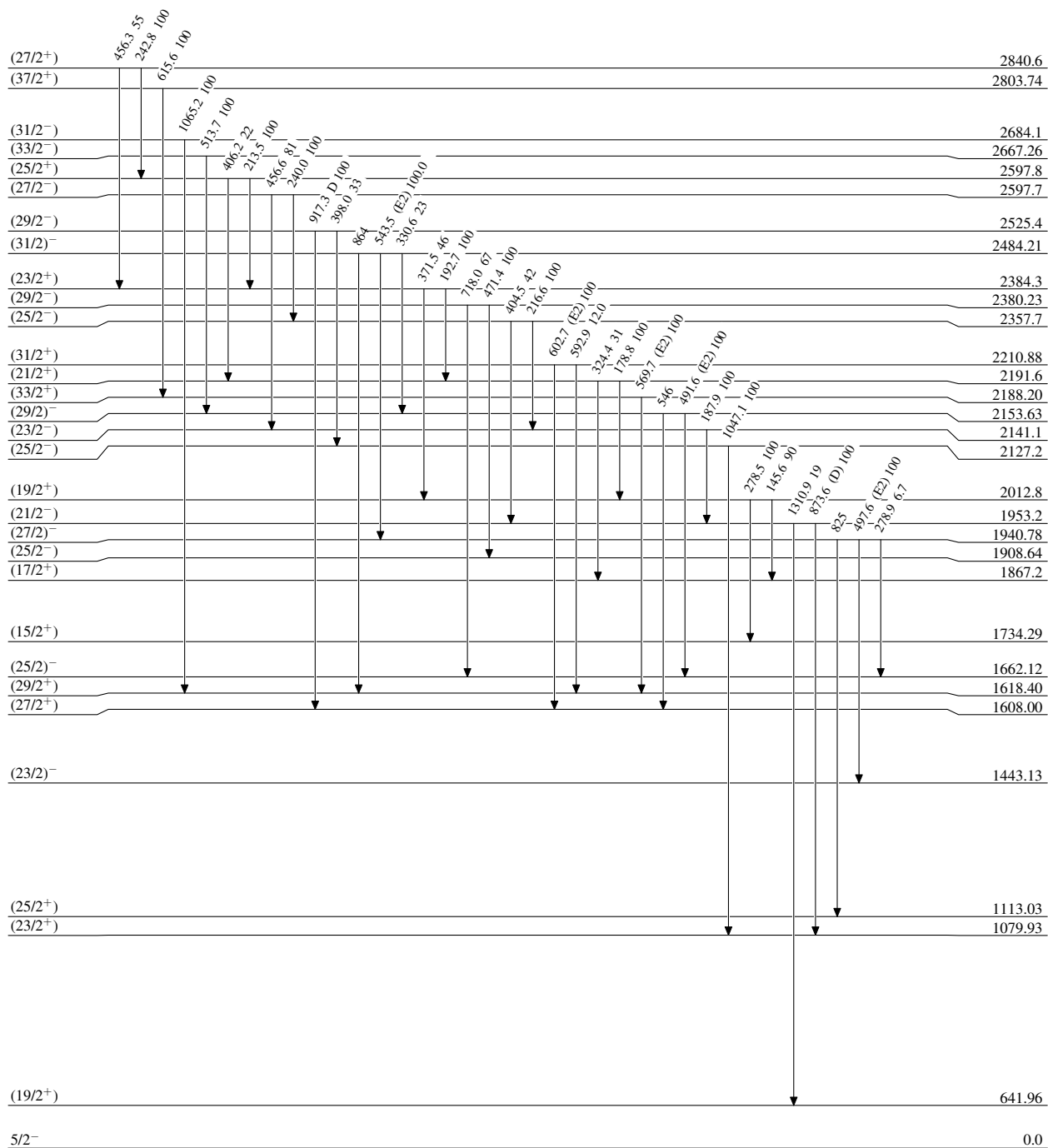
-----► γ Decay (Uncertain)



Adopted Levels, Gammas

Level Scheme (continued)

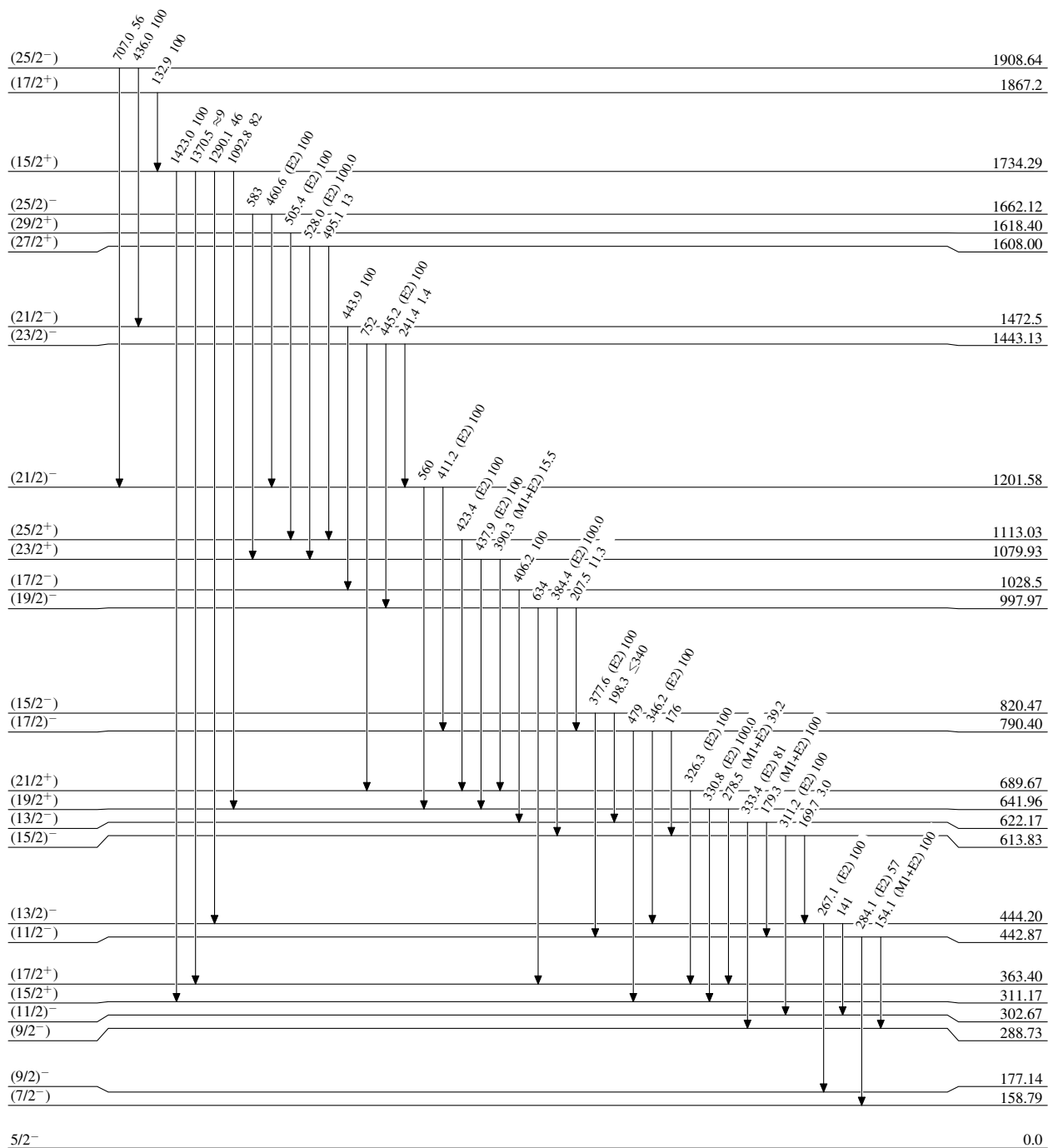
Intensities: Relative photon branching from each level



Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level



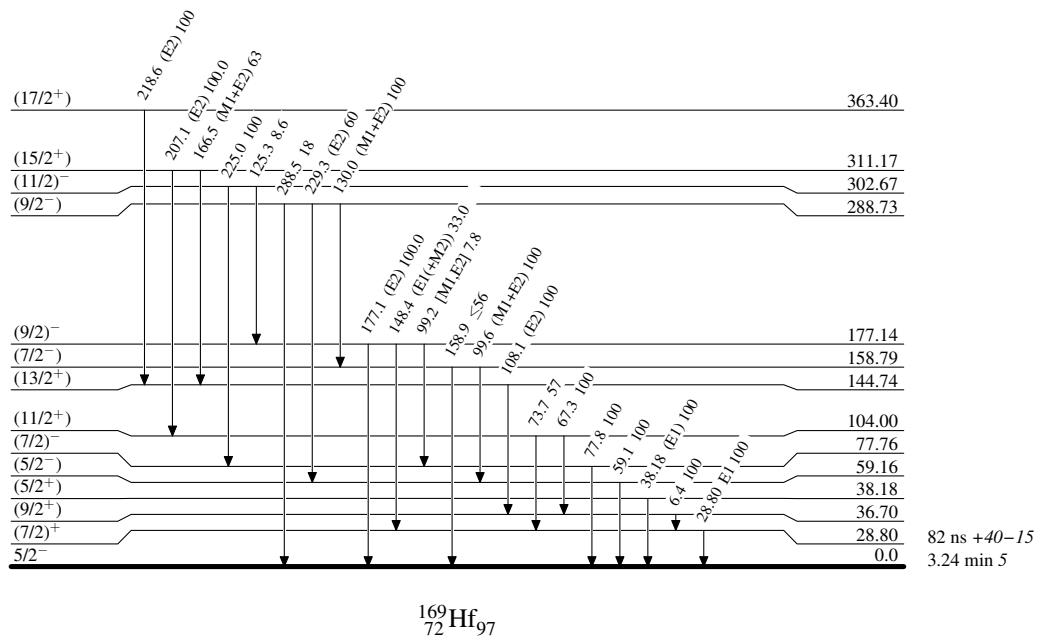
3.24 min 5

Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

 - - - - - $\blacktriangleright$ γ Decay (Uncertain)


Adopted Levels, Gammas

Band(A): 5/2[523] $\alpha=+1/2$ band (2001Sc49)		Band(a): 5/2[523] $\alpha=-1/2$ band (2001Sc49)	
(85/2 ⁻)	14277.8	(87/2 ⁻)	14385.1
1137		1113	
(81/2 ⁻)	13140.8	(83/2 ⁻)	13272.4
1106		1051	
(77/2 ⁻)	12034.8	(79/2 ⁻)	12221.4
1117		989	
(73/2 ⁻)	10917.5	(75/2 ⁻)	11232.0
1091		937	
(69/2 ⁻)	9826.8	(71/2 ⁻)	10294.6
1042		889	
(65/2 ⁻)	8784.9	(67/2 ⁻)	9405.3
978		866	
(61/2 ⁻)	7806.4	(63/2 ⁻)	8539.2
911		958	
(57/2 ⁻)	6895.1	(59/2 ⁻)	7581.4
849		914	
(53/2 ⁻)	6045.9	(55/2 ⁻)	6667.6
796		850	
(49/2 ⁻)	5250.4	(51/2 ⁻)	5817.7
740		783	
(45/2 ⁻)	4510.4	(47/2 ⁻)	5034.9
678		714	
(41/2 ⁻)	3832.8	(43/2 ⁻)	4320.6
612		648	
(37/2 ⁻)	3220.53	(39/2 ⁻)	3672.19
553		607	
(33/2 ⁻)	2667.26	(35/2 ⁻)	3065.68
514		582	
(29/2 ⁻)	2153.63	(31/2 ⁻)	2484.21
492		544	
(25/2 ⁻)	1662.12	(27/2 ⁻)	1940.78
461		498	
(21/2 ⁻)	1201.58	(23/2 ⁻)	1443.13
411		445	
(17/2 ⁻)	790.40	(19/2 ⁻)	997.97
346		384	
(13/2 ⁻)	444.20	(15/2 ⁻)	613.83
267		311	
(9/2 ⁻)	177.14	(11/2 ⁻)	302.67
177		225	
5/2 ⁻	0.0	(7/2 ⁻)	77.76

 $^{169}_{72}\text{Hf}_{97}$

Adopted Levels, Gammas (continued)

Band(B): 5/2[642]
 $\alpha=+1/2$ band (2001Sc49)

(89/2 ⁺)	15294.7
1179	
(85/2 ⁺)	14115.9
1160	
(81/2 ⁺)	12955.8
1148	
(77/2 ⁺)	11807.6
1131	
(73/2 ⁺)	10676.9
1102	
(69/2 ⁺)	9574.9
1060	
(65/2 ⁺)	8514.7
1005	
(61/2 ⁺)	7509.3
944	
(57/2 ⁺)	6565.4
876	
(53/2 ⁺)	5689.1
807	
(49/2 ⁺)	4882.4
741	
(45/2 ⁺)	4141.2
688	
(41/2 ⁺)	3453.6
650	
(37/2 ⁺)	2803.74
616	
(33/2 ⁺)	2188.20
570	
(29/2 ⁺)	1618.40
505	
(25/2 ⁺)	1113.03
(21/2 ⁺)	689.67
423	
(17/2 ⁺)	363.40
(13/2 ⁺)	144.74
326	
(9/2 ⁺)	38.18
219	
(5/2 ⁺)	36.70
108	
(1/2 ⁺)	28.80

Band(b): 5/2[642]
 $\alpha=-1/2$ band (2001Sc49)

(67/2 ⁺)	9719.1
1002	
(63/2 ⁺)	8717.5
966	
(59/2 ⁺)	7751.4
921	
(55/2 ⁺)	6830.0
873	
(51/2 ⁺)	5957.5
826	
(47/2 ⁺)	5131.8
789	
(43/2 ⁺)	4343.2
755	
(39/2 ⁺)	3588.4
714	
(35/2 ⁺)	2874.39
664	
(31/2 ⁺)	2210.88
603	
(27/2 ⁺)	1608.00
528	
(23/2 ⁺)	1079.93
438	
(19/2 ⁺)	641.96
331	
(15/2 ⁺)	311.17
207	
(11/2 ⁺)	104.00
74	
(7/2 ⁺)	28.80

Band(C): 5/2[512]
 $\alpha=+1/2$ band (2001Sc49)

(61/2 ⁻)	8099.1
919	
(57/2 ⁻)	7179.8
854	
(53/2 ⁻)	6326.3
782	
(49/2 ⁻)	5544.3
717	
(45/2 ⁻)	4827.5
672	
(41/2 ⁻)	4155.8
641	
(37/2 ⁻)	3514.9
600	
(33/2 ⁻)	2914.14
534	
(29/2 ⁻)	2380.23
471	
(25/2 ⁻)	1908.64
436	
(21/2 ⁻)	1472.5
444	
(17/2 ⁻)	1028.5
406	
(13/2 ⁻)	622.17
333	
(9/2 ⁻)	288.73
229	
(5/2 ⁻)	59.16

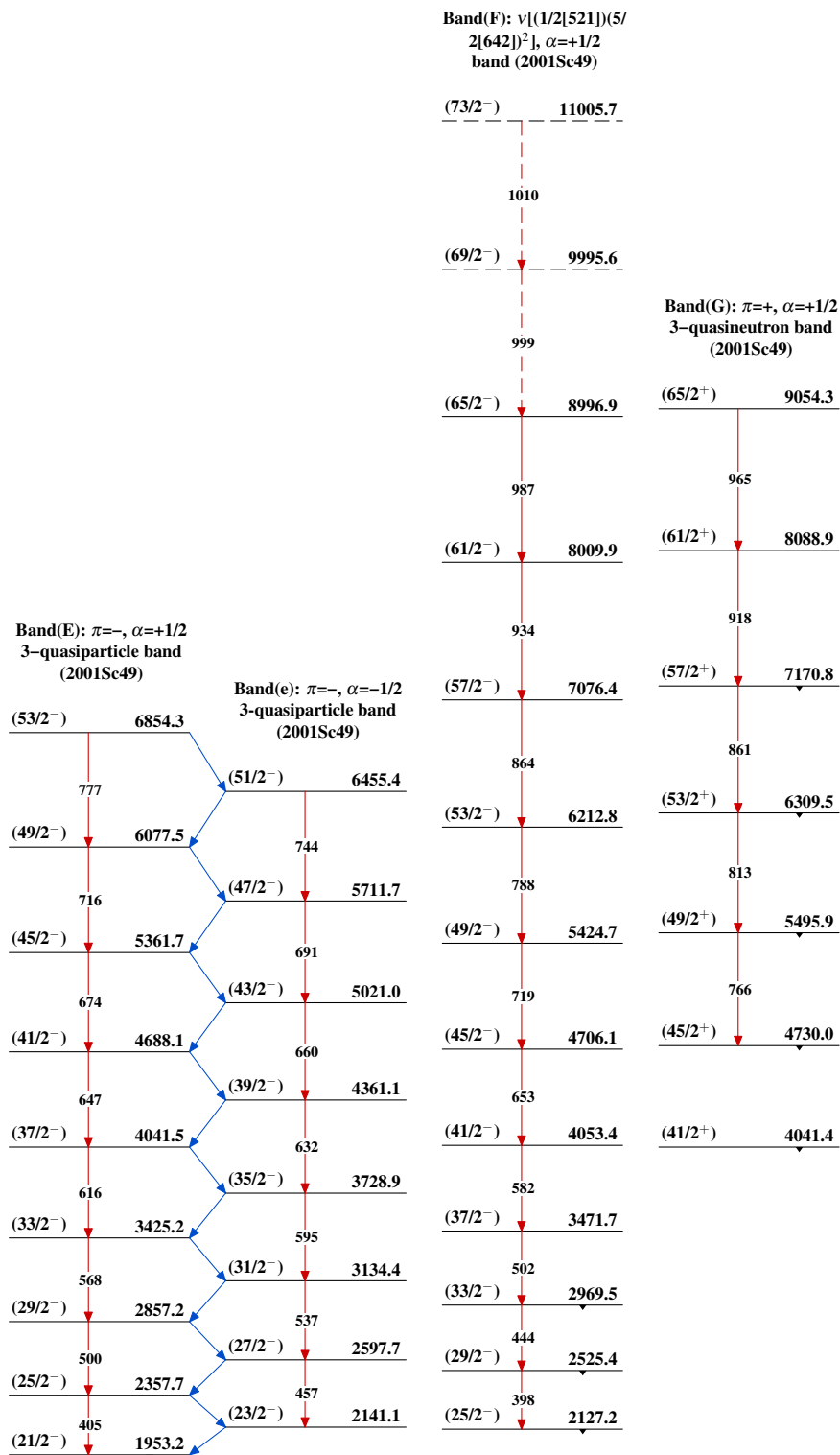
Band(c): 5/2[512]
 $\alpha=-1/2$ band (2001Sc49)

(63/2 ⁻)	8569.0
892	
(59/2 ⁻)	7677.2
887	
(55/2 ⁻)	6790.2
834	
(51/2 ⁻)	5956.2
782	
(47/2 ⁻)	5174.2
732	
(43/2 ⁻)	4442.0
673	
(39/2 ⁻)	3768.69
588	
(35/2 ⁻)	3180.1
496	
(31/2 ⁻)	2684.1
820.47	
(15/2 ⁻)	442.87
378	
(11/2 ⁻)	158.79
284	
(7/2 ⁻)	

Band(d): $\pi=+$, $\alpha=-1/2$
 3-quasiparticle band
 (2001Sc49)

(47/2 ⁺)	6097.9
727	
(43/2 ⁺)	5371.3
686	
(39/2 ⁺)	4685.4
665	
(35/2 ⁺)	4020.3
625	
(31/2 ⁺)	3395.6
555	
(27/2 ⁺)	2840.6
456	
(23/2 ⁺)	2384.3
372	
(19/2 ⁺)	2012.8
279	
(15/2 ⁺)	1734.29

Band(D): $\pi=+$, $\alpha=+1/2$ 3-quasiparticle band (2001Sc49)	5027.4
677	
(37/2 ⁺)	4350.5
650	
(33/2 ⁺)	3700.1
593	
(29/2 ⁺)	3107.3
510	
(25/2 ⁺)	2597.8
406	
(21/2 ⁺)	2191.6
324	
(17/2 ⁺)	1867.2

Adopted Levels, Gammas (continued)

^{169}Ta $\varepsilon+\beta^+$ decay (4.9 min) **1975Re05**

Parent: ^{169}Ta : $E=0.0$; $J^\pi=(5/2^+)$; $T_{1/2}=4.9$ min 5; $Q(\varepsilon)=4430$ 40; $\% \varepsilon + \% \beta^+$ decay=100.0

^{169}Ta - J^π , $T_{1/2}$: from ^{169}Ta Adopted Levels.

^{169}Ta - $Q(\varepsilon)$: from [2021Wa16](#).

The decay scheme (partial only) and all data are from [1975Re05](#). Sources from $^{159}\text{Tb}(^{16}\text{O},6n)$, $E(^{16}\text{O})=116$ MeV; metallic Tb targets (99.9% pure); measured E_γ , I_γ (Ge(Li), FWHM=2.1 keV at 1332 keV; Si(Li), FWHM=200 eV at 5.6 keV).

Others: [1969Ar22](#), [1975Gr44](#) – both measured ^{169}Ta half-life.

 ^{169}Hf Levels

<u>E(level)[†]</u>	<u>J^π[‡]</u>	<u>$T_{1/2}$[‡]</u>
0.0 [#]	$5/2^-$	3.24 min 5
28.80 4	$(7/2)^+$	82 ns +40–15
38.18 4	$(5/2^+)$	
77.7 [#] 1	$(7/2)^-$	
177.0 [#] 1	$(9/2)^-$	

[†] From E_γ ([1975Re05](#)).

[‡] From Adopted Levels.

[#] $5/2[523]$ band member.

 $\gamma(^{169}\text{Hf})$

Considerable intensity is unplaced, and origins of x-ray and $\gamma^\pm$ components, partially uncertain. It is not possible to deduce reliable absolute intensities.

$I_\gamma(\text{K x ray})$, $I_\gamma(\gamma^\pm)$ (relative to $I_\gamma(192.4\gamma)=100$):

		<u>E_γ</u>	<u>I_γ</u>
		-----	-----
Hf $\text{K}\alpha_1$	x ray	55.81 6	1350 140
Hf $\text{K}\beta_{2'}$	x ray	65.1 1	125 13
$\gamma^\pm$		511.0 1	1260 130 (see 511.0 γ below)

<u>E_γ[†]</u>	<u>I_γ[#]</u>	<u>$E_i(\text{level})$</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.[@]</u>	<u>α^{&}</u>	<u>Comments</u>
28.80 4	230 23	28.80	$(7/2)^+$	0.0	$5/2^-$	E1	2.003 29	Mult.: appreciable E1 component deduced from upper limit for total ^{169}Ta decay energy (≤ 3430 (1975Re05)), relative to $I_\gamma(28.8\gamma)$ (limit determined from x-ray and $\gamma^\pm$ intensities) (1975Re05).
38.18 4	57 6	38.18	$(5/2^+)$	0.0	$5/2^-$	(E1)	0.922 13	Mult.: see comment with 28.8 γ ; authors state preference for E1 assignment (M1 also possible), on the basis of similar, but less conclusive, argument.
^x 68.5 [‡] 1	38 8							
77.7 1	16 3	77.7	$(7/2)^-$	0.0	$5/2^-$			
(99.2)	1.9	177.0	$(9/2)^-$	77.7	$(7/2)^-$	[M1,E2]	3.87 24	E_γ : not observed (masked by 2^+ to 0^+ γ ray in ^{170}Hf). E_γ from Adopted Gammas. I_γ : I_γ from $I(177\gamma)$ and adopted branching for 177 level.
^x 132.8 1	20 4							
(148.4 I)	7.9	177.0	$(9/2)^-$	28.80	$(7/2)^+$	(E1(+M2))	0.21 8	E_γ : not observed; E_γ from Adopted

Continued on next page (footnotes at end of table)

^{169}Ta $\varepsilon+\beta^+$ decay (4.9 min) [1975Re05](#) (continued) $\gamma(^{169}\text{Hf})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^\#$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. @	$\alpha^\&$	Comments
Gammas. I_γ : I_γ from I(177 γ) and adopted branching for 177 level.								
$^{x153.5} I$	80 8							
$^{x170.4\ddagger} I$	18 4							
177.0 1	24 5	177.0	(9/2) ⁻	0.0	5/2 ⁻	(E2)	0.435 6	
$^{x187.8} 2$	12 2							
$^{x192.4} I$	100							
$^{x230.0} I$	28 6							
$^{x394.5} I$	35 7							
$^{x404.0} 2$	21 4							
$^{x440.8} I$	38 8							
$^{x511.0\ddagger} I$	1.26×10^3 13							Duplicate entry is given in x-ray and $\gamma^\pm$ table above. With uncertain isotope assignment, it is not clear how much $\gamma^\pm$ intensity is due to ^{169}Ta decay, and also whether or not ^{169}Ta might have an additional γ ray near this energy.
$^{x520.4} 2$	20 4							
$^{x529.0} 2$	26 5							
$^{x547.4} 3$	20 4							
$^{x595.0} 2$	59 6							

† $\Delta E_\gamma=0.1$ based on the authors' note: the accuracy of E_γ of the very low energy lines is believed to be 0.04 keV; for the energy region of x rays and above, the accuracy is about 0.1 keV. Other uncertainties are given by authors in [1975Re05](#).

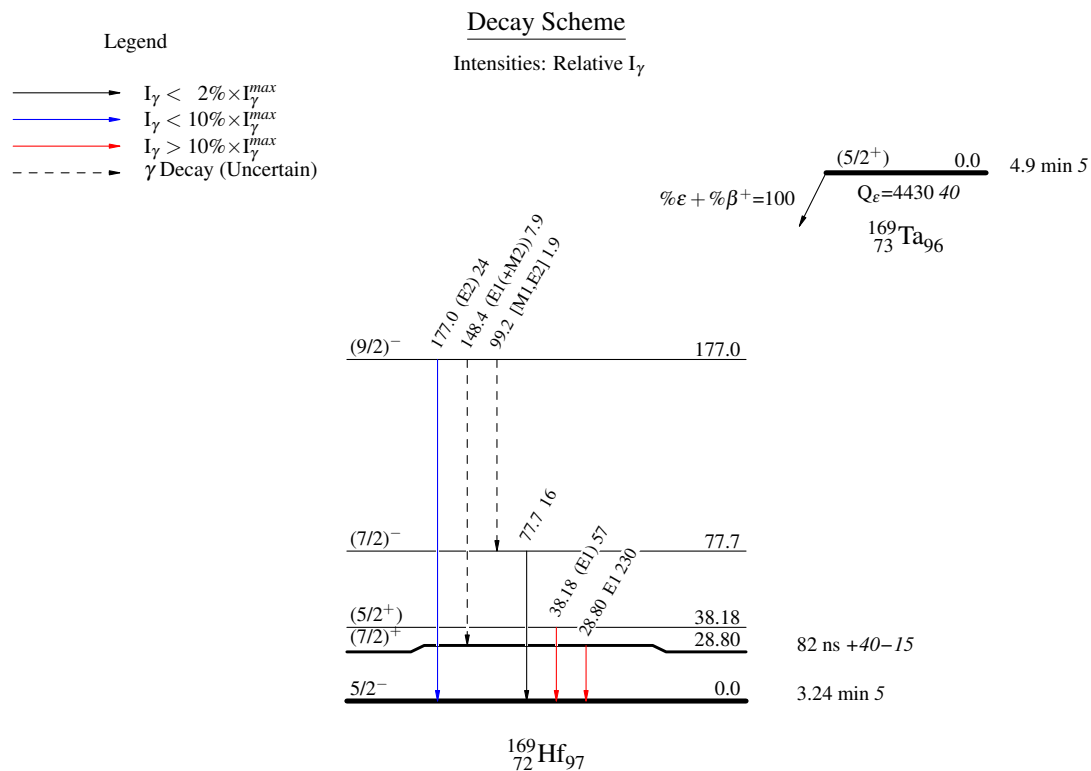
‡ Assignment to ^{169}Ta decay uncertain.

$^\#$ Arbitrary units, relative to $I_\gamma=100$ for 192.4 γ ([1975Re05](#)).

@ from Adopted Gammas.

& Total theoretical internal conversion coefficients, calculated using the BrIcc code ([2008Ki07](#)) with "Frozen Orbitals" approximation based on γ -ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

^{x} γ ray not placed in level scheme.

^{169}Ta $\varepsilon + \beta^+$ decay (4.9 min) 1975Re05


$^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ **2001Sc49**

Slightly edited, no significant changes compared to that in the previous evaluation (2008Ba31) by C.M. Baglin.

2001Sc49: E(^{76}Ge)=310 MeV; 85.25% ^{96}Zr target; GAMMASPHERE detector array (101 Compton-suppressed Ge detectors with BGO backplug); measured E γ , I γ , DCO ratios (unenumerated), 3- and 4-fold γ coin.

 ^{169}Hf Levels

Band structure is adopted from **2001Sc49**. The orbitals involved in the band labels are as follows: 5/2[642] (A,B); 3/2[651] (C,D); 5/2[523] (E); 5/2[512] (G,H); 1/2[521] (M,N).

E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$
0.0 [#]	5/2 ⁻	1952.0 ^f 12	(21/2 ⁻)	3699.7 ^d 12	(33/2 ⁺)	5812.3 [@] 24	51/2 ⁻
31.2 ^a 17	7/2 ⁺	2012.3 ^e 11	(19/2 ⁺)	3727.7 ^g 13	(35/2 ⁻)	5953.7 ^c 17	51/2 ⁻
37.6 ^{&} 15	9/2 ⁺	2125.6 ^h 12	(25/2 ⁻)	3766.7 ^c 16	39/2 ⁻	5954.7 ^a 24	51/2 ⁺
59.8 ^b 18	5/2 ⁻	2139.9 ^g 12	(23/2 ⁻)	3830.7 [#] 18	41/2 ⁻	6042.7 [#] 25	53/2 ⁻
78.1 [@] 8	7/2 ⁻	2152.4 [#] 13	29/2 ⁻	4019.8 ^e 12	(35/2 ⁺)	6076.3 ^f 14	(49/2 ⁻)
104.2 ^a 14	11/2 ⁺	2186.4 ^{&} 16	33/2 ⁺	4039.2 ⁱ 17	(41/2 ⁺)	6097.4 ^e 14	(47/2 ⁺)
144.9 ^{&} 13	13/2 ⁺	2191.1 ^d 12	(21/2 ⁺)	4040.3 ^f 13	(37/2 ⁻)	6210.7 ^h 16	(53/2 ⁻)
159.8 ^c 17	7/2 ⁻	2208.6 ^a 13	31/2 ⁺	4051.3 ^h 14	(41/2 ⁻)	6306.5 ⁱ 17	(53/2 ⁺)
176.9 [#] 8	9/2 ⁻	2356.5 ^f 12	(25/2 ⁻)	4138.5 ^{&} 17	45/2 ⁺	6324.5 ^b 16	53/2 ⁻
288.8 ^b 16	9/2 ⁻	2379.3 ^b 13	29/2 ⁻	4154.1 ^b 14	41/2 ⁻	6454.2 ^g 14	(51/2 ⁻)
302.6 [@] 10	11/2 ⁻	2383.8 ^e 12	(23/2 ⁺)	4315.5 [@] 22	43/2 ⁻	6560.3 ^{&} 21	57/2 ⁺
310.9 ^a 11	15/2 ⁺	2482.0 [@] 16	31/2 ⁻	4341.6 ^a 22	43/2 ⁺	6662.3 [@] 25	55/2 ⁻
363.3 ^{&} 11	17/2 ⁺	2523.6 ^h 13	(29/2 ⁻)	4350.0 ^d 13	(37/2 ⁺)	6787.7 ^c 18	55/2 ⁻
440.8 ^c 16	11/2 ⁻	2596.5 ^g 12	(27/2 ⁻)	4359.9 ^g 13	(39/2 ⁻)	6826.5 ^a 25	55/2 ⁺
443.7 [#] 10	13/2 ⁻	2597.3 ^d 12	(25/2 ⁺)	4439.7 ^c 17	43/2 ⁻	6853.1 ^f 14	(53/2 ⁻)
613.6 [@] 11	15/2 ⁻	2665.5 [#] 14	33/2 ⁻	4507.7 [#] 20	45/2 ⁻	6890.7 [#] 27	57/2 ⁻
621.8 ^b 14	13/2 ⁻	2682.9 ^c 16	31/2 ⁻	4684.9 ^e 13	(39/2 ⁺)	7074.3 ^h 16	(57/2 ⁻)
641.0 ^a 11	19/2 ⁺	2801.9 ^{&} 16	37/2 ⁺	4686.9 ^f 13	(41/2 ⁻)	7167.4 ⁱ 18	(57/2 ⁺)
689.7 ^{&} 13	21/2 ⁺	2840.1 ^e 12	(27/2 ⁺)	4704.0 ^h 15	(45/2 ⁻)	7178.0 ^b 16	57/2 ⁻
789.8 [#] 12	17/2 ⁻	2856.0 ^f 12	(29/2 ⁻)	4727.4 ⁱ 17	(45/2 ⁺)	7503.3 ^{&} 23	61/2 ⁺
818.8 ^c 16	15/2 ⁻	2872.6 ^a 17	35/2 ⁺	4825.8 ^b 15	45/2 ⁻	7576.3 [@] 25	59/2 ⁻
997.2 [@] 12	19/2 ⁻	2912.9 ^b 13	33/2 ⁻	4879.4 ^{&} 18	49/2 ⁺	7674.7 ^c 18	59/2 ⁻
1028.0 ^b 14	17/2 ⁻	2967.4 ^h 13	(33/2 ⁻)	5019.8 ^g 13	(43/2 ⁻)	7747.9 ^a 25	59/2 ⁺
1078.5 ^a 12	23/2 ⁺	3063.5 [@] 16	35/2 ⁻	5026.9 ^d 13	(41/2 ⁺)	7801.7 [#] 28	61/2 ⁻
1113.1 ^{&} 14	25/2 ⁺	3106.9 ^d 12	(29/2 ⁺)	5029.5 [@] 24	47/2 ⁻	8007.8 ^h 17	(61/2 ⁻)
1201.0 [#] 12	21/2 ⁻	3133.2 ^g 13	(31/2 ⁻)	5129.6 ^a 24	47/2 ⁺	8085.5 ⁱ 18	(61/2 ⁺)
1441.9 [@] 13	23/2 ⁻	3178.4 ^c 16	35/2 ⁻	5171.7 ^c 17	47/2 ⁻	8097.3 ^b 17	61/2 ⁻
1471.9 ^b 13	21/2 ⁻	3218.7 [#] 14	37/2 ⁻	5247.7 [#] 23	49/2 ⁻	8508.3 ^{&} 25	65/2 ⁺
1606.3 ^a 13	27/2 ⁺	3395.2 ^e 12	(31/2 ⁺)	5360.5 ^f 13	(45/2 ⁻)	8534.3 [@] 25	63/2 ⁻
1617.8 ^{&} 16	29/2 ⁺	3424.0 ^f 13	(33/2 ⁻)	5370.8 ^e 13	(43/2 ⁺)	8566.5 ^c 19	63/2 ⁻
1661.3 [#] 13	25/2 ⁻	3451.3 ^{&} 17	41/2 ⁺	5422.6 ^h 15	(49/2 ⁻)	8714.0 ^a 25	63/2 ⁺
1733.8 ^e 11	(15/2 ⁺)	3469.6 ^h 14	(37/2 ⁻)	5493.1 ⁱ 17	(49/2 ⁺)	8780.2 [#] 29	65/2 ⁻
1866.7 ^d 11	(17/2 ⁺)	3513.3 ^b 14	37/2 ⁻	5542.6 ^b 15	49/2 ⁻	8994.8 ^h 17	(65/2 ⁻)
1907.9 ^b 13	25/2 ⁻	3586.6 ^a 20	39/2 ⁺	5685.3 ^{&} 18	53/2 ⁺	9050.9 ⁱ 19	(65/2 ⁺)
1938.6 [@] 14	27/2 ⁻	3668.5 [@] 19	39/2 ⁻	5710.5 ^g 14	(47/2 ⁻)	9400.4 [@] 25	67/2 ⁻

Continued on next page (footnotes at end of table)

⁹⁶Zr(⁷⁶Ge,3n γ) **2001Sc49** (continued)

¹⁶⁹Hf Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$
9567.5 ^{&} 25	69/2 ⁺	10668.3 ^{&} 26	73/2 ⁺	12030.2 [#] 30	77/2 ⁻	14107.3 ^{&} 27	85/2 ⁺
9715.6 ^a 26	67/2 ⁺	10912.9 [#] 29	73/2 ⁻	12216.5 [@] 26	79/2 ⁻	14273.2 [#] 33	85/2 ⁻
9821.0 [#] 29	69/2 ⁻	11003.6 ^h 18	(73/2 ⁻)	12947.2 ^{&} 26	81/2 ⁺	14380.3 [@] 27	87/2 ⁻
9993.5 ^h 18	(69/2 ⁻)	11227.1 [@] 26	75/2 ⁻	13136.2 [#] 31	81/2 ⁻	15286.1 ^{&} 27	89/2 ⁺
10289.7 [@] 26	71/2 ⁻	11799.0 ^{&} 26	77/2 ⁺	13267.5 [@] 27	83/2 ⁻		

[†] From least-squares fit to E γ , assigning 1 keV uncertainty to E γ values quoted only to the nearest keV.

[‡] Authors' values, based on transition multipolarities, intraband transition B(M1)/B(E2) ratios, band alignments and crossing frequencies compared with ultimate cranking model calculations, established band structure in neighboring nuclides. These values are consistent with the adopted ones, but most adopted values are given in parentheses.

[#] Band(A): 5/2[523] $\alpha=+1/2$ band. E band; becomes EAB band at $\hbar\omega=260$ keV. A subsequent band crossing occurs at $\hbar\omega\approx 550$ keV; probably involves proton alignment, 1/2[541]@9/2[514] or 7/2[404]@1/2[660].

[@] Band(a): 5/2[523] $\alpha=-1/2$ band. F band; becomes FAB band at $\hbar\omega=270$ keV. A subsequent band crossing occurs at $\hbar\omega\approx 450$ keV; probably involves proton alignment, 1/2[541]@9/2[514] or 7/2[404]@1/2[660].

[&] Band(B): 5/2[642] $\alpha=+1/2$ band. A band; becomes ABC band at $\hbar\omega=310$ keV. Subsequent band crossing at $\hbar\omega\approx 565$ keV may involve an aligned proton pair (see **2001Sc49** for discussion of possible π orbitals).

^a Band(b): 5/2[642] $\alpha=-1/2$ band. B band; becomes BAD band at $\hbar\omega=370$ keV.

^b Band(C): 5/2[512] $\alpha=+1/2$ band. G band; becomes GAB band at $\hbar\omega=255$ keV.

^c Band(c): 5/2[512] $\alpha=-1/2$ band. H band; becomes HAB band at $\hbar\omega=255$ keV.

^d Band(D): $\pi=+$, $\alpha=+1/2$ 3-quasiparticle band. Strongly-coupled band; lowest-energy level may not be bandhead. A configuration: (ν 5/2[642])@(π 5/2[402])@(π 1/2[411]) with $K^\pi=1/2^+$ is very tentatively suggested in **2001Sc49**.

^e Band(d): $\pi=+$, $\alpha=-1/2$ 3-quasiparticle band. See comment on signature partner band.

^f Band(E): $\pi=-$, $\alpha=+1/2$ 3-quasiparticle band. Strongly-coupled band; lowest-energy level may not be bandhead. Possible configuration: (ν 5/2[642])@(π 9/2[514])@(π 1/2[411]) with $K^\pi=15/2^-$; this is consistent with observed B(M1)/B(E2) for intraband transitions from levels; however, see **2001Sc49** for other possibilities.

^g Band(e): $\pi=-$, $\alpha=-1/2$ 3-quasiparticle band. See comment on signature partner band.

^h Band(F): ν [(1/2[521])(5/2[642])(5/2[642])], $\alpha=+1/2$ band. MAB band. Participation of (ν 1/2[521]) supported by similarity of routhian with that for 1/2[521] band in ¹⁷¹Hf for $300<\hbar\omega<475$. Band crossing at $\hbar\omega=490$ keV may involve aligned proton pair.

ⁱ Band(G): $\pi=+$, $\alpha=+1/2$ 3-quasineutron band. Configuration: $\nu[(5/2[642])(1/2[521])(5/2[523])]$ (AMF band). In-band B(E2) values possibly enhanced by presence of coupling to γ -vibrational band built on 5/2[642].

$\gamma(^{169}\text{Hf})$

E γ [†]	I γ [†]	E _i (level)	J π_i	E _f	J π_f	E γ [†]	I γ [†]	E _i (level)	J π_i	E _f	J π_f
67 ^{&}		104.2	11/2 ⁺	37.6	9/2 ⁺	152 ^{&}		440.8	11/2 ⁻	288.8	9/2 ⁻
73 ^{&}		104.2	11/2 ⁺	31.2	7/2 ⁺	166 ^{&}		310.9	15/2 ⁺	144.9	13/2 ⁺
78 ^{&}		78.1	7/2 ⁻	0.0	5/2 ⁻	170 ^{&}		613.6	15/2 ⁻	443.7	13/2 ⁻
99 ^{&}		176.9	9/2 ⁻	78.1	7/2 ⁻	176 [#]		789.8	17/2 ⁻	613.6	15/2 ⁻
100 ^{&}		159.8	7/2 ⁻	59.8	5/2 ⁻	177 ^{&}		176.9	9/2 ⁻	0.0	5/2 ⁻
107 ^{&}		144.9	13/2 ⁺	37.6	9/2 ⁺	178.8 4	1.6 2	2191.1	(21/2 ⁺)	2012.3	(19/2 ⁺)
126 ^{&}		302.6	11/2 ⁻	176.9	9/2 ⁻	181 ^{&}		621.8	13/2 ⁻	440.8	11/2 ⁻
129 ^{&}		288.8	9/2 ⁻	159.8	7/2 ⁻	187.9 4	2.7 2	2139.9	(23/2 ⁻)	1952.0	(21/2 ⁻)
132.9 4	0.7 2	1866.7	(17/2 ⁺)	1733.8	(15/2 ⁺)	192.7 4	1.1 2	2383.8	(23/2 ⁺)	2191.1	(21/2 ⁺)
141 [#]		443.7	13/2 ⁻	302.6	11/2 ⁻	197 ^{&}		818.8	15/2 ⁻	621.8	13/2 ⁻
145.6 4	0.9 2	2012.3	(19/2 ⁺)	1866.7	(17/2 ⁺)	207 ^{&}		310.9	15/2 ⁺	104.2	11/2 ⁺

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$^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ **2001Sc49** (continued) $\gamma(^{169}\text{Hf})$ (continued)

E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π	E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π
213.5 4	1.8 2	2597.3	(25/2 ⁺)	2383.8	(23/2 ⁺)	411 &		1201.0	21/2 ⁻	789.8	17/2 ⁻
216.6 4	3.1 2	2356.5	(25/2 ⁻)	2139.9	(23/2 ⁻)	423 @		1113.1	25/2 ⁺	689.7	21/2 ⁺
218 &		363.3	17/2 ⁺	144.9	13/2 ⁺	436.0 4	0.9 3	1907.9	25/2 ⁻	1471.9	21/2 ⁻
224 &		302.6	11/2 ⁻	78.1	7/2 ⁻	438 @		1078.5	23/2 ⁺	641.0	19/2 ⁺
229 &		288.8	9/2 ⁻	59.8	5/2 ⁻	443.9 4	1.0 3	1471.9	21/2 ⁻	1028.0	17/2 ⁻
240.0 4	2.7 2	2596.5	(27/2 ⁻)	2356.5	(25/2 ⁻)	443.9 4	6.0 6	2967.4	(33/2 ⁻)	2523.6	(29/2 ⁻)
242.8 4	2.0 1	2840.1	(27/2 ⁺)	2597.3	(25/2 ⁺)	445 &		1441.9	23/2 ⁻	997.2	19/2 ⁻
259.5 4	2.2 2	2856.0	(29/2 ⁻)	2596.5	(27/2 ⁻)	456.3 4	1.1 1	2840.1	(27/2 ⁺)	2383.8	(23/2 ⁺)
266.7 4	1.8 2	3106.9	(29/2 ⁺)	2840.1	(27/2 ⁺)	456.6 4	2.2 2	2596.5	(27/2 ⁻)	2139.9	(23/2 ⁻)
267 &		443.7	13/2 ⁻	176.9	9/2 ⁻	460 &		1661.3	25/2 ⁻	1201.0	21/2 ⁻
277.2 4	2.0 2	3133.2	(31/2 ⁻)	2856.0	(29/2 ⁻)	471.4 4	1.2 3	2379.3	29/2 ⁻	1907.9	25/2 ⁻
278 &		641.0	19/2 ⁺	363.3	17/2 ⁺	479 #		789.8	17/2 ⁻	310.9	15/2 ⁺
278.5 4	1.0 2	2012.3	(19/2 ⁺)	1733.8	(15/2 ⁺)	491 &		2152.4	29/2 ⁻	1661.3	25/2 ⁻
281 &		440.8	11/2 ⁻	159.8	7/2 ⁻	493 &		1606.3	27/2 ⁺	1113.1	25/2 ⁺
288.3 4	1.5 1	3395.2	(31/2 ⁺)	3106.9	(29/2 ⁺)	495.5 4	0.8 3	3178.4	35/2 ⁻	2682.9	31/2 ⁻
290.8 4	1.7 2	3424.0	(33/2 ⁻)	3133.2	(31/2 ⁻)	497 &		1938.6	27/2 ⁻	1441.9	23/2 ⁻
303.7 4	1.7 2	3727.7	(35/2 ⁻)	3424.0	(33/2 ⁻)	499.5 4	0.6 2	2856.0	(29/2 ⁻)	2356.5	(25/2 ⁻)
304.5 4	1.4 2	3699.7	(33/2 ⁺)	3395.2	(31/2 ⁺)	502.2 4	9.2 5	3469.6	(37/2 ⁻)	2967.4	(33/2 ⁻)
311 &		613.6	15/2 ⁻	302.6	11/2 ⁻	505 @		1617.8	29/2 ⁺	1113.1	25/2 ⁺
312.6 4	1.7 2	4040.3	(37/2 ⁻)	3727.7	(35/2 ⁻)	509.5 4	1.1 2	3106.9	(29/2 ⁺)	2597.3	(25/2 ⁺)
319.6 4	1.2 2	4359.9	(39/2 ⁻)	4040.3	(37/2 ⁻)	513 &		2665.5	33/2 ⁻	2152.4	29/2 ⁻
320.2 4	1.3 1	4019.8	(35/2 ⁺)	3699.7	(33/2 ⁺)	528 @		1606.3	27/2 ⁺	1078.5	23/2 ⁺
324.4 4	0.5 1	2191.1	(21/2 ⁺)	1866.7	(17/2 ⁺)	533.6 4	2.0 4	2912.9	33/2 ⁻	2379.3	29/2 ⁻
326 &		689.7	21/2 ⁺	363.3	17/2 ⁺	536.7 4	1.3 2	3133.2	(31/2 ⁻)	2596.5	(27/2 ⁻)
327.0 4	1.9 4	4686.9	(41/2 ⁻)	4359.9	(39/2 ⁻)	543 &		2482.0	31/2 ⁻	1938.6	27/2 ⁻
330 &		641.0	19/2 ⁺	310.9	15/2 ⁺	546 #		2152.4	29/2 ⁻	1606.3	27/2 ⁺
330.2 4	1.4 3	4350.0	(37/2 ⁺)	4019.8	(35/2 ⁺)	553 &		3218.7	37/2 ⁻	2665.5	33/2 ⁻
332.9 4	1.5 2	5019.8	(43/2 ⁻)	4686.9	(41/2 ⁻)	555.1 4	1.0 3	3395.2	(31/2 ⁺)	2840.1	(27/2 ⁺)
333 &		621.8	13/2 ⁻	288.8	9/2 ⁻	560 #		1201.0	21/2 ⁻	641.0	19/2 ⁺
334.9 4	1.0 1	4684.9	(39/2 ⁺)	4350.0	(37/2 ⁺)	568.0 4	0.8 2	3424.0	(33/2 ⁻)	2856.0	(29/2 ⁻)
340.7 4	0.9 3	5360.5	(45/2 ⁻)	5019.8	(43/2 ⁻)	569 @		2186.4	33/2 ⁺	1617.8	29/2 ⁺
342.0 4	0.7 2	5026.9	(41/2 ⁺)	4684.9	(39/2 ⁺)	581 &		3063.5	35/2 ⁻	2482.0	31/2 ⁻
343.9 4	0.6 2	5370.8	(43/2 ⁺)	5026.9	(41/2 ⁺)	581.7 4	8.2 7	4051.3	(41/2 ⁻)	3469.6	(37/2 ⁻)
346 &		789.8	17/2 ⁻	443.7	13/2 ⁻	583 #		1661.3	25/2 ⁻	1078.5	23/2 ⁺
350.0 4	0.9 2	5710.5	(47/2 ⁻)	5360.5	(45/2 ⁻)	587.9 4	<0.3	4039.2	(41/2 ⁺)	3451.3	41/2 ⁺
365.8 4	0.8 3	6076.3	(49/2 ⁻)	5710.5	(47/2 ⁻)	588.3 4	1.3 3	3766.7	39/2 ⁻	3178.4	35/2 ⁻
371.5 4	0.5 1	2383.8	(23/2 ⁺)	2012.3	(19/2 ⁺)	588.9 4	<0.3	4727.4	(45/2 ⁺)	4138.5	45/2 ⁺
377.9 4	0.6 2	6454.2	(51/2 ⁻)	6076.3	(49/2 ⁻)	592.8 4	1.2 2	3699.7	(33/2 ⁺)	3106.9	(29/2 ⁺)
378 &		818.8	15/2 ⁻	440.8	11/2 ⁻	594.5 4	1.3 2	3727.7	(35/2 ⁻)	3133.2	(31/2 ⁻)
384 &		997.2	19/2 ⁻	613.6	15/2 ⁻	600.4 4	2.7 3	3513.3	37/2 ⁻	2912.9	33/2 ⁻
389 &		1078.5	23/2 ⁺	689.7	21/2 ⁺	602 @		2208.6	31/2 ⁺	1606.3	27/2 ⁺
398.0 4	1.5 5	2523.6	(29/2 ⁻)	2125.6	(25/2 ⁻)	605 &		3668.5	39/2 ⁻	3063.5	35/2 ⁻
398.9 4	0.4 2	6853.1	(53/2 ⁻)	6454.2	(51/2 ⁻)	612 &		3830.7	41/2 ⁻	3218.7	37/2 ⁻
404.5 4	1.3 2	2356.5	(25/2 ⁻)	1952.0	(21/2 ⁻)	616 @		2801.9	37/2 ⁺	2186.4	33/2 ⁺
406.2 4	1.0 3	1028.0	17/2 ⁻	621.8	13/2 ⁻	616.3 4	1.3 2	4040.3	(37/2 ⁻)	3424.0	(33/2 ⁻)
406.2 4	0.4 1	2597.3	(25/2 ⁺)	2191.1	(21/2 ⁺)	624.6 4	1.0 3	4019.8	(35/2 ⁺)	3395.2	(31/2 ⁺)

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$^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ **2001Sc49** (continued) $\gamma(^{169}\text{Hf})$ (continued)

E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π
632.2 4	1.1 2	4359.9	(39/2 ⁻)	3727.7	(35/2 ⁻)
634#		997.2	19/2 ⁻	363.3	17/2 ⁺
640.9 4	2.9 5	4154.1	41/2 ⁻	3513.3	37/2 ⁻
646.6 4	1.7 4	4686.9	(41/2 ⁻)	4040.3	(37/2 ⁻)
647&		4315.5	43/2 ⁻	3668.5	39/2 ⁻
649@		3451.3	41/2 ⁺	2801.9	37/2 ⁺
650.3 4	1.2 2	4350.0	(37/2 ⁺)	3699.7	(33/2 ⁺)
652.7 4	6.6 7	4704.0	(45/2 ⁻)	4051.3	(41/2 ⁻)
659.9 4	1.4 3	5019.8	(43/2 ⁻)	4359.9	(39/2 ⁻)
664&		2872.6	35/2 ⁺	2208.6	31/2 ⁺
665.1 4	0.8 3	4684.9	(39/2 ⁺)	4019.8	(35/2 ⁺)
671.7 4	3.6 6	4825.8	45/2 ⁻	4154.1	41/2 ⁻
673.0 4	2.8 5	4439.7	43/2 ⁻	3766.7	39/2 ⁻
673.6 4	0.9 3	5360.5	(45/2 ⁻)	4686.9	(41/2 ⁻)
676.9 4	0.5 2	5026.9	(41/2 ⁺)	4350.0	(37/2 ⁺)
677&		4507.7	45/2 ⁻	3830.7	41/2 ⁻
685.9 4	0.5 2	5370.8	(43/2 ⁺)	4684.9	(39/2 ⁺)
687&		4138.5	45/2 ⁺	3451.3	41/2 ⁺
688.2 4	0.8 3	4727.4	(45/2 ⁺)	4039.2	(41/2 ⁺)
690.7 4	0.8 2	5710.5	(47/2 ⁻)	5019.8	(43/2 ⁻)
703.1 4	0.8 3	3766.7	39/2 ⁻	3063.5	35/2 ⁻
707.0 4	0.5 2	1907.9	25/2 ⁻	1201.0	21/2 ⁻
714&		3586.6	39/2 ⁺	2872.6	35/2 ⁺
714&		5029.5	47/2 ⁻	4315.5	43/2 ⁻
715.8 4	0.9 3	6076.3	(49/2 ⁻)	5360.5	(45/2 ⁻)
716.8 4	2.8 6	5542.6	49/2 ⁻	4825.8	45/2 ⁻
718.0 4	0.8 3	2379.3	29/2 ⁻	1661.3	25/2 ⁻
718.6 4	4.2 5	5422.6	(49/2 ⁻)	4704.0	(45/2 ⁻)
726.6 4	0.5 2	6097.4	(47/2 ⁺)	5370.8	(43/2 ⁺)
732.0 4	3.3 5	5171.7	47/2 ⁻	4439.7	43/2 ⁻
740&		5247.7	49/2 ⁻	4507.7	45/2 ⁻
741@		4879.4	49/2 ⁺	4138.5	45/2 ⁺
743.7 4	0.5 2	6454.2	(51/2 ⁻)	5710.5	(47/2 ⁻)
752#		1441.9	23/2 ⁻	689.7	21/2 ⁺
755&		4341.6	43/2 ⁺	3586.6	39/2 ⁺
758.8 4	3.2 3	2967.4	(33/2 ⁻)	2208.6	31/2 ⁺
760.5 4	0.9 3	2912.9	33/2 ⁻	2152.4	29/2 ⁻
765.7 4	1.3 4	5493.1	(49/2 ⁺)	4727.4	(45/2 ⁺)
776.8 4	0.5 2	6853.1	(53/2 ⁻)	6076.3	(49/2 ⁻)
781.9 4	2.1 4	6324.5	53/2 ⁻	5542.6	49/2 ⁻
782.0 4	4.0 5	5953.7	51/2 ⁻	5171.7	47/2 ⁻
782.8 4	7.0 3	5812.3	51/2 ⁻	5029.5	47/2 ⁻
788&		5129.6	47/2 ⁺	4341.6	43/2 ⁺
788.1 4	3.5 6	6210.7	(53/2 ⁻)	5422.6	(49/2 ⁻)
795&		6042.7	53/2 ⁻	5247.7	49/2 ⁻
806@		5685.3	53/2 ⁺	4879.4	49/2 ⁺
813.3 4	2.1 5	6306.5	(53/2 ⁺)	5493.1	(49/2 ⁺)
825#		1938.6	27/2 ⁻	1113.1	25/2 ⁺
825.1 4	4.5 5	5954.7	51/2 ⁺	5129.6	47/2 ⁺
834.0 4	2.3 4	6787.7	55/2 ⁻	5953.7	51/2 ⁻
847.8 4	0.7 3	3513.3	37/2 ⁻	2665.5	33/2 ⁻

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$^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ **2001Sc49** (continued) $\gamma(^{169}\text{Hf})$ (continued)

E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.‡	Comments
848&		6890.7	57/2 ⁻	6042.7	53/2 ⁻		
850.0 4	4.8 4	6662.3	55/2 ⁻	5812.3	51/2 ⁻		
853.5 4	1.6 6	7178.0	57/2 ⁻	6324.5	53/2 ⁻		
860.9 4	2.5 5	7167.4	(57/2 ⁺)	6306.5	(53/2 ⁺)		
863.6 4	2.3 6	7074.3	(57/2 ⁻)	6210.7	(53/2 ⁻)		
864#		2482.0	31/2 ⁻	1617.8	29/2 ⁺		
866.1 4	1.2 4	9400.4	67/2 ⁻	8534.3	63/2 ⁻		
871.8 4	3.5 5	6826.5	55/2 ⁺	5954.7	51/2 ⁺		
873.6 4	4.7 5	1952.0	(21/2 ⁻)	1078.5	23/2 ⁺	(D)	DCO=1.25 19.
875@		6560.3	57/2 ⁺	5685.3	53/2 ⁺		
887.0 4	1.6 6	7674.7	59/2 ⁻	6787.7	55/2 ⁻		
889.3 4	1.4 4	10289.7	71/2 ⁻	9400.4	67/2 ⁻		
891.8 4	0.6 3	8566.5	63/2 ⁻	7674.7	59/2 ⁻		
911&		7801.7	61/2 ⁻	6890.7	57/2 ⁻		
914.0 4	3.1 3	7576.3	59/2 ⁻	6662.3	55/2 ⁻		
917.3 4	4.5 5	2523.6	(29/2 ⁻)	1606.3	27/2 ⁺	D	DCO=1.4 4.
918.1 4	1.8 4	8085.5	(61/2 ⁺)	7167.4	(57/2 ⁺)		
919.3 4	1.0 4	8097.3	61/2 ⁻	7178.0	57/2 ⁻		
921.4 4	1.3 5	7747.9	59/2 ⁺	6826.5	55/2 ⁺		
933.5 4	1.2 4	8007.8	(61/2 ⁻)	7074.3	(57/2 ⁻)		
935.4 4	0.7 3	4154.1	41/2 ⁻	3218.7	37/2 ⁻		
937.4 4	1.0 3	11227.1	75/2 ⁻	10289.7	71/2 ⁻		
943@		7503.3	61/2 ⁺	6560.3	57/2 ⁺		
958.0 4	2.0 3	8534.3	63/2 ⁻	7576.3	59/2 ⁻		
964.9 4	1.4 4	3766.7	39/2 ⁻	2801.9	37/2 ⁺		
965.4 4	0.9 4	9050.9	(65/2 ⁺)	8085.5	(61/2 ⁺)		
966.1 4	0.4 4	8714.0	63/2 ⁺	7747.9	59/2 ⁺		
978.5 4	4.0 5	8780.2	65/2 ⁻	7801.7	61/2 ⁻		
987.0 4	1.1 4	8994.8	(65/2 ⁻)	8007.8	(61/2 ⁻)		
988.4 4	0.8 3	4439.7	43/2 ⁻	3451.3	41/2 ⁺		
989.4 4	1.3 5	12216.5	79/2 ⁻	11227.1	75/2 ⁻		
992.0 4	0.7 3	3178.4	35/2 ⁻	2186.4	33/2 ⁺		
998.7 ^a 4	0.8 4	9993.5?	(69/2 ⁻)	8994.8	(65/2 ⁻)		
1001.6 ^a 4	<0.3	9715.6?	67/2 ⁺	8714.0	63/2 ⁺		
1005&		8508.3	65/2 ⁺	7503.3	61/2 ⁺		
1010.1 ^a 4	0.7 4	11003.6?	(73/2 ⁻)	9993.5?	(69/2 ⁻)		
1033.2 4	0.8 3	5171.7	47/2 ⁻	4138.5	45/2 ⁺		
1040.8 4	2.6 5	9821.0	69/2 ⁻	8780.2	65/2 ⁻		
1047.1 4	1.5 5	2125.6	(25/2 ⁻)	1078.5	23/2 ⁺		
1051.0 4	1.0 3	13267.5	83/2 ⁻	12216.5	79/2 ⁻		
1059.2 4	5.8 7	9567.5	69/2 ⁺	8508.3	65/2 ⁺		
1065.2 4	0.7 3	2682.9	31/2 ⁻	1617.8	29/2 ⁺		
1091.9 4	1.4 4	10912.9	73/2 ⁻	9821.0	69/2 ⁻		
1092.8 4	0.9 2	1733.8	(15/2 ⁺)	641.0	19/2 ⁺		
1100.8 4	3.1 7	10668.3	73/2 ⁺	9567.5	69/2 ⁺		
1106 1	1.0 4	13136.2	81/2 ⁻	12030.2	77/2 ⁻		
1112.7 4	0.8 3	14380.3	87/2 ⁻	13267.5	83/2 ⁻		
1117.3 4	0.8 4	12030.2	77/2 ⁻	10912.9	73/2 ⁻		
1130.7 4	1.6 7	11799.0	77/2 ⁺	10668.3	73/2 ⁺		
1137 1	<0.5	14273.2	85/2 ⁻	13136.2	81/2 ⁻		
1148.2 4	1.1 6	12947.2	81/2 ⁺	11799.0	77/2 ⁺		
1160.1 4	0.7 6	14107.3	85/2 ⁺	12947.2	81/2 ⁺		

Continued on next page (footnotes at end of table)

$^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ **2001Sc49** (continued) $\gamma(^{169}\text{Hf})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π
1178.8 4	<0.5	15286.1	89/2 ⁺	14107.3	85/2 ⁺	1354.6 4	0.9 3	5493.1	(49/2 ⁺)	4138.5	45/2 ⁺
1237.4 4	0.6 2	4039.2	(41/2 ⁺)	2801.9	37/2 ⁺	1370.5 4	≈0.1	1733.8	(15/2 ⁺)	363.3	17/2 ⁺
1276.2 4	0.6 2	4727.4	(45/2 ⁺)	3451.3	41/2 ⁺	1423.0 4	1.1 2	1733.8	(15/2 ⁺)	310.9	15/2 ⁺
1290.1 4	0.5 1	1733.8	(15/2 ⁺)	443.7	13/2 ⁻	1427.1 4	0.8 3	6306.5	(53/2 ⁺)	4879.4	49/2 ⁺
1310.9 4	0.9 3	1952.0	(21/2 ⁻)	641.0	19/2 ⁺	1482.1 4	<0.5	7167.4	(57/2 ⁺)	5685.3	53/2 ⁺

[†] From **2001Sc49**. The authors report an uncertainty of about 0.2 to 0.4 keV in E_γ ; the evaluator assigns a 0.4 keV uncertainty to all E_γ data. I_γ data are estimated from doubly-gated coincidence spectra with gates below and have been corrected to correspond to branching ratios determined from gates above whenever such branching ratios were analyzed (**2001Sc49**).

[‡] Based on DCO ratio. The authors give ratios for only two transitions, but many more unenumerated ratios were measured. **2001Sc49** report an average DCO ratio of 0.98 4 for stretched Q transitions and 1.57 10 for stretched D transitions.

From level scheme in fig. 1 of **2001Sc49**; reported from this reaction study only.

@ From level scheme in fig. 1 and spectrum of fig. 2 of **2001Sc49**; only the rounded energy is reported.

& From level scheme in fig. 1 of **2001Sc49**; since this level scheme is based on information from the literature in addition to the authors' data from the $^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ reaction, it is not clear whether this E_γ was in fact determined in $(^{76}\text{Ge}, 3n\gamma)$.

^a Placement of transition in the level scheme is uncertain.

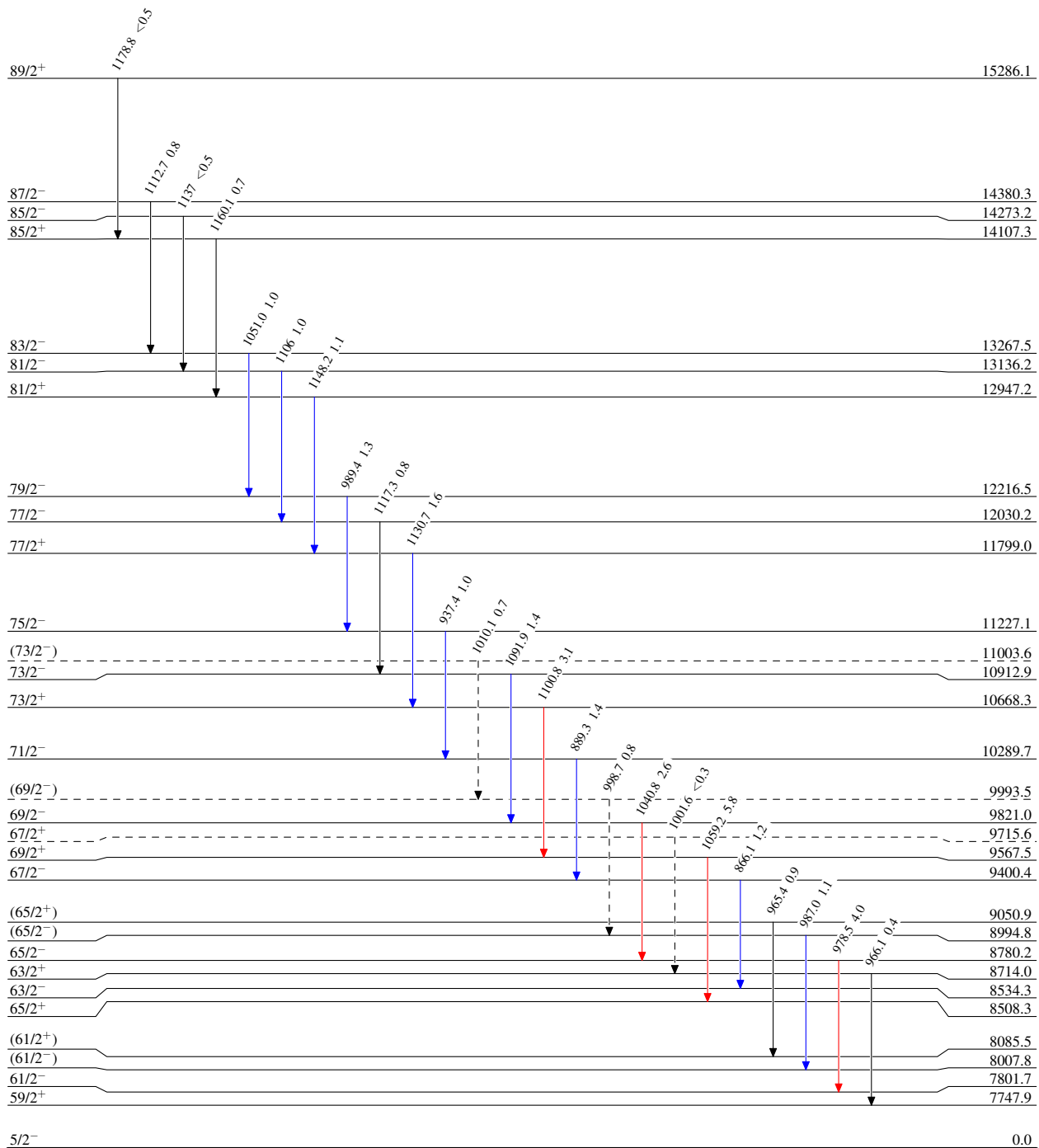
$^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ 2001Sc49

Legend

Level Scheme

 Intensities: Relative I_γ

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$
- - - - -→ γ Decay (Uncertain)



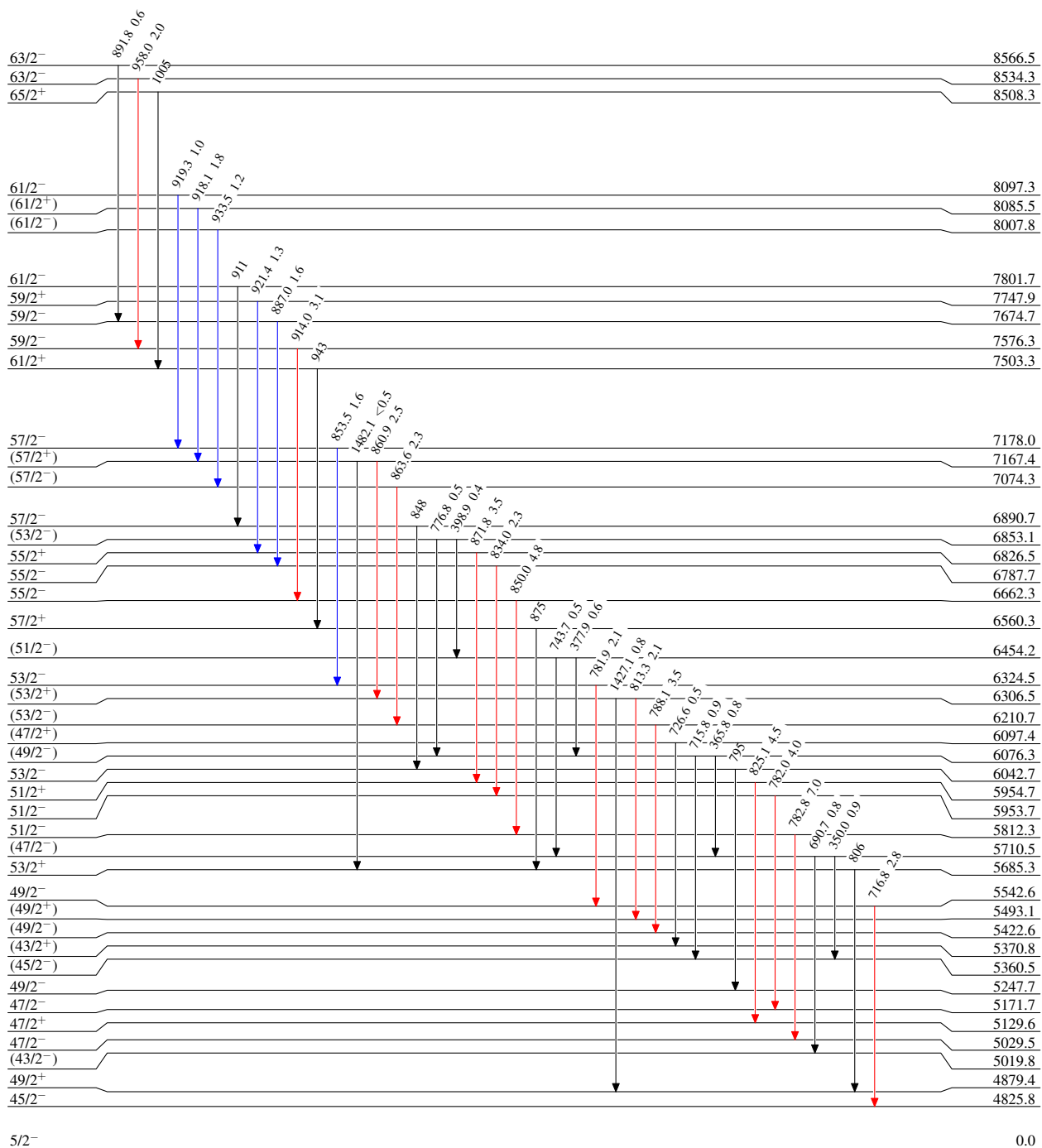
$^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ 2001Sc49

Level Scheme (continued)

Intensities: Relative I_γ

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$



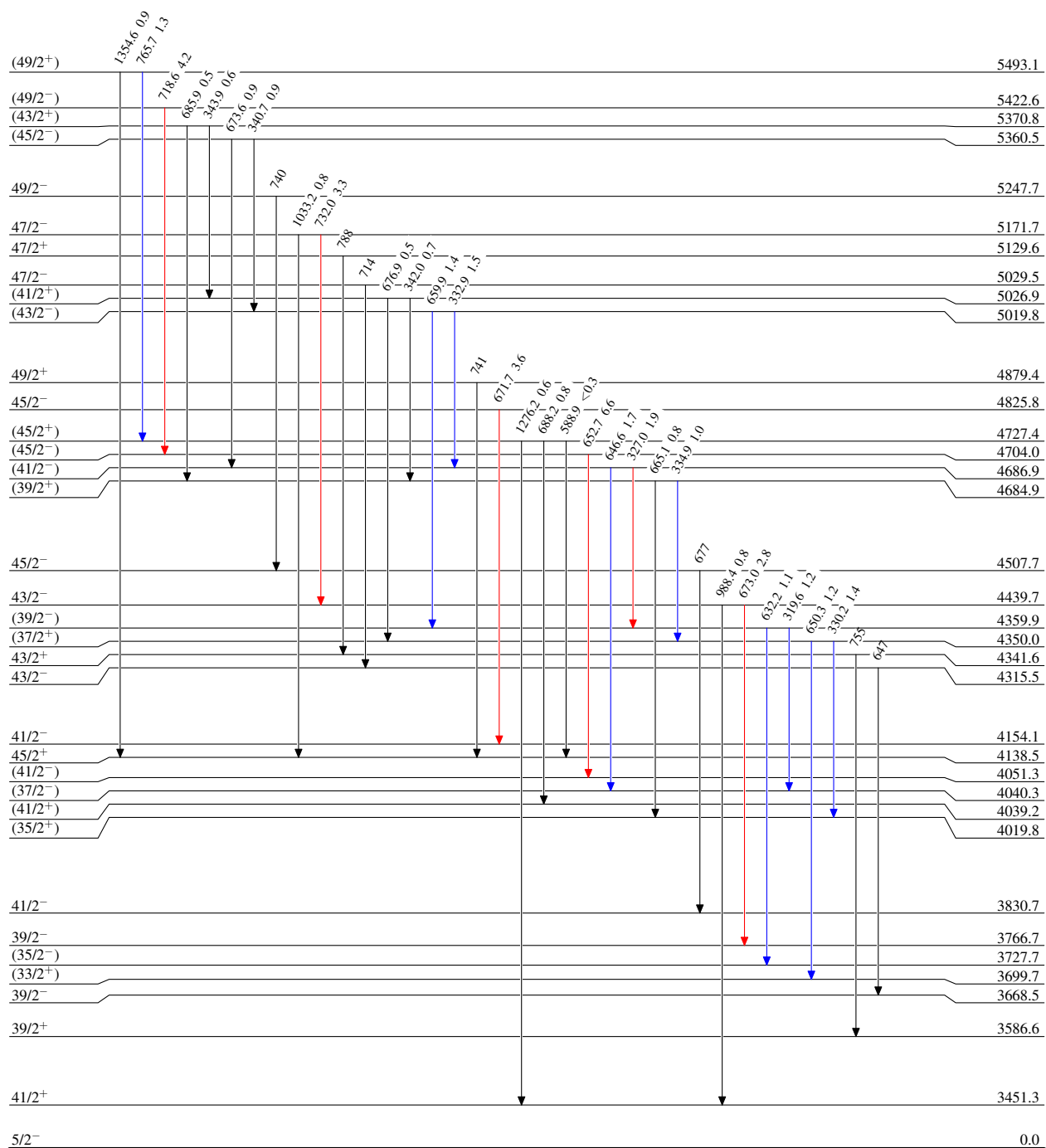
$^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ 2001Sc49

Level Scheme (continued)

Intensities: Relative I_γ

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$



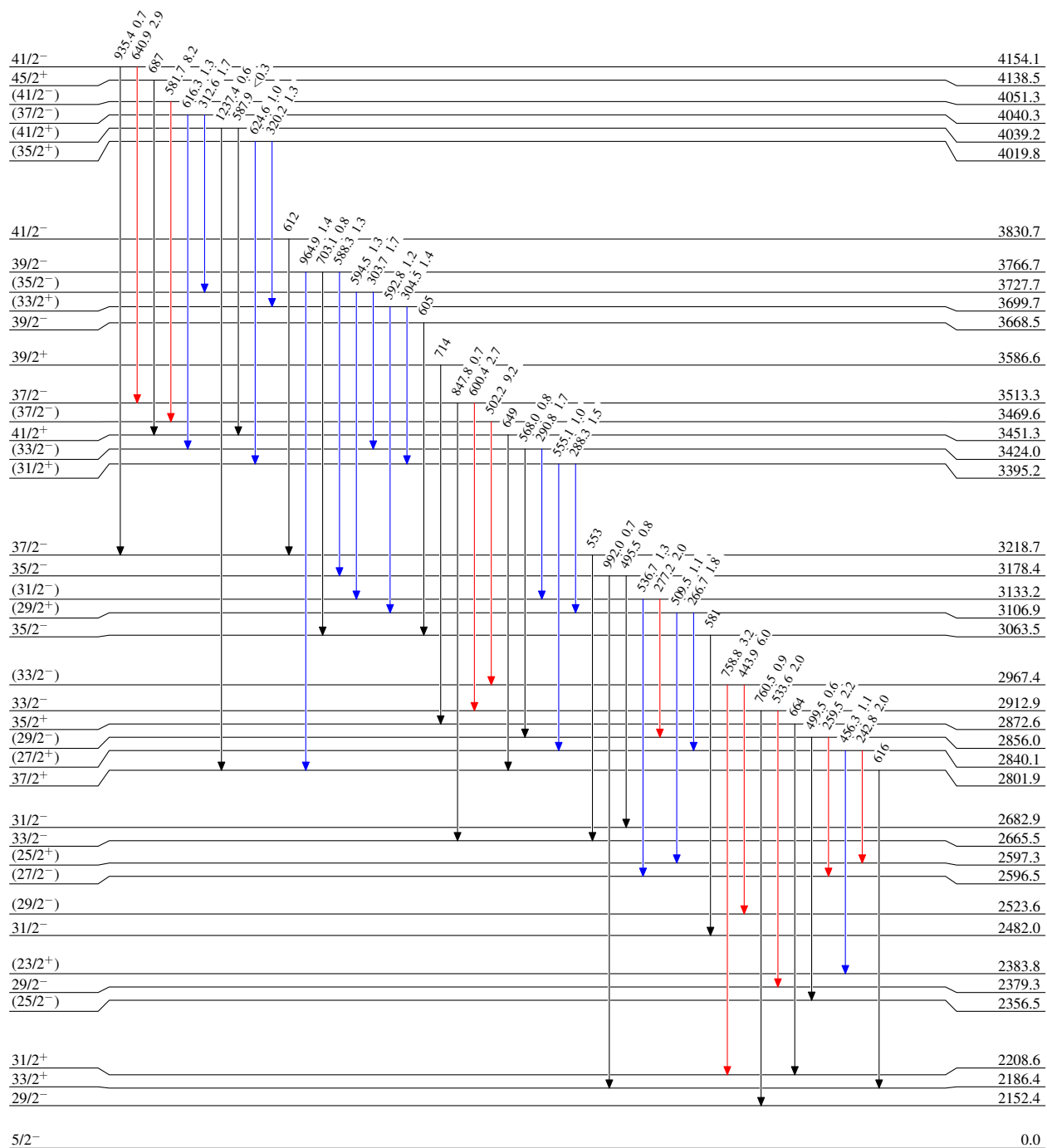
$^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ 2001Sc49

Level Scheme (continued)

Intensities: Relative I_γ

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$



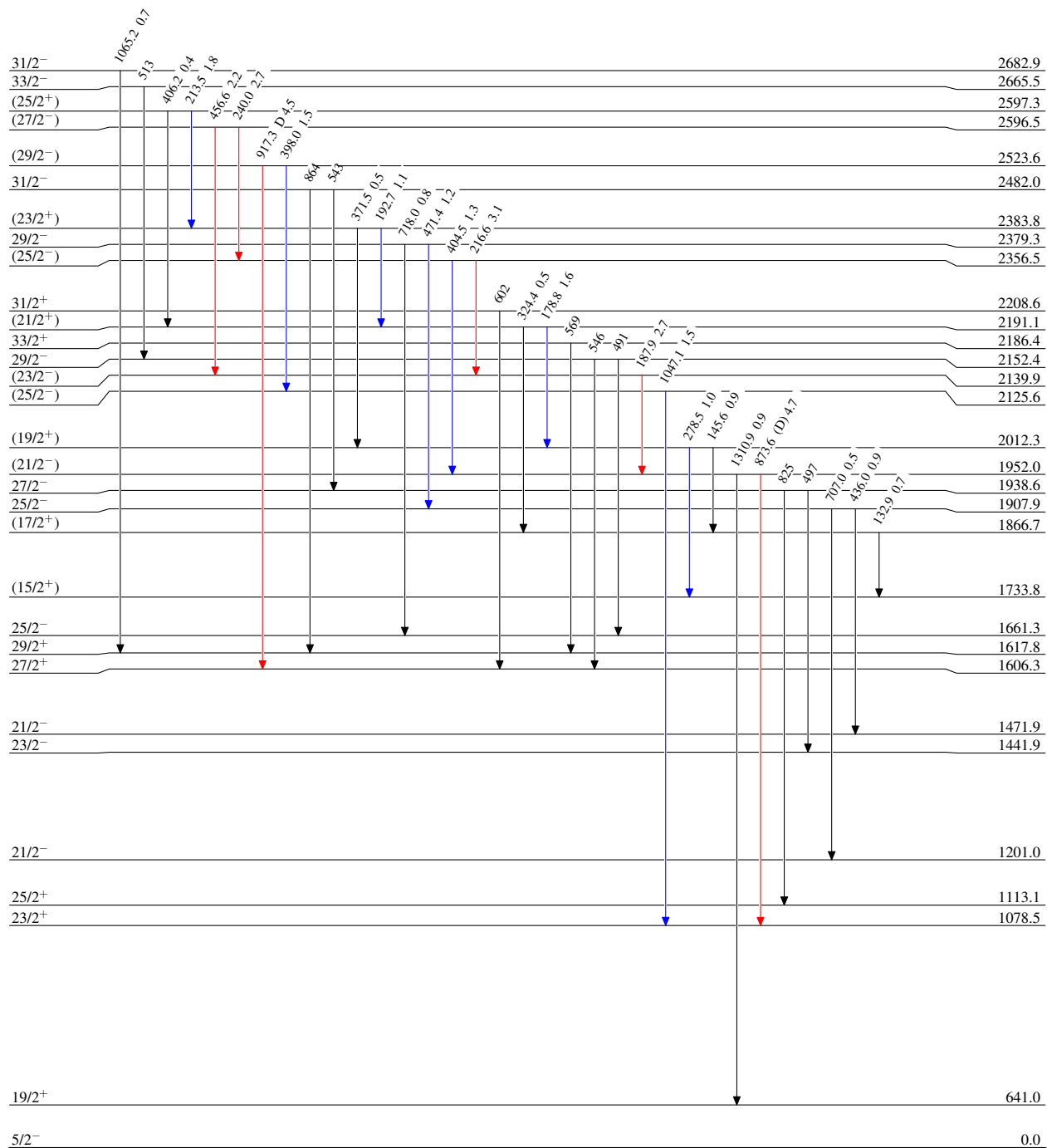
$^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ 2001Sc49

Level Scheme (continued)

Intensities: Relative I_γ

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$



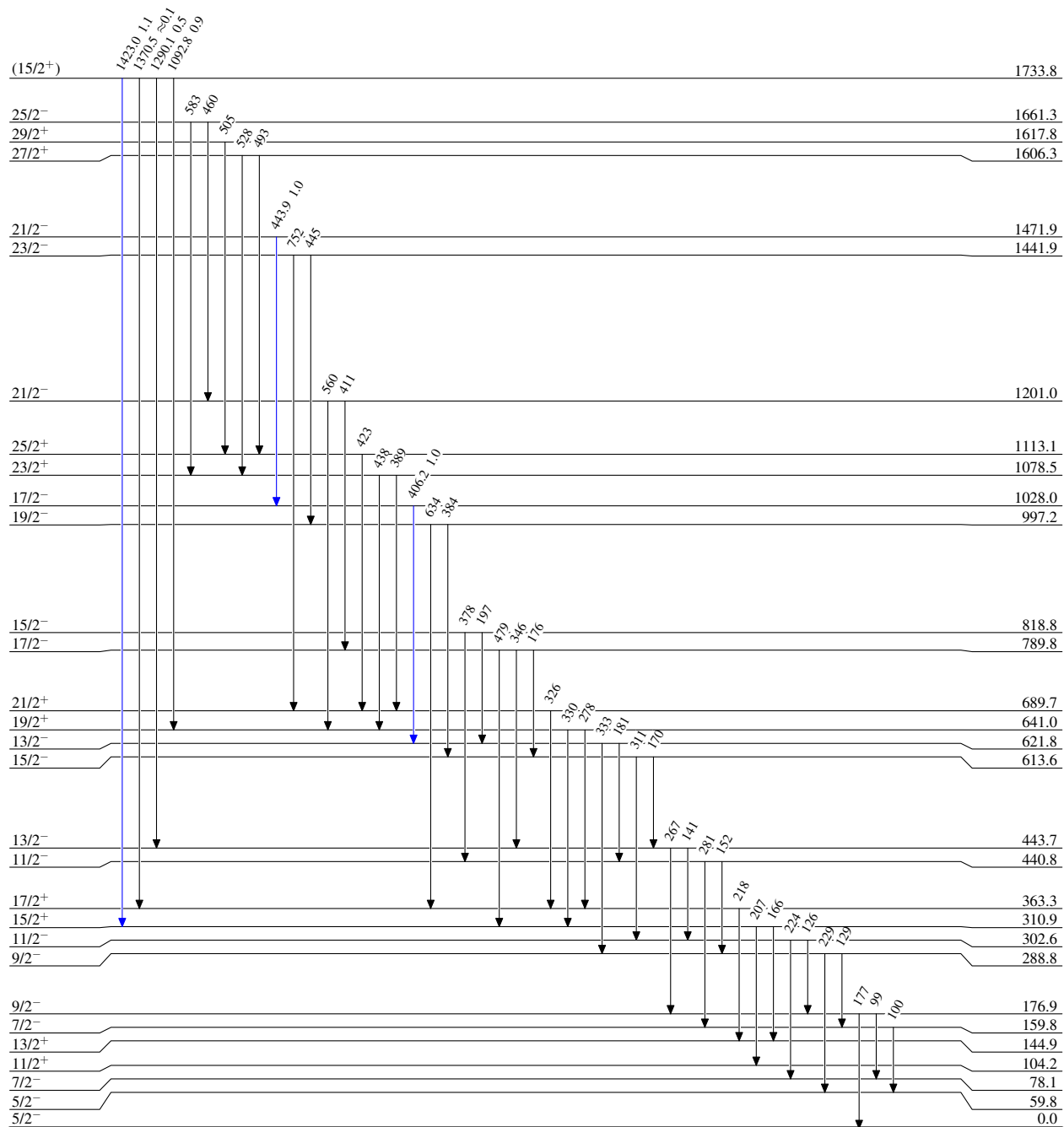
$^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ 2001Sc49

Level Scheme (continued)

Intensities: Relative I_γ

Legend

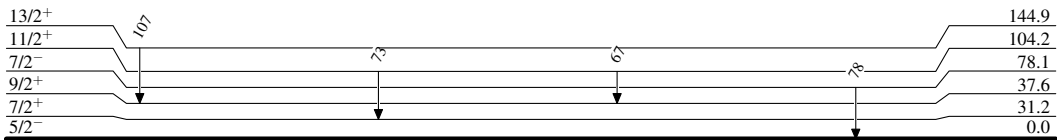
- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$

 $^{169}_{72}\text{Hf}_{97}$

⁹⁶Zr(⁷⁶Ge,3n γ) 2001Sc49

Level Scheme (continued)

Intensities: Relative I _{γ}

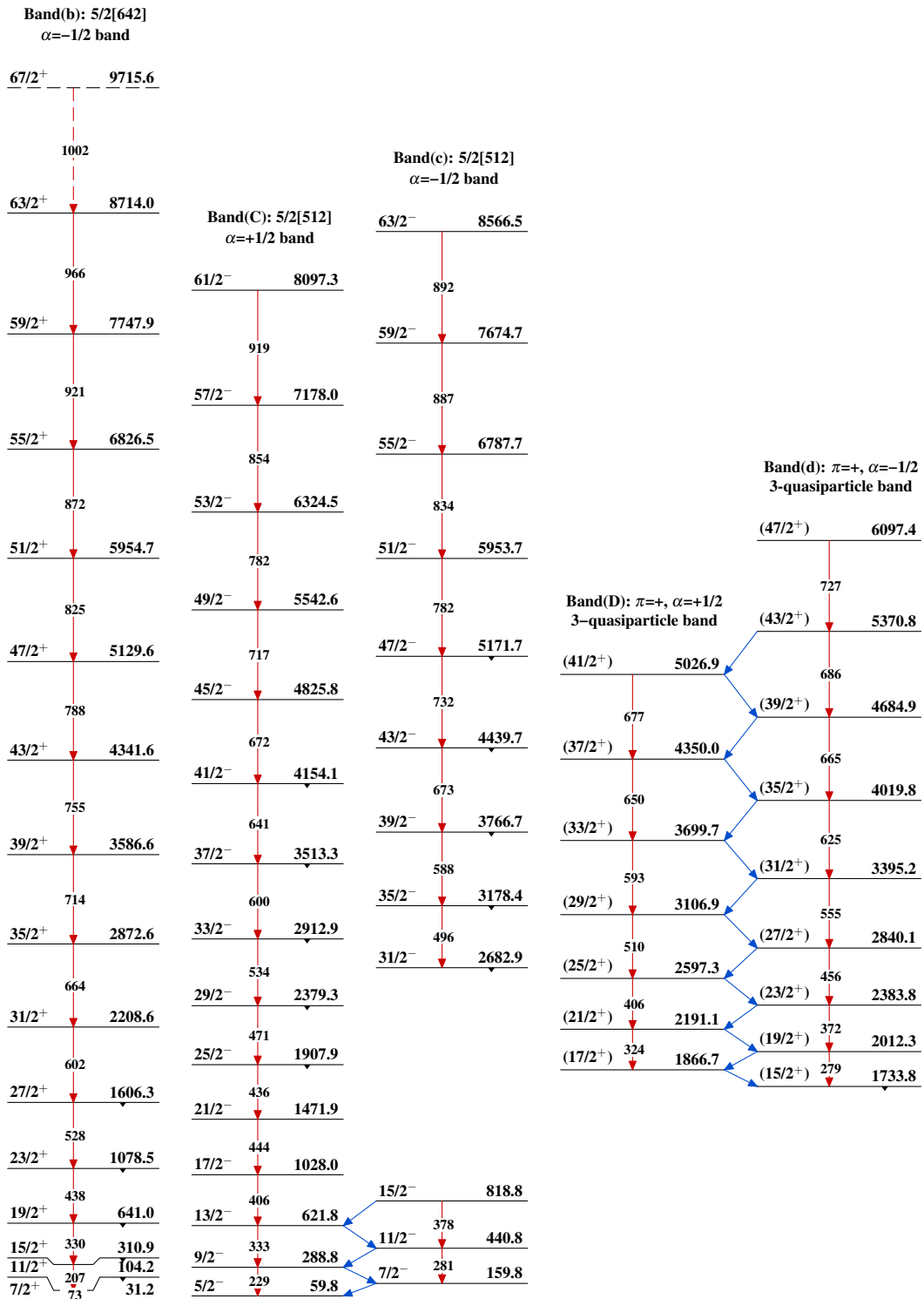


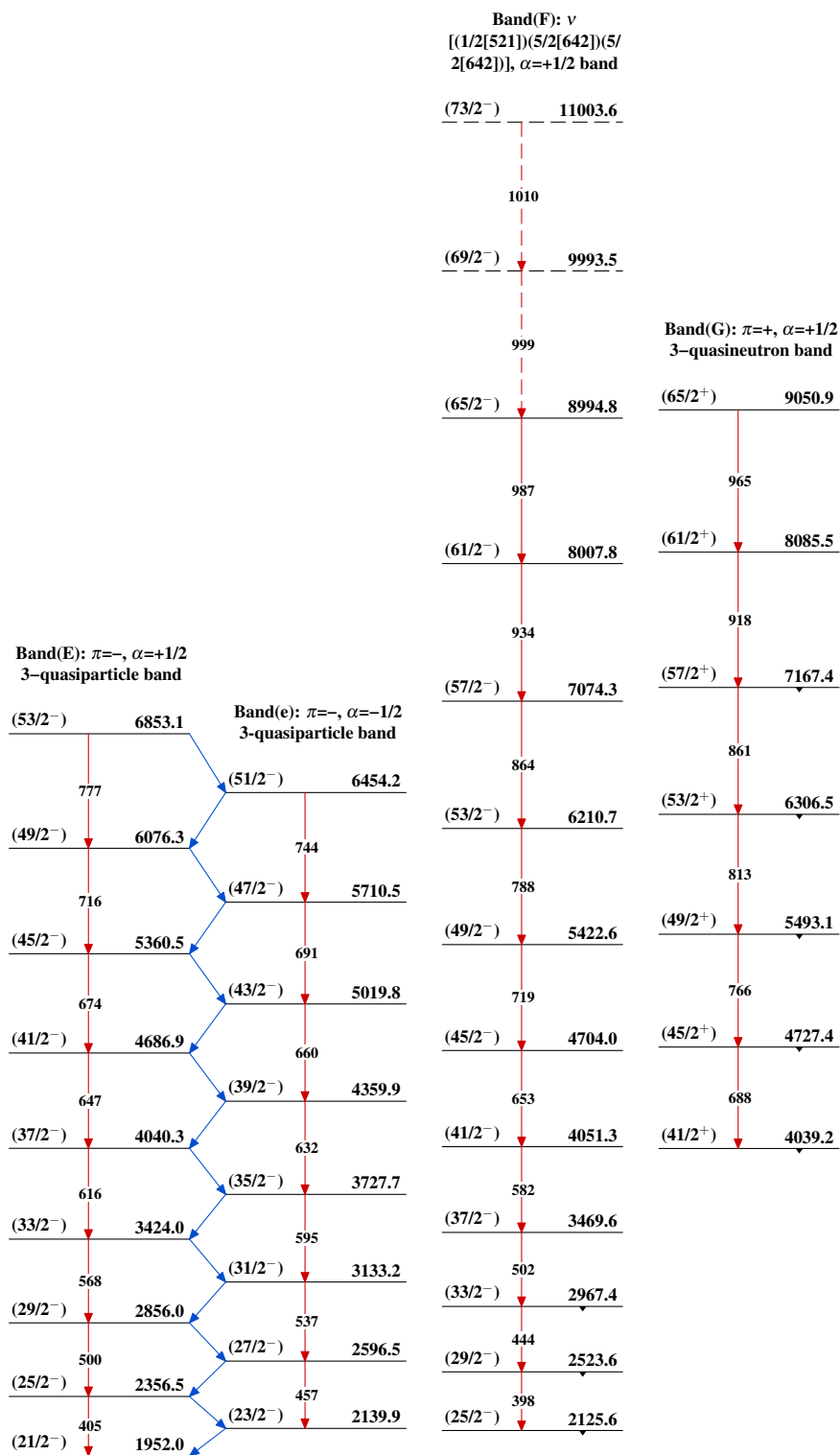
¹⁶⁹Hf₇₂⁹⁷

$^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ 2001Sc49

Band(A): 5/2[523] $\alpha=+1/2$ band		Band(a): 5/2[523] $\alpha=-1/2$ band		Band(B): 5/2[642] $\alpha=+1/2$ band	
85/2 ⁻	14273.2	87/2 ⁻	14380.3	89/2 ⁺	15286.1
↓ 1137		↓ 1113		↓ 1179	
81/2 ⁻	13136.2	83/2 ⁻	13267.5	85/2 ⁺	14107.3
↓ 1106		↓ 1051		↓ 1160	
77/2 ⁻	12030.2	79/2 ⁻	12216.5	81/2 ⁺	12947.2
↓ 1117		↓ 989		↓ 1148	
73/2 ⁻	10912.9	75/2 ⁻	11227.1	77/2 ⁺	11799.0
↓ 1092		↓ 937		↓ 1131	
69/2 ⁻	9821.0	71/2 ⁻	10289.7	73/2 ⁺	10668.3
↓ 1041		↓ 889		↓ 1101	
65/2 ⁻	8780.2	67/2 ⁻	9400.4	69/2 ⁺	9567.5
↓ 979		↓ 866		↓ 1059	
61/2 ⁻	7801.7	63/2 ⁻	8534.3	65/2 ⁺	8508.3
↓ 911		↓ 958		↓ 1005	
57/2 ⁻	6890.7	59/2 ⁻	7576.3	61/2 ⁺	7503.3
↓ 848		↓ 914		↓ 943	
53/2 ⁻	6042.7	55/2 ⁻	6662.3	57/2 ⁺	6560.3
↓ 795		↓ 850		↓ 875	
49/2 ⁻	5247.7	51/2 ⁻	5812.3	53/2 ⁺	5685.3
↓ 740		↓ 783		↓ 806	
45/2 ⁻	4507.7	47/2 ⁻	5029.5	49/2 ⁺	4879.4
↓ 677		↓ 714		↓ 741	
41/2 ⁻	3830.7	43/2 ⁻	4315.5	45/2 ⁺	4138.5
↓ 612		↓ 647		↓ 687	
37/2 ⁻	3218.7	39/2 ⁻	3668.5	41/2 ⁺	3451.3
↓ 553		↓ 605		↓ 649	
33/2 ⁻	2665.5	35/2 ⁻	3063.5	37/2 ⁺	2801.9
↓ 513		↓ 581		↓ 616	
29/2 ⁻	2152.4	31/2 ⁻	2482.0	33/2 ⁺	2186.4
↓ 491		↓ 543		↓ 569	
25/2 ⁻	1661.3	27/2 ⁻	1938.6	29/2 ⁺	1617.8
↓ 460		↓ 497		↓ 505	
21/2 ⁻	1201.0	23/2 ⁻	1441.9	25/2 ⁺	1113.1
↓ 411		↓ 445		↓ 423	
17/2 ⁻	789.8	19/2 ⁻	997.2	21/2 ⁺	689.7
↓ 346		↓ 384		↓ 326	
13/2 ⁻	443.7	15/2 ⁻	613.6	17/2 ⁺	363.3
↓ 267		↓ 311		↓ 218	
9/2 ⁻	176.9	11/2 ⁻	302.6	13/2 ⁺	144.9
↓ 177		↓ 224		↓ 107	
5/2 ⁻	0.0	7/2 ⁻	78.1	9/2 ⁺	37.6

 $^{169}_{72}\text{Hf}_{97}$

$^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ 2001Sc49 (continued)

$^{96}\text{Zr}(^{76}\text{Ge}, 3n\gamma)$ 2001Sc49 (continued) $^{169}_{72}\text{Hf}_{97}$

$^{130}\text{Te}(^{44}\text{Ca},5\text{n}\gamma), ^{124}\text{Sn}(^{50}\text{Ti},5\text{n}\gamma)$ **1991Ga18,1990IrZZ**

Slightly edited, no significant changes compared to that in the previous evaluation (2008Ba31) by C.M. Baglin.

1991Ga18: E(^{44}Ca)=195 MeV; HHIRF Spin Spectrometer (18 Compton-suppressed Ge + 52 NaI elements), measured E γ , I γ , $\gamma\gamma$ coin; HHIRF Compact Ball Array (20 Compton-suppressed Ge detectors at 45°, 90° and 135°), Au-backed enriched ^{130}Te target, measured $\gamma\gamma\gamma$ coin, lifetimes using DSAM.**1990IrZZ:** E(^{50}Ti)=205 MeV; ESSA30 detector array; observed 5/2[642] band members through J=57/2, and 5/2[523] band members through J=49/2. The authors give no further details of results. ^{169}Hf Levels

E(level) [†]	J π [#]	T _{1/2} [‡]	Comments
0.0 ^a	5/2 ⁻		
28.86 ^d 26	7/2 ⁺		
35.7 ^c 4	9/2 ⁺		
77.84 ^b 16	7/2 ⁻		
102.96 ^d 32	11/2 ⁺		
143.9 ^c 4	13/2 ⁺		
177.26 ^a 16	9/2 ⁻		
302.76 ^b 19	11/2 ⁻		
310.5 ^d 4	15/2 ⁺		
362.7 ^c 4	17/2 ⁺		
444.54 ^a 22	13/2 ⁻		
614.18 ^b 23	15/2 ⁻		
641.3 ^d 4	19/2 ⁺		
689.1 ^c 4	21/2 ⁺		
790.89 ^a 27	17/2 ⁻		
998.43 ^b 27	19/2 ⁻		
1079.5 ^d 4	23/2 ⁺		
1112.6 ^c 5	25/2 ⁺		
1202.30 ^a 30	21/2 ⁻		
1443.82 ^b 30	23/2 ⁻		
1607.8 ^d 5	27/2 ⁺		
1618.0 ^c 5	29/2 ⁺		
1663.00 ^a 34	25/2 ⁻		
1941.72 ^b 34	27/2 ⁻		
2154.7 ^a 4	29/2 ⁻		
2188.0 ^c 5	33/2 ⁺		
2210.6 ^d 5	31/2 ⁺		
2485.4 ^b 4	31/2 ⁻		
2668.4 ^a 4	33/2 ⁻		
2804.1 ^c 5	37/2 ⁺		
2874.1 ^d 5	35/2 ⁺		
3066.9 ^b 4	35/2 ⁻		
3221.7 ^a 5	37/2 ⁻		
3454.2 ^c 6	41/2 ⁺		
3588.1 ^d 5	39/2 ⁺	0.29 ps 19	T _{1/2} : from $\tau=0.42$ ps 27.
3673.4 ^b 5	39/2 ⁻		
3834.0 ^a 5	41/2 ⁻		
4142.0 ^c 6	45/2 ⁺	0.29 ps 5	T _{1/2} : from $\tau=0.42$ ps 7.
4321.8 ^b 5	43/2 ⁻	0.20 ps +11-7	T _{1/2} : from $\tau=0.29$ ps +16-10.

Continued on next page (footnotes at end of table)

$^{130}\text{Te}(^{44}\text{Ca},5n\gamma), ^{124}\text{Sn}(^{50}\text{Ti},5n\gamma)$ **1991Ga18,1990IrZZ (continued)** ^{169}Hf Levels (continued)

E(level) [†]	J ^π [#]	T _{1/2} [‡]	Comments
4342.9 ^d 6	43/2 ⁺	0.20 ps +13-9	T _{1/2} : from τ=0.29 ps +19-13.
4511.6 ^a 6	45/2 ⁻	0.23 ps 4	T _{1/2} : from τ=0.33 ps 6.
4883.2 ^c 6	49/2 ⁺	0.18 ps 4	T _{1/2} : from τ=0.26 ps 6.
5036.1 ^b 6	47/2 ⁻	0.21 ps +10-14	T _{1/2} : from τ=0.31 ps +14-20.
5131.5 ^d 6	47/2 ⁺	0.15 ps 5	T _{1/2} : from τ=0.22 ps 7.
5251.6 ^a 6	49/2 ⁻	0.13 ps +5-4	T _{1/2} : from τ=0.19 ps +7-6.
5690.0 ^c 7	53/2 ⁺	0.055 ps 21	T _{1/2} : from τ=0.08 ps 3.
5818.9 ^b 6	51/2 ⁻	0.11 ps 3	T _{1/2} : from τ=0.16 ps 4.
5957.2 ^d 6	51/2 ⁺	0.14 ps 10	T _{1/2} : from τ=0.20 ps 14.
6047.1 ^a 6	53/2 ⁻	0.049 ps 21	T _{1/2} : from τ=0.07 ps 3.
6566.3 ^c 7	57/2 ⁺	0.11 ps +4-6	T _{1/2} : from τ=0.16 ps +6-8.
6668.8 ^b 6	55/2 ⁻		
6829.7 ^d 7	55/2 ⁺		
6896.3 ^a 7	57/2 ⁻	0.09 ps 4	T _{1/2} : from τ=0.13 ps 6.
7510.2 ^c 7	61/2 ⁺	0.09 ps 3	T _{1/2} : from τ=0.13 ps 5.
7582.5 ^b 7	59/2 ⁻		
7747.1 ^d 7	59/2 ⁺		
7807.6 ^a 7	61/2 ⁻	0.11 ps 6	T _{1/2} : from τ=0.16 ps 9.
8515.6 ^c 8	65/2 ⁺		
8540.3 ^b 7	63/2 ⁻		
8786.0 ^a 7	65/2 ⁻		
9545.1 ^{&b} 7	67/2 ⁻		
9575.8 ^c 8	69/2 ⁺		
9827.9 ^a 7	69/2 ⁻		
10677.8 ^c 8	73/2 ⁺		
10918.6 ^a 8	(73/2 ⁻)		
11823.8 ^{@c} 8	77/2 ⁺		
13005.3 ^{@c} 9	81/2 ⁺		

[†] From least-squares fit to E_γ.[‡] From DSAM measurements of **1991Ga18**.[#] Authors' values from **1991Ga18**. These are consistent with adopted values (apart from the use of parentheses for many adopted values) except for levels with E>9400 whose energies have not been adopted.[@] Adopted energy differs because gammas placed here as 77/2⁺ to 73/2⁺ and as 81/2⁺ to 77/2⁺ transitions, respectively, are in fact the 81/2⁺ to 77/2⁺ and the 89/2⁺ to 85/2⁺ transitions.[&] Level not included in Adopted Levels because a subsequent (HI,xnγ) study (viz. that by **2001Sc49**) did not confirm the γ shown deexciting the level here.^a Band(A): 5/2[523] α=+1/2 band.^b Band(a): 5/2[523] α=-1/2 band.^c Band(B): 5/2[642] α=+1/2 band.^d Band(b): 5/2[642] α=-1/2 band.

$^{130}\text{Te}(^{44}\text{Ca},5\text{n}\gamma), ^{124}\text{Sn}(^{50}\text{Ti},5\text{n}\gamma)$ **1991Ga18,1990IrZZ (continued)** $\gamma(^{169}\text{Hf})$

E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π
(7.1 ‡ 3)		35.7	9/2 ⁺	28.86	7/2 ⁺
67.0 2		102.96	11/2 ⁺	35.7	9/2 ⁺
74.1 2	6.4 26	102.96	11/2 ⁺	28.86	7/2 ⁺
77.8 2	0.68 20	77.84	7/2 ⁻	0.0	5/2 ⁻
99.2 2	0.71 10	177.26	9/2 ⁻	77.84	7/2 ⁻
108.4 2	5.4 2	143.9	13/2 ⁺	35.7	9/2 ⁺
125.3 2	0.47 10	302.76	11/2 ⁻	177.26	9/2 ⁻
148.4 2	3.0 2	177.26	9/2 ⁻	28.86	7/2 ⁺
166.8 2	15.4 9	310.5	15/2 ⁺	143.9	13/2 ⁺
169.7 2	0.47 5	614.18	15/2 ⁻	444.54	13/2 ⁻
177.3 2	9.1 1	177.26	9/2 ⁻	0.0	5/2 ⁻
207.3 2	24.4 2	310.5	15/2 ⁺	102.96	11/2 ⁺
207.5 2	2.0 2	998.43	19/2 ⁻	790.89	17/2 ⁻
218.8 2	85 4	362.7	17/2 ⁺	143.9	13/2 ⁺
225.1 2	5.5 2	302.76	11/2 ⁻	77.84	7/2 ⁻
241.4 2	0.48 12	1443.82	23/2 ⁻	1202.30	21/2 ⁻
267.3 2	33.0 17	444.54	13/2 ⁻	177.26	9/2 ⁻
278.7 2	11.6 5	641.3	19/2 ⁺	362.7	17/2 ⁺
278.9 2	2.0 2	1941.72	27/2 ⁻	1663.00	25/2 ⁻
311.4 2	15.9 14	614.18	15/2 ⁻	302.76	11/2 ⁻
326.5 2	100 1	689.1	21/2 ⁺	362.7	17/2 ⁺
330.6 2	5.9 11	2485.4	31/2 ⁻	2154.7	29/2 ⁻
330.8 2	29.6 2	641.3	19/2 ⁺	310.5	15/2 ⁺
346.3 2	30.8 4	790.89	17/2 ⁻	444.54	13/2 ⁻
384.3 2	17.7 3	998.43	19/2 ⁻	614.18	15/2 ⁻
390.3 2	5.0 2	1079.5	23/2 ⁺	689.1	21/2 ⁺
411.4 2	33.2 5	1202.30	21/2 ⁻	790.89	17/2 ⁻
423.6 2	98 1	1112.6	25/2 ⁺	689.1	21/2 ⁺
438.1 2	32.3 20	1079.5	23/2 ⁺	641.3	19/2 ⁺
445.4 2	34 3	1443.82	23/2 ⁻	998.43	19/2 ⁻
460.8 2	33.8 8	1663.00	25/2 ⁻	1202.30	21/2 ⁻
491.6 2	30.6 6	2154.7	29/2 ⁻	1663.00	25/2 ⁻
495.1 2	3.8 8	1607.8	27/2 ⁺	1112.6	25/2 ⁺
497.8 2	30 5	1941.72	27/2 ⁻	1443.82	23/2 ⁻
505.5 2	108 1	1618.0	29/2 ⁺	1112.6	25/2 ⁺
513.7 2	25.4 4	2668.4	33/2 ⁻	2154.7	29/2 ⁻
528.2 2	29.3 2	1607.8	27/2 ⁺	1079.5	23/2 ⁺
543.7 2	25.2 6	2485.4	31/2 ⁻	1941.72	27/2 ⁻
553.3 2	19.5 5	3221.7	37/2 ⁻	2668.4	33/2 ⁻
569.8 2	104 1	2188.0	33/2 ⁺	1618.0	29/2 ⁺
581.5 2	23.9 6	3066.9	35/2 ⁻	2485.4	31/2 ⁻
592.9 2	2.5 5	2210.6	31/2 ⁺	1618.0	29/2 ⁺
602.7 2	20.8 6	2210.6	31/2 ⁺	1607.8	27/2 ⁺
606.5 2	15.3 8	3673.4	39/2 ⁻	3066.9	35/2 ⁻
612.3 2	16.6 4	3834.0	41/2 ⁻	3221.7	37/2 ⁻
616.1 2	88 1	2804.1	37/2 ⁺	2188.0	33/2 ⁺
648.4 2	11.7 6	4321.8	43/2 ⁻	3673.4	39/2 ⁻
650.1 2	67 1	3454.2	41/2 ⁺	2804.1	37/2 ⁺
663.7 2	13.4 7	2874.1	35/2 ⁺	2210.6	31/2 ⁺
677.6 2	13.0 5	4511.6	45/2 ⁻	3834.0	41/2 ⁻
686.0 & 2	3.0 9	2874.1	35/2 ⁺	2188.0	33/2 ⁺
687.8 2	49.3 8	4142.0	45/2 ⁺	3454.2	41/2 ⁺
714.0 2	9.9 9	3588.1	39/2 ⁺	2874.1	35/2 ⁺
714.3 2	9.6 5	5036.1	47/2 ⁻	4321.8	43/2 ⁻
740.0 2	8.0 4	5251.6	49/2 ⁻	4511.6	45/2 ⁻

Continued on next page (footnotes at end of table)

$^{130}\text{Te}(^{44}\text{Ca},5n\gamma), ^{124}\text{Sn}(^{50}\text{Ti},5n\gamma)$ **1991Ga18,1990IrZZ (continued)** $\gamma(^{169}\text{Hf})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π
741.2 2	28.1 6	4883.2	49/2 ⁺	4142.0	45/2 ⁺
754.8 2	5.0 2	4342.9	43/2 ⁺	3588.1	39/2 ⁺
782.8 2	7.1 4	5818.9	51/2 ⁻	5036.1	47/2 ⁻
788.6 2	3.7 2	5131.5	47/2 ⁺	4342.9	43/2 ⁺
795.5 2	5.2 3	6047.1	53/2 ⁻	5251.6	49/2 ⁻
806.8 2	20.8 7	5690.0	53/2 ⁺	4883.2	49/2 ⁺
825.7 2	2.2 4	5957.2	51/2 ⁺	5131.5	47/2 ⁺
849.2 2	3.4 5	6896.3	57/2 ⁻	6047.1	53/2 ⁻
849.9 2	4.1 8	6668.8	55/2 ⁻	5818.9	51/2 ⁻
872.5 2	1.5 8	6829.7	55/2 ⁺	5957.2	51/2 ⁺
876.3 2	14.3 3	6566.3	57/2 ⁺	5690.0	53/2 ⁺
911.3 2	2.1 4	7807.6	61/2 ⁻	6896.3	57/2 ⁻
913.7 2	3.7 9	7582.5	59/2 ⁻	6668.8	55/2 ⁻
917.4 2	1.3 7	7747.1	59/2 ⁺	6829.7	55/2 ⁺
943.9 2	6.2 3	7510.2	61/2 ⁺	6566.3	57/2 ⁺
957.8 2	1.6 8	8540.3	63/2 ⁻	7582.5	59/2 ⁻
978.4 2	1.1 5	8786.0	65/2 ⁻	7807.6	61/2 ⁻
1004.8 [#] 2	0.6 3	9545.1	67/2 ⁻	8540.3	63/2 ⁻
1005.4 2	4.4 3	8515.6	65/2 ⁺	7510.2	61/2 ⁺
1041.9 2	0.48 24	9827.9	69/2 ⁻	8786.0	65/2 ⁻
1060.2 2	1.5 3	9575.8	69/2 ⁺	8515.6	65/2 ⁺
1090.7 ^{&} 2	0.52 26	10918.6?	(73/2 ⁻)	9827.9	69/2 ⁻
1102.0 2	0.7 3	10677.8	73/2 ⁺	9575.8	69/2 ⁺
1146.0 [@] 2	0.36 18	11823.8	77/2 ⁺	10677.8	73/2 ⁺
1181.5 [@] 2	0.27 14	13005.3	81/2 ⁺	11823.8	77/2 ⁺

[†] E_γ and relative photon intensity data are from **1991Ga18**, except as noted. The energy uncertainty typically is ≈ 0.2 keV.[‡] γ not observed; deduced from the difference of $E_\gamma=74.1$ 2 and $E_\gamma=67.0$ 2 depopulating the 103 keV level.[#] γ is probably incorrectly placed; see comment on 9545 level.[@] γ placed higher in cascade in Adopted Levels.[&] Placement of transition in the level scheme is uncertain.

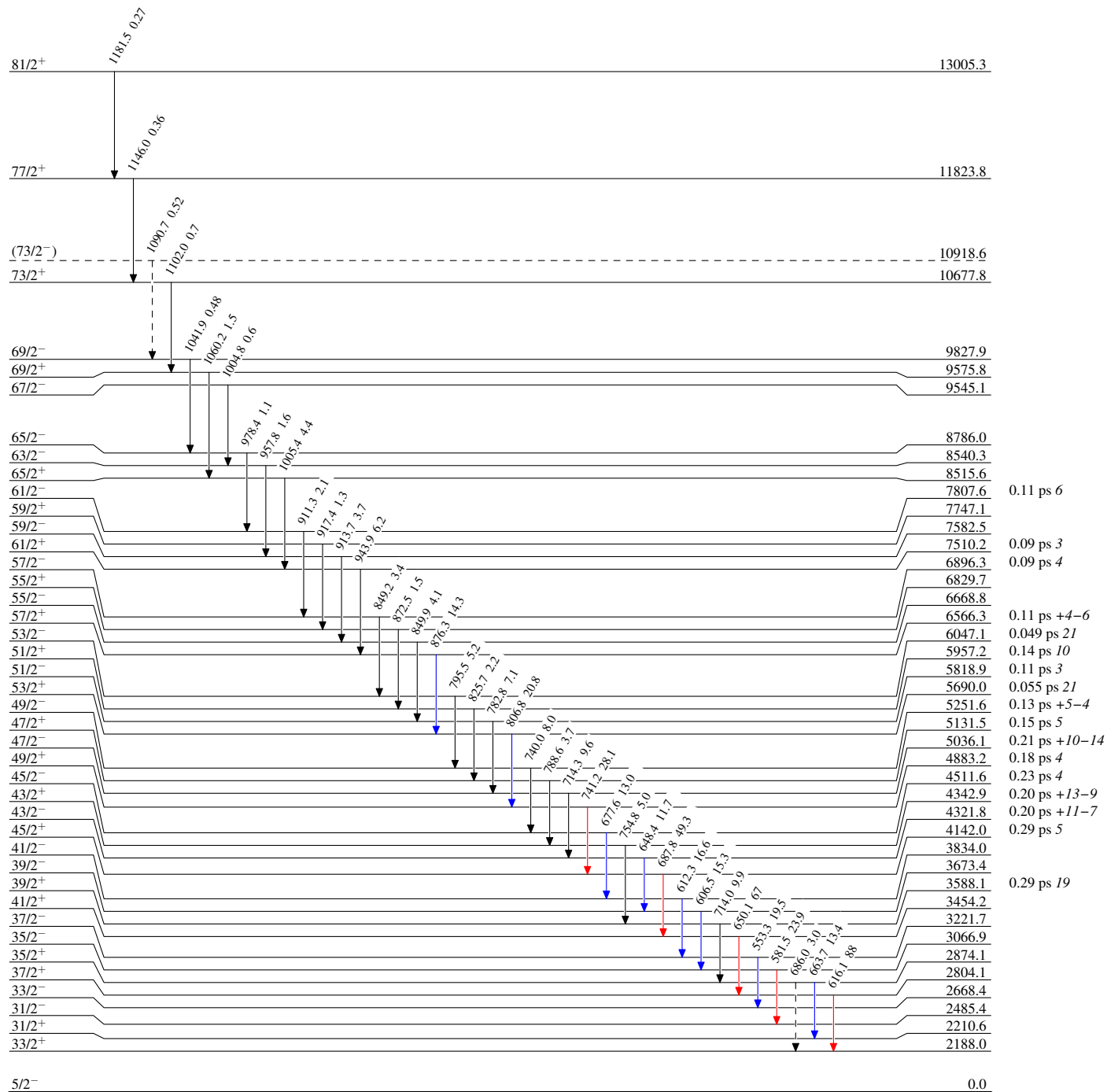
$^{130}\text{Te}(^{44}\text{Ca},5n\gamma), ^{124}\text{Sn}(^{50}\text{Ti},5n\gamma)$ 1991Ga18,1990IrZZ

Legend

Level Scheme

 Intensities: relative I_γ from $(^{44}\text{Ca},5n\gamma)$

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$
- - - γ Decay (Uncertain)



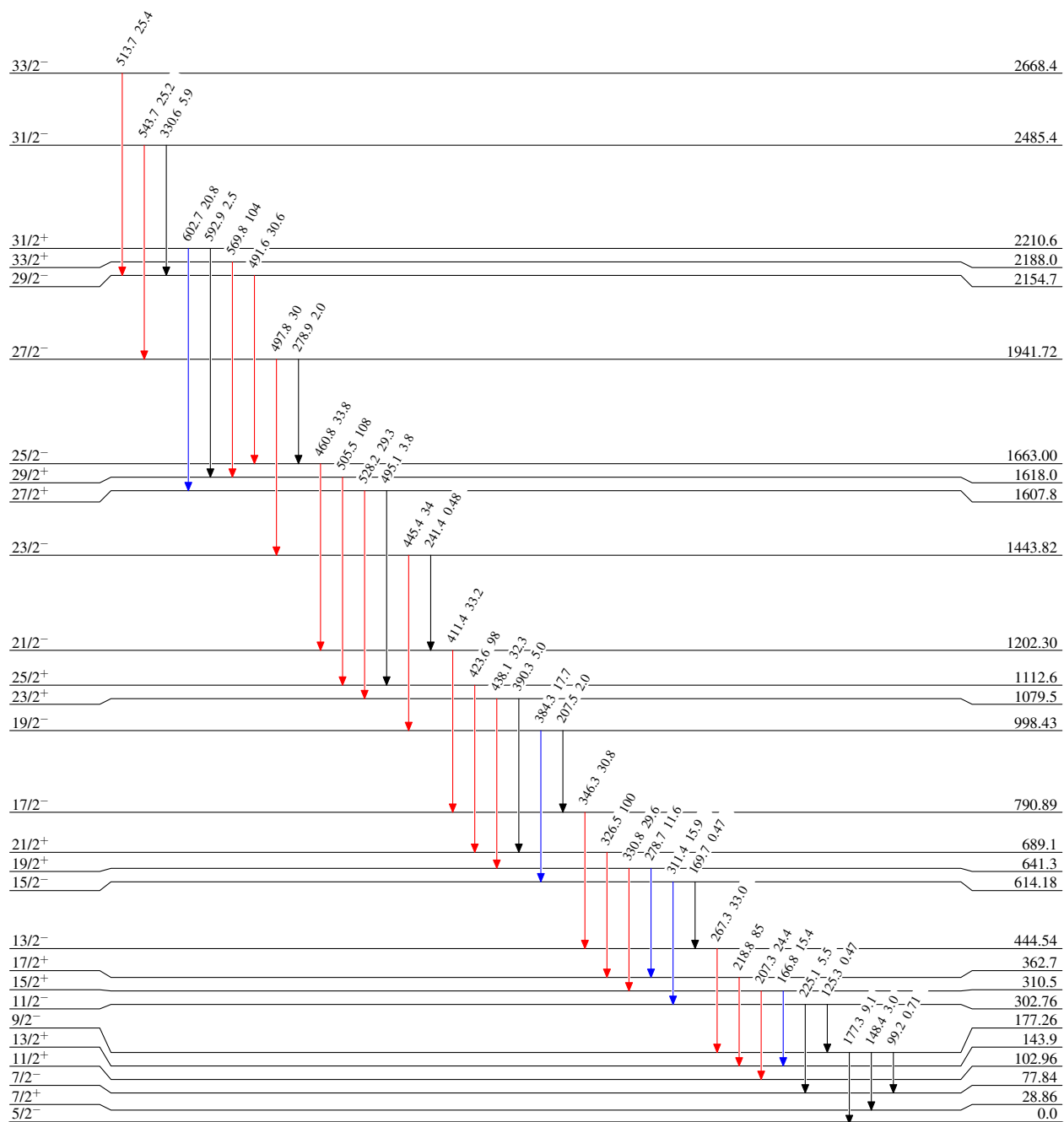
$^{130}\text{Te}(^{44}\text{Ca},5n\gamma), ^{124}\text{Sn}(^{50}\text{Ti},5n\gamma)$ 1991Ga18,1990IrZZ

Level Scheme (continued)

Intensities: relative I_γ from $(^{44}\text{Ca},5n\gamma)$

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$

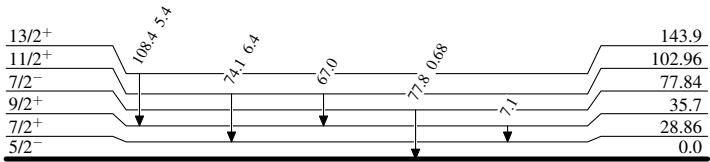
 $^{169}_{72}\text{Hf}_{97}$

¹³⁰Te(⁴⁴Ca,5nγ), ¹²⁴Sn(⁵⁰Ti,5nγ) 1991Ga18,1990IrZZ

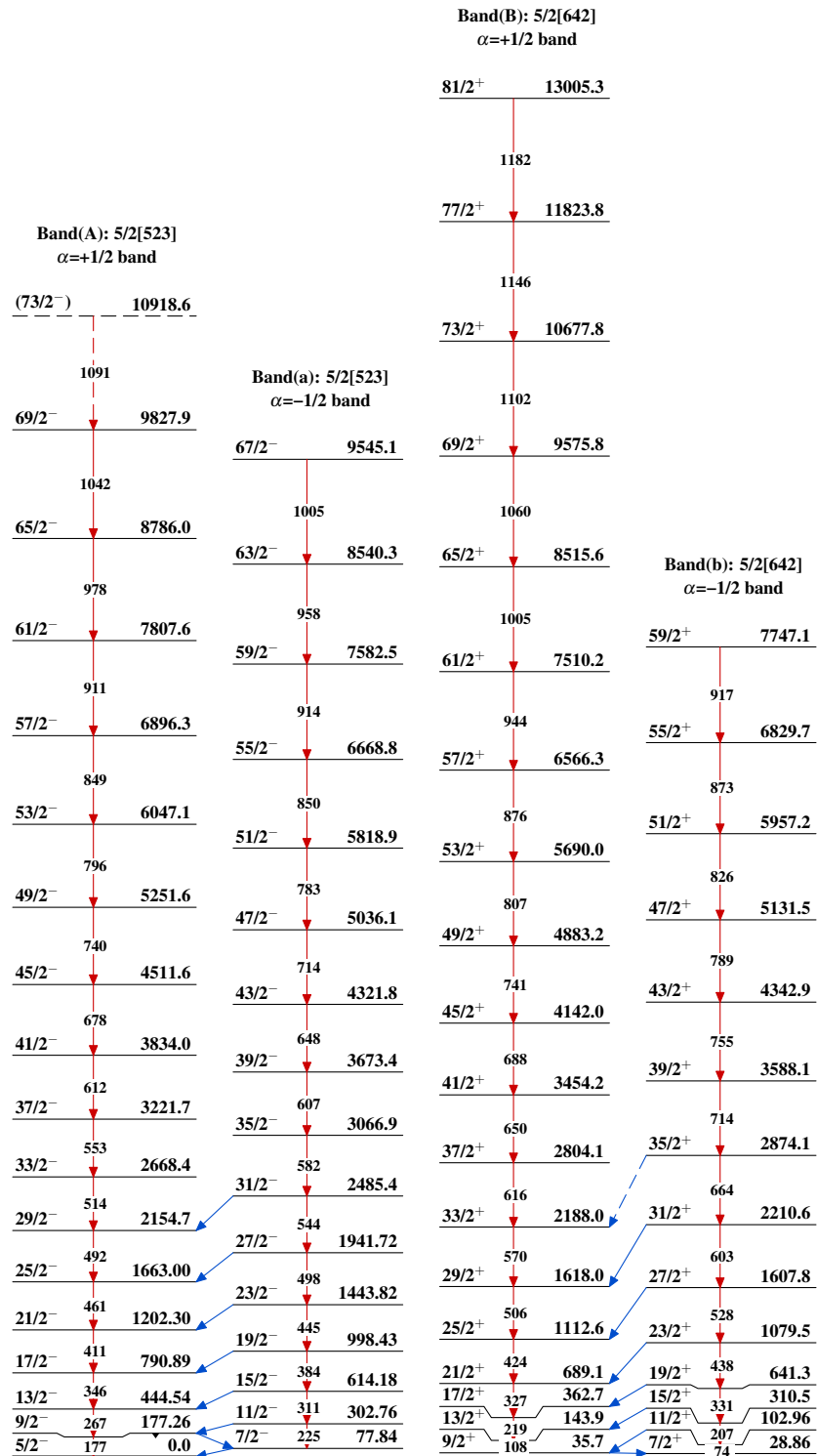
Legend

Level Scheme (continued)
Intensities: relative I_γ from (⁴⁴Ca,5nγ)

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}
- - - - - → γ Decay (Uncertain)



¹⁶⁹Hf₇₂⁹⁷

$^{130}\text{Te}(^{44}\text{Ca},5n\gamma), ^{124}\text{Sn}(^{50}\text{Ti},5n\gamma)$ 1991Ga18,1990IrZZ

$^{159}\text{Tb}(^{14}\text{N},4n\gamma)$ 1975Re05

Slightly edited, no significant changes compared to that in the previous evaluation (2008Ba31) by C.M. Baglin.

$E(^{14}\text{N})=56\text{--}92$ MeV; metallic Tb targets (99.9% pure); measured excit, $E\gamma$, $I\gamma$; Ge(Li) (FWHM=1.5-2.0 keV at 662 keV), prompt and delayed $\gamma\gamma$ coin, $\gamma(\theta)$ ($\theta=30^\circ$ to 120°); used pulsed beam to look for isomeric states (except for 28.8 level, no γ -emitting isomers were found in the 50-ns to 200-ms range). Used Nilsson model (including Coriolis-coupling effects) to interpret level structure.

 ^{169}Hf Levels

E(level) [†]	J^π [‡]	$T_{1/2}$	Comments
0.0 [#]	5/2 ⁻		
28.80 [@] 8	7/2 ⁺	82 ^a ns +40-15	
34.74 [@] 23	9/2 ⁺		
38.18 [@] 4	(5/2 ⁺)		E(level): tentative band member proposed in 1975Re05.
59.16 ^{&} 8	5/2 ⁻		
77.70 [#] 8	7/2 ⁻		
102.00 [@] 22	11/2 ⁺		
142.58 [@] 24	13/2 ⁺		
158.79 ^{&} 8	7/2 ⁻		
177.20 [#] 7	9/2 ⁻		
288.73 ^{&} 10	9/2 ⁻		
302.70 [#] 13	11/2 ⁻		
309.06 [@] 23	15/2 ⁺		
361.23 [@] 25	17/2 ⁺		
442.86 ^{&} 11	11/2 ⁻		
444.30 [#] 12	13/2 ⁻		
613.90 [#] 16	15/2 ⁻		
622.16 ^{&} 13	13/2 ⁻		
639.81 [@] 24	19/2 ⁺		
687.51 [@] 26	21/2 ⁺		
790.50 [#] 16	17/2 ⁻		
820.46 ^{&} 13	15/2 ⁻		
998.40 [#] 26	19/2 ⁻		
1077.73 [@] 26	23/2 ⁺		
1110.91 [@] 28	25/2 ⁺		
1201.70 [#] 19	21/2 ⁻		
1443.60 [#] 28	23/2 ⁻		
1605.73 [@] 28	27/2 ⁺		
1616.31 [@] 30	29/2 ⁺		
1662.30 [#] 21	25/2 ⁻		
1941.20 [#] 34	27/2 ⁻		
2152.5 [#] 6	29/2 ⁻		
2186.0 [@] 4	33/2 ⁺		
2208.44 [@] 34	31/2 ⁺		
2484.7 [#] 4	31/2 ⁻		
2801.6 [@] 4	37/2 ⁺		
2871.4? [@] 6	(35/2 ⁺)		

Continued on next page (footnotes at end of table)

$^{159}\text{Tb}(^{14}\text{N},4n\gamma)$ **1975Re05** (continued) ^{169}Hf Levels (continued)

E(level) [†]	$J^{\pi\ddagger}$
3451.1 [@] 7	41/2 ⁺
4138.1? [@] 21	45/2 ⁺
4856.1? ^{@b} 29	(49/2 ⁺) ^b

[†] From a least-squares fit to E_{γ} .[‡] Authors' values from coincidence data, rotational structure, and γ -ray multipolarities. These are consistent with values in Adopted Levels and differ only with regard to the addition of parentheses to most adopted values.

Band(A): 5/2[523] band.

@ Band(B): 5/2[642] band. Structure strongly perturbed.

& Band(C): 5/2[512] band.

^a From $\gamma\gamma(t)$.^b Not adopted; deexciting γ not confirmed in other (HI,xn γ) reaction studies. $\gamma(^{169}\text{Hf})$ $I_{\gamma}(\text{K x ray})$ (relative to $I_{\gamma}(207.1)=100$).

K	x ray	E_{γ}	I_{γ}
-----	-----	-----	-----
Hf $K\alpha_2$	x ray + Lu $K\alpha_1$	x ray	54.3
Hf $K\alpha_1$	x ray	55.9	450
Hf $K\beta_1'$	x ray	63.1	190
Hf $K\beta_2'$	x ray	65.1	60

E_{γ} [†]	I_{γ} [‡]	$E_i(\text{level})$	J_i^{π}	E_f	J_f^{π}	Mult. [#]	Comments
(5.9 2)		34.74	9/2 ⁺	28.80	7/2 ⁺		
^x 22.0 2	54						E_{γ} : from energy difference between $E_{\gamma}=73.2$ 2 and $E_{\gamma}=67.3$ 1 from 102.00 keV level.
^x 23.1 1	260						
^x 26.1 1	45						
28.8 1	150 15	28.80	7/2 ⁺	0.0	5/2 ⁻		
^x 32.1 1	710						
^x 33.2 2	120						
^x 34.2 1	350						
(38.18 4)		38.18	(5/2 ⁺)	0.0	5/2 ⁻		E_{γ} : from Adopted Gammas.
59.1 1	&	59.16	5/2 ⁻	0.0	5/2 ⁻		
^x 61.3 1	220						
67.3 1	30 6	102.00	11/2 ⁺	34.74	9/2 ⁺		
^x 68.6 1	17						
73.2 2	17 4	102.00	11/2 ⁺	28.80	7/2 ⁺		
^x 75.0 1	23						
^x 76.4 2	25						
77.8 1	53 11	77.70	7/2 ⁻	0.0	5/2 ⁻		$A_2=+0.32$ 21; $A_4=+0.1$ 3
^x 84.8 1	15						
^x 88.5 1	43						
^x 92.9 2	9						$A_2=-0.1$ 3; $A_4=+0.3$ 5
^x 94.5 1	23						
99.6 ^b 1	26 ^b 3	158.79	7/2 ⁻	59.16	5/2 ⁻	D+Q	I_{γ} : deduced from $I_{\gamma}=29$ 3 for both placements of 99.6 γ and

Continued on next page (footnotes at end of table)

$^{159}\text{Tb}(^{14}\text{N},4n\gamma)$ **1975Re05** (continued) $\gamma(^{169}\text{Hf})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^\ddagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. #	$\delta^\oplus$	Comments
								$I_\gamma=3.4$ for placement from 177.2 level (based on adopted branching). Mult.: from $A_2=-0.19$ 11, $A_4=+0.14$ 16 for doublet dominated by this transition. I_γ : from adopted $I_\gamma(99.6\gamma)/I_\gamma(177.1\gamma)=0.078$ 11 and $I_\gamma(177.1\gamma)=44.0$. $I_\gamma=29$ 3 for 99.6 γ doublet. 1975Re05 deduce $\delta(\text{D,Q})=0.70$ 21 from branching ratio and rotational model assuming $K=5/2$, but it is unclear how, or if, they divided $I(99.6\gamma)$ between its two placements.
99.6 ^b 1	3.4 ^b 5	177.20	9/2 ⁻	77.70	7/2 ⁻			$A_2=+0.34$ 4; $A_4=+0.03$ 7
107.8 1	41 4	142.58	13/2 ⁺	34.74	9/2 ⁺	Q		$A_2=+0.13$ 17; $A_4=+0.3$ 3 $A_2=+0.32$ 20; $A_4=+0.4$ 3 $A_2=+0.2$ 5; $A_4=+0.6$ 6
^x 111.3 2	3							$A_2=-0.16$ 21; $A_4=0.0$ 3
^x 113.4 1	9							$A_2=-0.40$ 8; $A_4=+0.11$ 13
^x 117.3 1	7							$\delta: -4.0 \leq \delta \leq -0.05$ from $\gamma(\theta)$. 0.35 10 based on branching.
^x 119.9 2	18							$A_2=+0.08$ 19; $A_4=+0.1$ 3
^x 122.3 2	24							$A_2=+0.33$ 22; $A_4=+0.3$ 3
^x 125.5 2	9.4					D(+Q)		$A_2=-0.17$ 7; $A_4=+0.09$ 12
130.0 1	29 3	288.73	9/2 ⁻	158.79	7/2 ⁻	D+Q	-2 2	$A_2=-0.13$ 4; $A_4=+0.02$ 8 I_γ : much larger than expected based on adopted branching.
^x 133.4 1	3.3							$A_2=+0.4$ 6; $A_4=+0.9$ 8
^x 139.6 1	6.6							$A_2=-0.47$ 14; $A_4=-0.11$ 21
^x 146.8 1	35.1					D(+Q)		$\delta: -6.0 \leq \delta \leq -0.03$ from $\gamma(\theta)$. 0.22 7 based on branching.
148.4 1	50 ^a 10	177.20	9/2 ⁻	28.80	7/2 ⁺	D(+Q)		$A_2=+0.27$ 14; $A_4=+0.39$ 22 $A_2=+0.17$ 20; $A_4=+0.4$ 3
^x 152.5 1	7.3							$A_2=-0.69$ 16; $A_4=-0.30$ 25
154.1 1	22.8 23	442.86	11/2 ⁻	288.73	9/2 ⁻	D+Q	-3 3	$A_2=-0.88$ 4; $A_4=+0.12$ 8
^x 157.2 1	9.2							$A_2=+0.17$ 6; $A_4=-0.06$ 10
158.9 1	12.1 ^a 24	158.79	7/2 ⁻	0.0	5/2 ⁻			$A_2=-0.32$ 11; $A_4=0.00$ 17
^x 162.7 1	4.8							$\delta: -10 \leq \delta \leq +0.02$ from $\gamma(\theta)$. 0.18 5 based on branching.
^x 164.8 1	33.5					D+Q		$A_2=+0.13$ 20; $A_4=+0.2$ 3
166.5 1	112 11	309.06	15/2 ⁺	142.58	13/2 ⁺	D+Q	-0.8 1	$A_2=0.0$ 3; $A_4=+0.7$ 4
^x 169.3 2	6.8							$A_2=-0.1$ 3; $A_4=-0.5$ 5
^x 170.8 2	7.3							$A_2=+0.37$ 20; $A_4=+0.6$ 3
^x 172.0 4	3.2							$A_2=+0.09$ 11; $A_4=+0.21$ 18
177.1 1	44 5	177.20	9/2 ⁻	0.0	5/2 ⁻	Q		$A_2=+0.13$ 6; $A_4=+0.24$ 10
179.3 1	24.8 25	622.16	13/2 ⁻	442.86	11/2 ⁻	D+Q	≤ 0	$A_2=+0.28$ 2; $A_4=-0.02$ 5
^x 182.0 1	21.8							$A_2=-0.46$ 19; $A_4=-0.3$ 3
^x 187.9 3	6.1							$A_2=+0.12$ 17; $A_4=+0.20$ 26
^x 189.0 2	6.0							$A_2=+0.26$ 2; $A_4=-0.07$ 5
^x 191.2 1	21.2							$A_2=+0.6$ 3; $A_4=0.0$ 4
^x 192.7 1	13.7							
198.3 1	51 ^a 6	820.46	15/2 ⁻	622.16	13/2 ⁻			
207.1 1	100 10	309.06	15/2 ⁺	102.00	11/2 ⁺	Q		
^x 213.8 2	15.2					D+Q		
^x 216.9 2	12.1							
218.6 1	241 24	361.23	17/2 ⁺	142.58	13/2 ⁺	Q		
^x 223.3 3	19.7							

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$^{159}\text{Tb}(^{14}\text{N},4n\gamma)$ **1975Re05** (continued) $\gamma(^{169}\text{Hf})$ (continued)

E_γ †	I_γ ‡	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. #	$\delta^@$	Comments
225.0 1	122 ^a 13	302.70	11/2 ⁻	77.70	7/2 ⁻			$A_2=+0.08$ 2; $A_4=+0.01$ 5
229.3 3	17.4 18	288.73	9/2 ⁻	59.16	5/2 ⁻	Q		$A_2=+0.18$ 18; $A_4=-0.14$ 26
^x 238.6 1	18.1					D+Q		$A_2=+0.78$ 19; $A_4=+0.7$ 3
^x 240.6 1	6.9							$A_2=-0.2$ 3; $A_4=-0.6$ 4
^x 241.9 2	6.9							
^x 243.2 2	9.1							$A_2=-0.03$ 26; $A_4=-0.2$ 4
^x 246.9 2	4.2							
^x 249.5 2	4.7							
^x 265.0 1	16.0					D(+Q)		$A_2=-0.19$ 17; $A_4=-0.07$ 26
267.1 1	62 7	444.30	13/2 ⁻	177.20	9/2 ⁻	Q		$A_2=+0.30$ 4; $A_4=0.00$ 7
^x 270.5 2	8.2							
278.5 1	47 5	639.81	19/2 ⁺	361.23	17/2 ⁺	D+Q	-1.0 5	$A_2=-0.81$ 7; $A_4=+0.25$ 11
284.1 1	13 2	442.86	11/2 ⁻	158.79	7/2 ⁻	Q		$A_2=+0.26$ 13; $A_4=0.00$ 21
288.5 2	5.1 10	288.73	9/2 ⁻	0.0	5/2 ⁻			
^x 295.5 2	10							
^x 304.6 1	5.5							
311.2 1	47 5	613.90	15/2 ⁻	302.70	11/2 ⁻	Q		$A_2=+0.21$ 4; $A_4=-0.09$ 7
^x 316.1 2	16							$A_2=+0.21$ 21; $A_4=+0.5$ 3
326.3 1	194 20	687.51	21/2 ⁺	361.23	17/2 ⁺	Q		$A_2=+0.29$ 2; $A_4=-0.07$ 5
330.8 1	132 13	639.81	19/2 ⁺	309.06	15/2 ⁺	Q		$A_2=+0.19$ 2; $A_4=-0.02$ 5
333.4 4	20 2	622.16	13/2 ⁻	288.73	9/2 ⁻	(Q)		$A_2=+0.22$ 12; $A_4=+0.37$ 17
^x 339.0 2	10					D(+Q)		$A_2=-0.18$ 13; $A_4=+0.09$ 20
^x 340.0 2	9.3							
346.2 1	67 7	790.50	17/2 ⁻	444.30	13/2 ⁻	Q		$A_2=+0.29$ 4; $A_4=-0.05$ 7
^x 348.7 2	19							
^x 350.7 2	19					D+Q		$A_2=-0.49$ 13; $A_4=+0.65$ 20
^x 352.0 2	24							$A_2=+0.5$ 3; $A_4=+1.1$ 4
^x 354.4 2	6.8							
^x 367.0 3	9.7							$A_2=+0.22$ 21; $A_4=+0.1$ 3
377.6 1	15 2	820.46	15/2 ⁻	442.86	11/2 ⁻	Q		$A_2=+0.41$ 10; $A_4=-0.13$ 15
^x 379.6 2	6.1							
^x 381.2 2	14.3							$A_2=+0.7$ 4; $A_4=-0.2$ 5
^x 383.6 3	17.9							
384.5 2	36 ^a 8	998.40	19/2 ⁻	613.90	15/2 ⁻	(Q)		$A_2=+0.29$ 7; $A_4=+0.02$ 11
^x 387.8 2	7.7							
^x 389.5 2	17.9							
390.3 2	17 3	1077.73	23/2 ⁺	687.51	21/2 ⁺	D+Q	-1.0 5	$A_2=-0.94$ 17; $A_4=+0.17$ 24
^x 392.3 3	7.9							$A_2=+0.3$ 3; $A_4=+0.1$ 5
^x 394.9 3	3.0							
^x 406.3 1	13.3							$A_2=+0.33$ 12; $A_4=-0.13$ 19
411.2 1	52 5	1201.70	21/2 ⁻	790.50	17/2 ⁻	Q		$A_2=+0.25$ 8; $A_4=+0.07$ 13
^x 415.0 4	2.6							
^x 416.2 10	2.1							
423.4 1	129 13	1110.91	25/2 ⁺	687.51	21/2 ⁺	Q		$A_2=+0.29$ 3; $A_4=-0.08$ 5
^x 436.1 3	13							$A_2=+0.17$ 26; $A_4=0.0$ 4
437.9 1	77 8	1077.73	23/2 ⁺	639.81	19/2 ⁺	Q		$A_2=+0.26$ 4; $A_4=-0.10$ 6
^x 439.9 2	10.1							$A_2=-0.07$ 15; $A_4=+0.41$ 22
^x 442.0 2	12.4							$A_2=+0.14$ 22; $A_4=+0.2$ 3
^x 443.5 2	15.9							$A_2=+0.12$ 13; $A_4=-0.04$ 19
445.2 1	43 4	1443.60	23/2 ⁻	998.40	19/2 ⁻	Q		$A_2=+0.26$ 6; $A_4=+0.01$ 9
^x 458.6 2	11.2							
460.6 1	48 5	1662.30	25/2 ⁻	1201.70	21/2 ⁻	Q		$A_2=+0.26$ 5; $A_4=-0.05$ 8
^x 463.1 2	15.8							
^x 468.4 1	8.5					D(+Q)		$A_2=-0.30$ 20; $A_4=+0.4$ 3

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$^{159}\text{Tb}(^{14}\text{N},4n\gamma)$ **1975Re05** (continued) $\gamma(^{169}\text{Hf})$ (continued)

E_γ †	I_γ ‡	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. #	Comments
$^{x470.5}$ 2	5.0						$A_2=+0.41$ 17; $A_4=-0.01$ 25
$^{x475.5}$ 3	8.3						$A_2=+0.38$ 15; $A_4=+0.13$ 22
$^{x478.8}$ 2	12.8					D(+Q)	$A_2=-0.31$ 16; $A_4=+0.18$ 23
$^{x482.1}$ 4	&						$A_2=+0.43$ 22; $A_4=+0.2$ 3
$^{x484.2}$ 4	&						$A_2=+0.14$ 25; $A_4=-0.4$ 4
490.2 5	6.0 12	2152.5	29/2 ⁻	1662.30	25/2 ⁻	Q	$A_2=+0.25$ 14; $A_4=-0.06$ 20
494.9 ^c 6	&	1605.73	27/2 ⁺	1110.91	25/2 ⁺		
497.6 2	22.8 23	1941.20	27/2 ⁻	1443.60	23/2 ⁻	Q	$A_2=+0.12$ 7; $A_4=-0.31$ 10
505.4 1	76 8	1616.31	29/2 ⁺	1110.91	25/2 ⁺	Q	$A_2=+0.26$ 3; $A_4=-0.10$ 5
528.0 1	36 4	1605.73	27/2 ⁺	1077.73	23/2 ⁺	Q	$A_2=+0.26$ 5; $A_4=-0.07$ 8
$^{x531.6}$ 3	9.0						
$^{x533.6}$ 3	18.8						$A_2=+0.24$ 23; $A_4=+0.4$ 4
$^{x536.0}$ 2	20.8						
543.5 2	9.5 19	2484.7	31/2 ⁻	1941.20	27/2 ⁻	Q	$A_2=+0.35$ 17; $A_4=+0.08$ 24
$^{x545.5}$ 2	14.3						
$^{x546.7}$ 2	13.1						
$^{x553.1}$ 2	11.4						$A_2=+0.33$ 13; $A_4=+0.01$ 19
$^{x560.9}$ 3	5.1						Out of energy sequence in authors' γ -ray table; evaluator assumes that 1975Re05 intended $E_\gamma=506.9$ to be $E_\gamma=560.9$.
$^{x562.8}$ 3	4.4						
$^{x568.7}$ 2	12						
569.7 2	34 3	2186.0	33/2 ⁺	1616.31	29/2 ⁺	Q	$A_2=+0.20$ 4; $A_4=-0.13$ 6
$^{x573.1}$ 2	2.2						
$^{x577.1}$ 5	&						$A_2=+0.28$ 26; $A_4=-0.3$ 4
$^{x578.3}$ 2	11.6						$A_2=0.0$ 4; $A_4=-0.3$ 5
$^{x582.4}$ 2	30.2						$A_2=-0.07$ 25; $A_4=+0.1$ 4
602.7 2	18.8 19	2208.44	31/2 ⁺	1605.73	27/2 ⁺	Q	$A_2=+0.15$ 8; $A_4=-0.16$ 13
$^{x609.2}$ 2	19.3						
$^{x612.6}$ 2	6.6						
615.6 2	36 4	2801.6	37/2 ⁺	2186.0	33/2 ⁺		$A_2=+0.01$ 23; $A_4=-0.4$ 3
$^{x619.5}$ 5	5.4						
$^{x621.3}$ 3	6.8						
649.5 5	&	3451.1	41/2 ⁺	2801.6	37/2 ⁺		$A_2=+0.1$ 3; $A_4=-0.7$ 5
663.0 ^c 5	&	2871.4?	(35/2 ⁺)	2208.44	31/2 ⁺		$A_2=+0.1$ 4; $A_4=-0.5$ 6
687 ^c 2	&	4138.1?	45/2 ⁺	3451.1	41/2 ⁺		
$^{x706.3}$ 5	&						$A_2=+0.5$ 4; $A_4=0.0$ 5
^{x708} 2	&						
718 ^c 2	&	4856.1?	(49/2 ⁺)	4138.1?	45/2 ⁺		
$^{x719.7}$ 2	17.0					D(+Q)	$A_2=-0.38$ 14; $A_4=-0.19$ 20
$^{x727.0}$ 2	6.9						
$^{x729.8}$ 3	6.3						
$^{x752.8}$ 10	&						$A_2=-0.12$ 24; $A_4=+0.8$ 4
$^{x833.9}$ 10	&						$A_2=+0.22$ 18; $A_4=+0.4$ 3
$^{x836.3}$ 10	&						
$^{x838.9}$ 10	&						
$^{x843.2}$ 5	&					D(+Q)	$A_2=-0.35$ 25; $A_4=+0.1$ 3
$^{x846.1}$ 5	&						
$^{x849.0}$ 10	&						
$^{x870.7}$ 10	&					D(+Q)	$A_2=-0.6$ 4; $A_4=-0.5$ 5

Continued on next page (footnotes at end of table)

$^{159}\text{Tb}(^{14}\text{N}, 4n\gamma)$ **1975Re05** (continued) $\gamma(^{169}\text{Hf})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^\ddagger$	$E_i(\text{level})$	Mult. [#]	Comments
^x 883.9 10	&			$A_2=+0.17$ 11; $A_4=+0.12$ 17
^x 895.4 10	&			$A_2=+0.30$ 16; $A_4=+0.13$ 23
^x 911.4 2	16.3			
^x 916.8 3	10.6			
^x 922.5 3	5.0			
^x 937.5 2	17.9		D(+Q)	$A_2=-0.17$ 19; $A_4=+0.3$ 3
^x 946.8 2	7.3			
^x 958.2 10	&			$A_2=+0.2$ 4; $A_4=+0.8$ 6
^x 960.0 10	&			
^x 978.2 10	&			
^x 983.0 2	&			
^x 991.0 2	&			
^x 1014.5 2	23.9			
^x 1116.1 3	10.1			
^x 1121.3 3	65.3			
^x 1173.3 6	14.3			
^x 1189.1 3	25.8			
^x 1220.1 11	23.4			
^x 1221.9 5	36.7			

[†] **1975Re05** indicate ^{169}Hf assignments for all placed transitions, but do not show isotopic assignments for any of the unplaced γ 's listed here; thus, the latter may belong to nuclides other than ^{169}Hf .

[‡] Arbitrary units for $E(^{14}\text{N})=70$ MeV, $\theta=90^\circ$. $\Delta I_\gamma=10\%$ for well-resolved transitions with $I_\gamma>10$, 20% for others (evaluator lists specific uncertainties for placed transitions only). See **1975Re05** for photon intensities for many transitions after correction for anisotropy.

[#] Inferred from measured $\gamma(\theta)$. Stretched Q assignments were based on large positive A_2 and small negative A_4 , and D(+Q) assignments, on negative A_2 and placement relative to cascading Q transitions within the same band.

[@] From γ -ray angular distributions; model-dependent values based on crossover-to-cascade branching ratios are given in comments.

& Weak; observed only in $\gamma\gamma$ -coin spectrum.

^a Includes possible component from contaminant. See **1975Re05** for source.

^b Multiply placed with intensity suitably divided.

^c Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

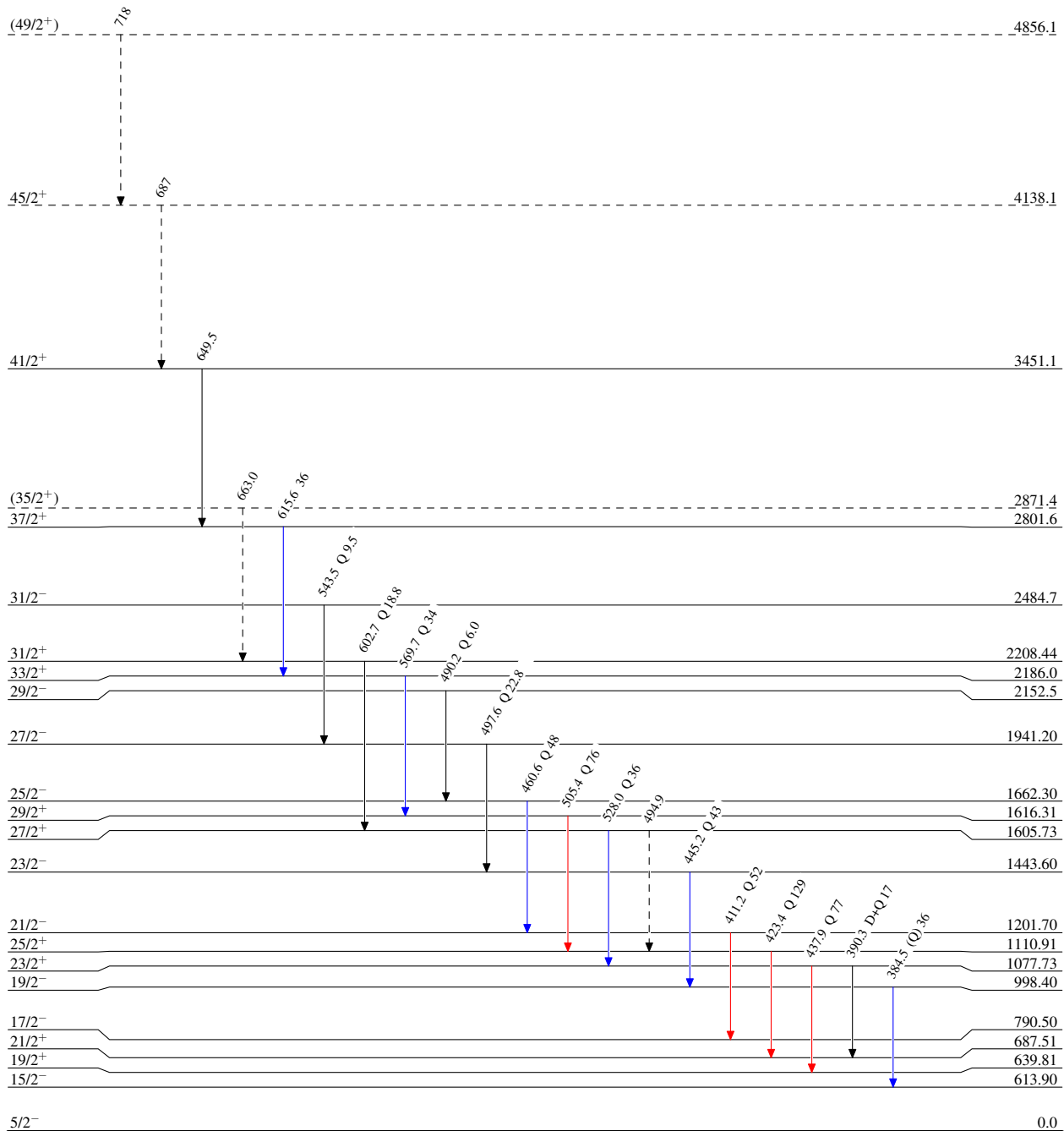
$^{159}\text{Tb}(^{14}\text{N},4n\gamma)$ 1975Re05

Legend

Level Scheme

 Intensities: relative I_γ for $E(^{14}\text{N})=70$ MeV, $\theta=90^\circ$

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$
- - - γ Decay (Uncertain)


 $^{169}_{72}\text{Hf}_{97}$

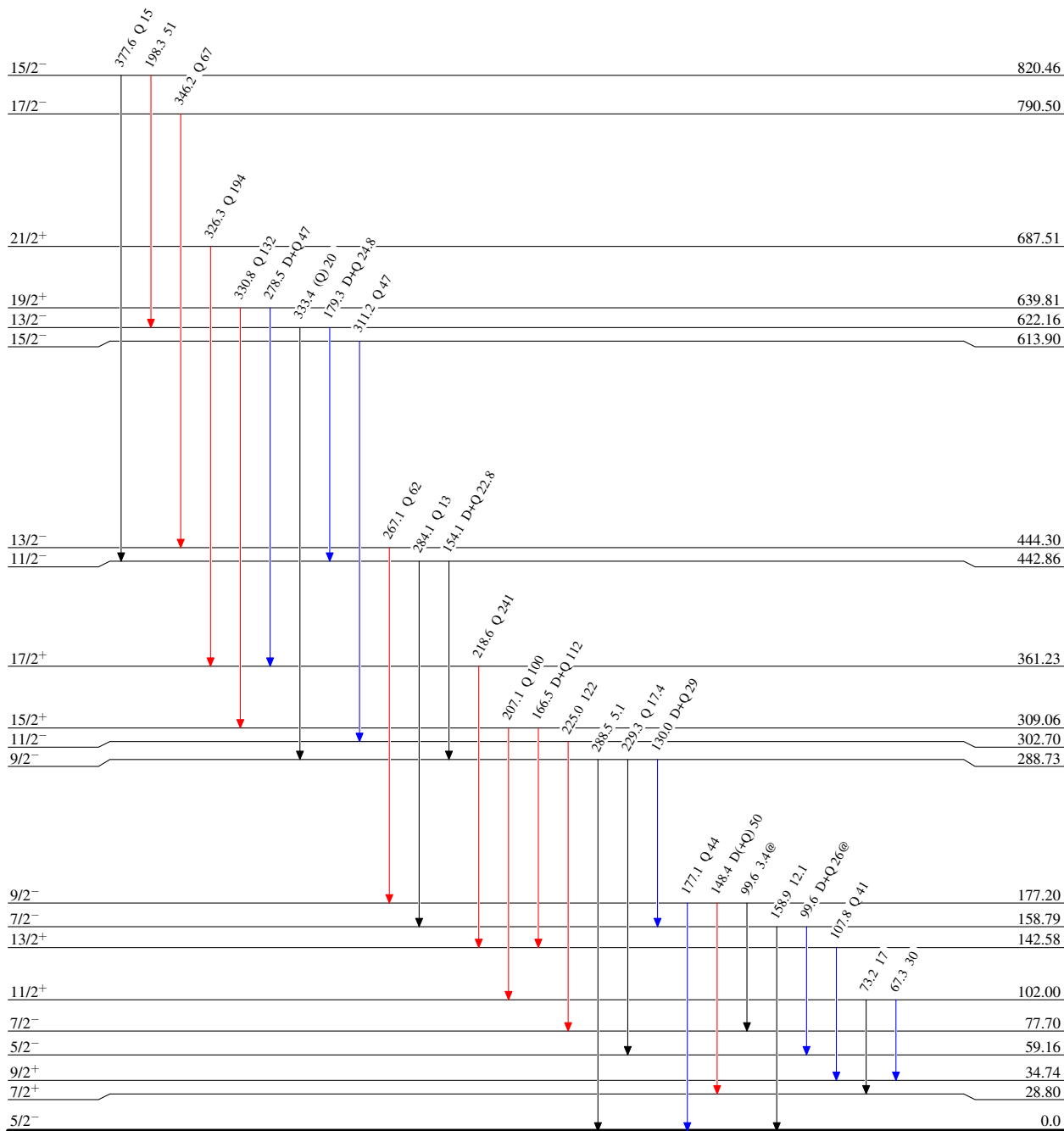
$^{159}\text{Tb}(^{14}\text{N},4\text{n}\gamma)$ 1975Re05

Level Scheme (continued)

 Intensities: relative I_γ for $E(^{14}\text{N})=70$ MeV, $\theta=90^\circ$
 @ Multiply placed: intensity suitably divided

Legend

$\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\text{max}}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\text{max}}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\text{max}}$



82 ns + 40-15

 $^{169}_{72}\text{Hf}_{97}$

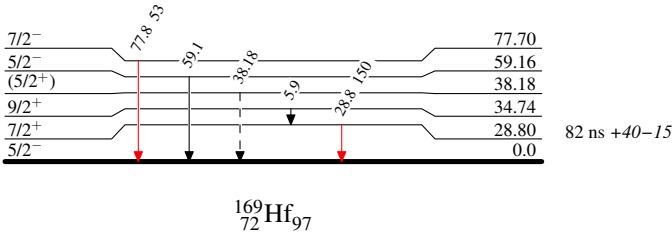
¹⁵⁹Tb(¹⁴N,4n γ) 1975Re05

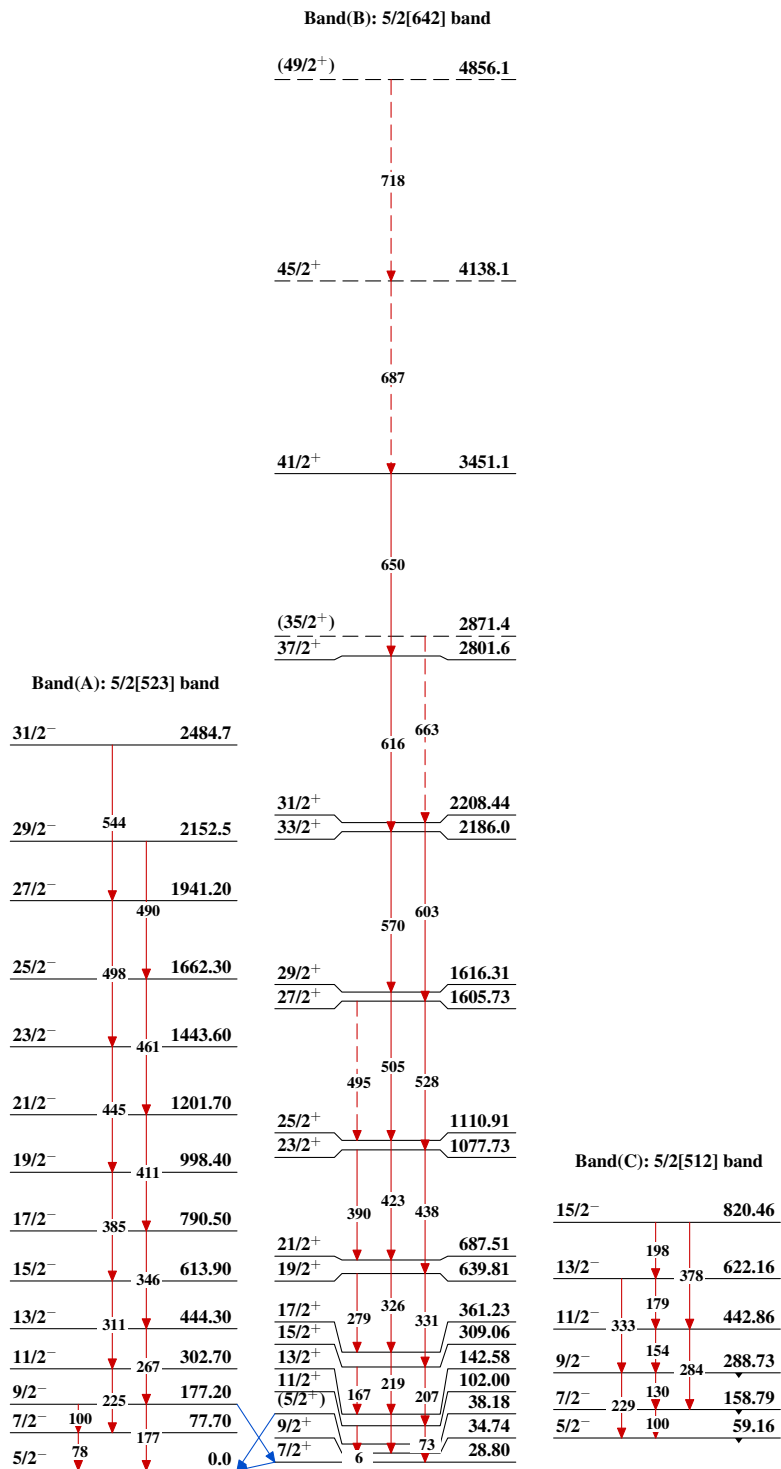
Level Scheme (continued)

Intensities: relative I γ for E(¹⁴N)=70 MeV, $\theta=90^\circ$
@ Multiply placed: intensity suitably divided

Legend

- $\longrightarrow$ I γ < 2% $\times$ I γ^{max}
- $\longrightarrow$ I γ < 10% $\times$ I γ^{max}
- $\longrightarrow$ I γ > 10% $\times$ I γ^{max}
- - - - $\longrightarrow$ γ Decay (Uncertain)



$^{159}\text{Tb}(^{14}\text{N},4\text{n}\gamma)$ 1975Re05 $^{169}_{72}\text{Hf}_{97}$

Adopted Levels, Gammas

$Q(\beta^-) = -5370$ 30; $S(n) = 9970$ 40; $S(p) = 2220$ 40; $Q(\alpha) = 3730$ 40 2021Wa16

$S(2n) = 18080$ 40, $S(2p) = 7340$ 50 (2021Wa16).

Identification: genetic relationship to known ^{169}Hf daughter; excitation functions for $^{155}\text{Gd}(^{19}\text{F}, xn\gamma)$ (1988Yu02).

Other Reactions:

$^{154}\text{Gd}(^{20}\text{Ne}, p4n\gamma)$: 1985Re06 (γ rays observed, but no data given).

$^{160}\text{Dy}(^{14}\text{N}, 5n\gamma)$: 1985Re06 (γ rays observed, but no data given).

 ^{169}Ta Levels

The level structure shown here is based on the $^{124}\text{Sn}(^{51}\text{V}, 6n\gamma)$ reaction study by 2006Ha46, in which a number of interconnected bands were identified. However, the 180.1 level deexcited by the delayed 153 γ and 170 γ feeding the $3/2^+$ $1/2[411]$ and $1/2^+$ $1/2[411]$ levels, respectively, is assigned there as the $1/2^-$ $1/2[541]$ state, at variance with TDPAD measurements in ($^{16}\text{O}, 5n\gamma$) which determine $Q = 2.23$ 13 and indicate $J = 5/2$. $\pi = -$ would imply M2 multipolarity for the 170 γ and that would violate RUL, thereby favoring an assignment of $5/2^+$ for this level. However, all available low-energy configurations have been assigned elsewhere. Note that the $5/2^+$ level in the $1/2[411]$ band has almost identical energy and is deexcited by a 152 γ and a 170 γ also, but those intraband transitions should be prompt.

Cross Reference (XREF) Flags

- A ^{169}W ε decay (75 s)
- B $^{124}\text{Sn}(^{51}\text{V}, 6n\gamma)$
- C $^{155}\text{Gd}(^{19}\text{F}, 5n\gamma)$, $^{122}\text{Sn}(^{51}\text{V}, 4n\gamma)$
- D $^{159}\text{Tb}(^{16}\text{O}, 6n\gamma)$

E(level) [†]	J^π [‡]	$T_{1/2}$ [@]	XREF	Comments
0.0 ^g	($5/2^+$)	4.9 min 5	ABCD	$\% \varepsilon + \% \beta^+ = 100$ J^π : band assignment consistent with $5/2[402]$ bandhead energy systematics in odd-A Ta isotopes ($E = 239, 70, 36, 95$ for $A = 179, 177, 175, 167$, respectively). $T_{1/2}$: weighted average of 5.0 min 5 (1969Ar22, 1975Gr44) and 4.7 min 7 (1975Re05). Uncertainty is the lowest from the input data.
0.0+z? ^m			C	
11.4 ⁱ 3	($1/2^+$)		AB D	
27.5 ^j 3	($3/2^+$)		ABCD	
96.50 ^h 12	($7/2^+$)		AB D	J^π : M1 96.5 γ to ($5/2^+$) g.s.; band assignment.
135.75 ^c 13	($7/2^+$)		ABCD	J^π : M1(+E2) 135.8 γ to ($5/2^+$) g.s.; band assignment.
147.9+z? ^m 5			C	
179.89 ⁱ 29	($5/2^+$)		BC	
180.11 30	($5/2^+$)	17 ns 4	ABCD	$Q = 2.23$ 13 (2005Ku40) J^π : $5/2$ from TDPAD (2005Ku40) in ($^{16}\text{O}, 6n\gamma$); 169 γ to $1/2^+$ is not M2 from RUL. However, state is assigned as $1/2^-$ $1/2[541]$ in ($^{51}\text{V}, 6n\gamma$). Further experimental work is essential in order to resolve this contradiction. Level differs from 179.9 level because that level's intraband transitions are not expected to be delayed. $T_{1/2}$: other value: 44 ns 5 (2005Ku40 in ($^{16}\text{O}, 6n\gamma$)) from fit to time spectrum gated by 153 γ +170 γ , but statistical accuracy not good and presence of impurities cannot be ruled out. Q : Time differential perturbed angular distribution method in ($^{16}\text{O}, 6n\gamma$).
191.94 ^{&} 27	($5/2^-$)		ABC	J^π : D, $\Delta J = 1$, 164.5 γ to ($3/2^+$). $J = 5/2$ member of $1/2[541]$ orbital expected at low energy based on odd-A Ta systematics ($E(\text{level}) = 628$ (^{179}Ta), 186 (^{177}Ta), 51

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{169}Ta Levels (continued)				
E(level) [†]	J ^π [‡]	T _{1/2} [@]	XREF	Comments
219.75 ^d 19	(9/2 ⁻)	28 ns 5	ABCD	(^{175}Ta), g.s. (^{173}Ta and ^{171}Ta); decoupling parameter $\approx +4$ for $\alpha = +1/2$ band members matches that expected for 1/2[541] band. Q=2.28 13 (2005Ku40) J ^π : E1 123.1γ to (7/2 ⁺); band assignment. T _{1/2} : other value: 54 ns 6 (2005Ku40 in ($^{16}\text{O}, 6\text{n}\gamma$)) from fit to time spectrum gated by 123γ, but statistical accuracy is not good and presence of impurities cannot be ruled out. Q: Time differential perturbed angular distribution method in ($^{16}\text{O}, 6\text{n}\gamma$).
233.36 ^j 28	(7/2 ⁺)		BC	
244.79 ^g 12	(9/2 ⁺)		AB D	XREF: D(285.0)
298.04 ^b 12	(9/2 ⁺)		AB	
299.51 ^{&} 25	(9/2 ⁻)		ABCD	
301.2+z? ^m 7			C	
336.64 ^e 22	(11/2 ⁻)		BCD	
348.46 ^a 31	(3/2 ⁻)		AB	
358.50 19	(5/2 ⁻ , 7/2, 9/2 ⁺) [#]		A	
420.13 ^h 14	(11/2 ⁺)		BCD	XREF: C(460.3)D(460.3)
466.10 ⁱ 28	(9/2 ⁺)		BC	
468.68 ^a 26	(7/2 ⁻)		AB	
487.70 ^c 14	(11/2 ⁺)		B	
506.77 ^d 22	(13/2 ⁻)		BCD	
514.1+z? ^m 9			C	
522.31 ^{&} 23	(13/2 ⁻)		BCD	XREF: D(499.3+x)
555.82 28			A	
568.45 ^j 27	(11/2 ⁺)		BC	
616.96 ^g 15	(13/2 ⁺)		BC	XREF: C(657.2)
692.44 ^e 24	(15/2 ⁻)		BCD	
695.98 ^b 15	(13/2 ⁺)		B	
723.53 ^a 23	(11/2 ⁻)		B	
744.6+z? ^m 10			C	
795.53 35			A	
835.94 ^h 16	(15/2 ⁺)		BC	
848.86 ⁱ 27	(13/2 ⁺)		BC	
858.67 ^{&} 23	(17/2 ⁻)		BCD	XREF: D(836.0+x)
924.90 ^d 26	(17/2 ⁻)		BC	
927.98 ^c 16	(15/2 ⁺)		B	
999.42 ^j 25	(15/2 ⁺)		BC	
1069.68 ^g 17	(17/2 ⁺)		BC	XREF: C(1110.0)
1076.57 ^a 25	(15/2 ⁻)		B	
1081.0+z? ^m 11			C	
1150.55 ^e 27	(19/2 ⁻)		BC	
1170.58 ^b 17	(17/2 ⁺)		B	
1296.66 ^{&} 24	(21/2 ⁻)		BC	
1304.33 ⁱ 24	(17/2 ⁺)		BC	
1321.20 ^h 18	(19/2 ⁺)		BC	XREF: C(1362.1)
1430.64 ^d 29	(21/2 ⁻)		BC	
1432.90 ^c 18	(19/2 ⁺)		B	
1493.59 ^j 23	(19/2 ⁺)		BC	

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Adopted Levels, Gammas (continued) ^{169}Ta Levels (continued)

E(level) [†]	J ^π [‡]	XREF	Comments
1518.67 ^a 25	(19/2 ⁻)	B	XREF: C(1622.1)
1581.12 ^g 20	(21/2 ⁺)	BC	
1683.13 ^e 30	(23/2 ⁻)	BC	
1697.50 ^b 18	(21/2 ⁺)	B	
1789.22 ⁱ 23	(21/2 ⁺)	BC	
1820.09 ^{&} 25	(25/2 ⁻)	BC	
1855.07 ^h 21	(23/2 ⁺)	BC	
1875.02 ^f 23	(21/2 ⁺)	B	
1977.08 ^c 21	(23/2 ⁺)	B	
1994.68 ^d 31	(25/2 ⁻)	BC	
2017.38 ^j 25	(23/2 ⁺)	BC	
2035.37 ^a 26	(23/2 ⁻)	B	
2129.83 ^g 21	(25/2 ⁺)	BC	XREF: C(2171.4)
2205.73 ^f 20	(25/2 ⁺)	BC	
2217.68 ^l 28	(23/2 ⁺)	B	
2257.38 ^b 21	(25/2 ⁺)	B	
2262.15 ^e 33	(27/2 ⁻)	BC	
2335.03 ⁱ 25	(25/2 ⁺)	B	
2405.44 ^h 21	(27/2 ⁺)	BC	
2412.45 ^{&} 27	(29/2 ⁻)	BC	
2498.92 ^c 24	(27/2 ⁺)	B	
2530.48 ^j 26	(27/2 ⁺)	BC	
2541.56 ^k 30	(25/2 ⁻)	B	
2571.10 ^d 34	(29/2 ⁻)	BC	
2602.88 ^a 27	(27/2 ⁻)	B	XREF: C(2676.8)
2623.40 ^l 27	(27/2 ⁺)	B	
2634.80 ^g 21	(29/2 ⁺)	BC	
2667.51 ^f 22	(29/2 ⁺)	BC	
2711.52 ^b 24	(29/2 ⁺)	B	
2745.52 ⁱ 30	(29/2 ⁺)	B	
2795.58 ^e 35	(31/2 ⁻)	BC	
2845.01 ^h 23	(31/2 ⁺)	BC	
2851.43 ^k 28	(29/2 ⁻)	B	XREF: C(2886.8)
2940.62 ^c 31	(31/2 ⁺)	B	
2986.52 ^j 32	(31/2 ⁺)	BC	
3003.7 ^d 4	(33/2 ⁻)	BC	
3053.77 ^g 24	(33/2 ⁺)	BC	
3053.79 ^{&} 31	(33/2 ⁻)	BC	
3074.64 ^l 26	(31/2 ⁺)	B	
3150.13 ^b 31	(33/2 ⁺)	B	
3152.46 ^a 29	(31/2 ⁻)	B	
3173.41 ⁱ 27	(33/2 ⁺)	B	
3176.71 ^f 27	(33/2 ⁺)	B	
3210.7 ^e 4	(35/2 ⁻)	BC	
3237.5? 10		C	
3241.82 ^k 29	(33/2 ⁻)	B	

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Adopted Levels, Gammas (continued) ^{169}Ta Levels (continued)

E(level) [†]	J ^π [‡]	XREF	Comments
3296.89 ^h 26	(35/2 ⁺)	BC	XREF: C(3339.1)
3402.3 ^c 4	(35/2 ⁺)	B	
3440.4 ^d 4	(37/2 ⁻)	BC	XREF: C(3583.0)
3461.8 ^j 4	(35/2 ⁺)	BC	
3541.17 ^g 27	(37/2 ⁺)	BC	
3620.5 ^a 4	(35/2 ⁻)	B	
3622.01 ^l 26	(35/2 ⁺)	B	
3652.8 ^b 4	(37/2 ⁺)	B	
3663.23 ^{&} 32	(37/2 ⁻)	BC	XREF: C(3871.9)
3689.31 ⁱ 29	(37/2 ⁺)	B	
3698.7 ^e 4	(39/2 ⁻)	BC	
3741.81 ^f 29	(37/2 ⁺)	B	
3795.28 ^k 32	(37/2 ⁻)	B	
3829.81 ^h 29	(39/2 ⁺)	BC	
3952.1 ^c 4	(39/2 ⁺)	B	XREF: C(4152.4)
3974.2 ^d 4	(41/2 ⁻)	BC	
4019.8 ^j 4	(39/2 ⁺)	BC	
4110.13 ^g 30	(41/2 ⁺)	BC	
4137.3 ^a 4	(39/2 ⁻)	B	
4225.01 ^l 33	(39/2 ⁺)	B	
4230.8 ^{&} 4	(41/2 ⁻)	BC	XREF: C(4481.2)
4240.3 ^b 4	(41/2 ⁺)	B	
4281.7 ^e 4	(43/2 ⁻)	BC	
4285.6 ⁱ 4	(41/2 ⁺)	B	
4360.9 ^f 4	(41/2 ⁺)	B	
4438.84 ^h 31	(43/2 ⁺)	BC	
4503.5 ^k 4	(41/2 ⁻)	B	XREF: C(4793.6)
4582.1 ^c 5	(43/2 ⁺)	B	
4601.5 ^d 4	(45/2 ⁻)	BC	
4651.4 ^j 5	(43/2 ⁺)	B	
4728.8 ^a 5	(43/2 ⁻)	B	
4750.68 ^g 33	(45/2 ⁺)	BC	
4860.6 ^{&} 4	(45/2 ⁻)	BC	XREF: C(5153.6)
4883.5 ^l 4	(43/2 ⁺)	B	
4903.1 ^b 5	(45/2 ⁺)	B	
4946.8 ^e 4	(47/2 ⁻)	BC	
4948.2 ⁱ 4	(45/2 ⁺)	B	
5031.0 ^f 4	(45/2 ⁺)	B	
5111.35 ^h 34	(47/2 ⁺)	BC	XREF: C(5492.2)
5245.1 ^k 4	(45/2 ⁻)	B	
5279.0 ^c 5	(47/2 ⁺)	B	
5305.7 ^d 5	(49/2 ⁻)	BC	
5316.8 ⁿ 5	(47/2 ⁺)	B	
5354.7 ^j 5	(47/2 ⁺)	B	
5391.3 ^a 5	(47/2 ⁻)	B	XREF: C(5492.2)
5450.0 ^g 4	(49/2 ⁺)	BC	

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Adopted Levels, Gammas (continued) ^{169}Ta Levels (continued)

E(level) [†]	J ^π [‡]	XREF	Comments
5556.7 ^{&l} 5	(49/2 ⁻)	BC	
5591.8 ^l 4	(47/2 ⁺)	B	
5627.4 ^b 5	(49/2 ⁺)	B	
5642.3 ⁱ 5	(49/2 ⁺)	B	
5679.1 ^e 5	(51/2 ⁻)	BC	
5746.7 ^f 5	(49/2 ⁺)	B	
5834.8 ^h 4	(51/2 ⁺)	BC	XREF: C(5877.1)
5987.8 ^k 5	(49/2 ⁻)	B	
6003.5 ⁿ 7	(51/2 ⁺)	B	
6024.3 ^c 6	(51/2 ⁺)	B	
6073.9 ^d 5	(53/2 ⁻)	BC	
6104.0 ^j 6	(51/2 ⁺)	B	
6111.3 ^a 7	(51/2 ⁻)	B	
6195.1 ^g 4	(53/2 ⁺)	BC	XREF: C(6236.9)
6315.1 ^{&} 5	(53/2 ⁻)	B	
6351.3 ⁱ 7	(53/2 ⁺)	B	
6391.2 ^b 6	(53/2 ⁺)	B	
6467.2 ^e 5	(55/2 ⁻)	BC	
6521.4 ^f 5	(53/2 ⁺)	B	
6599.5 ^h 4	(55/2 ⁺)	BC	XREF: C(6642.1)
6742.7 ⁿ 9	(55/2 ⁺)	B	
6812.5 ^c 7	(55/2 ⁺)	B	
6887.7 ^j 8	(55/2 ⁺)	B	
6901.3 ^d 5	(57/2 ⁻)	BC	
6978.2 ^g 4	(57/2 ⁺)	BC	XREF: C(7020.4)
7128.7 ^{&} 6	(57/2 ⁻)	B	
7194.9 ^b 8	(57/2 ⁺)	B	
7309.5 ^e 5	(59/2 ⁻)	BC	
7327.7 ^f 7	(57/2 ⁺)	B	
7409.5 ^h 5	(59/2 ⁺)	B	
7789.9 ^d 5	(61/2 ⁻)	B	
7809.8 ^g 5	(61/2 ⁺)	B	
7993.5 ^{&} 6	(61/2 ⁻)	B	
8182.3 ^f 9	(61/2 ⁺)	B	
8206.7 ^e 6	(63/2 ⁻)	B	
8279.5 ^h 7	(63/2 ⁺)	B	
8694.9 ^g 5	(65/2 ⁺)	B	
8745.5 ^d 7	(65/2 ⁻)	B	
8913.1 ^{&} 8	(65/2 ⁻)	B	
9085.3 ^f 10	(65/2 ⁺)	B	
9157.8 ^e 8	(67/2 ⁻)	B	
9634.9 ^g 7	(69/2 ⁺)	B	
9886.8 ^{&} 9	(69/2 ⁻)	B	
10154.4 ^e 9	(71/2 ⁻)	B	
10916.6 ^{&} 11	(73/2 ⁻)	B	
11992.6 ^h 12	(77/2 ⁻)	B	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Ta Levels (continued)

- [†] From least-squares fit to adopted E_γ , assigning $\Delta E_\gamma=1$ keV for all data to which authors have not assigned an uncertainty.
- [‡] Values given without comment come from ($^{51}\text{V}, 6n\gamma$) data; they are based on transition multiplicities, on deduced band structure and on systematics of band structures in neighboring odd-A, odd-Z nuclides. The 9/2[514] and 5/2[402] configuration assignments are also supported by measured $B(M1)(\Delta J=1 \text{ transition})/B(E2)(\Delta J=2 \text{ transition})$ for intraband transitions deexciting individual band members (1993Li15). Band parameters for the 1/2[541], $\alpha=+1/2$ band are close to those for known 1/2[541] bands in this mass region.
- [#] 359 γ to (5/2⁺) g.s.; 139 γ to (9/2⁻) 220 level.
- [@] From delayed $\gamma\gamma$ coin in ($^{16}\text{O}, 6n\gamma$) (1998Zh03), except as noted.
- [&] Band(A): 1/2[541], $\alpha=+1/2$ band (2006Ha46). Band parameters: $A=14.4$, $a=+4.3$ (5/2, 9/2, 13/2, 17/2 levels). Band crossing at $\hbar\omega=0.30$ MeV due to alignment of first pair of $i_{13/2}$ neutrons. Steady gain in alignment suggests subsequent crossing by structure with a second pair of aligned $i_{13/2}$ neutrons. The location of the $J=1/2$ band member is unclear; it is expected to lie very close to the $J=5/2$ member (at 192 here and in ($^{51}\text{V}, 6n\gamma$), but at 180 in ($^{16}\text{O}, 6n\gamma$) and ($^{19}\text{F}, 5n\gamma$)) but the $J=1/2$ level has not been observed in neighboring nuclides. 2006Ha46 assign a 180.1 level as the $J=1/2$ bandhead but, although the energy is reasonable, this is not adopted here because of a conflicting assignment of $J=5/2$ for that level from TDPAD (2005Ku40). Further experimental work is required to resolve this discrepancy.
- ^a Band(a): π 1/2[541], $\alpha=-1/2$ band (2006Ha46). Band crossing at $\hbar\omega=0.26$ MeV due to configuration with first pair of aligned $i_{13/2}$ neutrons. Steady gain in alignment suggests subsequent crossing by a configuration with a second pair of aligned $i_{13/2}$ neutrons. Band parameters could not be extracted for this band; no reasonable fit to energy sequence was possible.
- ^b Band(B): π 7/2[404], $\alpha=+1/2$ band (2006Ha46). Bandhead expected at low energy, based on systematics; ^{179}Ta , ^{177}Ta and ^{175}Ta have 7/2[404] ground states, and this bandhead lies at 52 keV in ^{171}Ta . First crossing occurs at $\hbar\omega=0.238$ MeV due to structure with first pair of aligned $i_{13/2}$ neutrons, second crossing at $\hbar\omega=0.37$ MeV due to structure with second pair of aligned $i_{13/2}$ neutrons. Above the first crossing there is mixing of 5/2[402] and 7/2[404] configurations.
- ^c Band(b): π 7/2[404], $\alpha=-1/2$ band (2006Ha46). See comment on signature partner band.
- ^d Band(C): π 9/2[514], $\alpha=+1/2$ band (2006Ha46). Band crossing at $\hbar\omega=0.24$ MeV due to alignment of first pair of $i_{13/2}$ neutrons. Steady gain in alignment suggests crossing by configuration with a second pair of aligned $i_{13/2}$ neutrons.
- ^e Band(c): π 9/2[514], $\alpha=-1/2$ band (2006Ha46). See comment on signature partner band.
- ^f Band(D): π 1/2[660], $\alpha=+1/2$ band (2006Ha46). Decoupled band. No evidence of a wobbling mode of excitation is suggested, although the population intensity of this band is weak.
- ^g Band(E): π 5/2[402], $\alpha=+1/2$ band (2006Ha46). First crossing at $\hbar\omega=0.242$ MeV due to alignment of first pair of $i_{13/2}$ neutrons, second crossing at $\hbar\omega=0.37$ MeV due to alignment of second pair of $i_{13/2}$ neutrons. Above the first crossing there is mixing of 5/2[402] and 7/2[404] configurations.
- ^h Band(e): π 5/2[402], $\alpha=-1/2$ band (2006Ha46). See comment on signature partner band.
- ⁱ Band(F): π 1/2[411], $\alpha=+1/2$ band (2006Ha46). Band parameters: $A=18.6$, $B=-33$, $a=-0.66$ ($J=1/2$ through 13/2 levels). First crossing at $\hbar\omega=0.24$ MeV due to alignment of first pair of $i_{13/2}$ neutrons, second crossing at $\hbar\omega=0.37$ MeV due to structure with second pair of aligned $i_{13/2}$ neutrons.
- ^j Band(f): 1/2[411], $\alpha=-1/2$ band (2006Ha46). Apparent $K=1/2$ decoupled band; 1/2[411] is only low-energy $K=1/2$ orbital available. See comment on signature partner band.
- ^k Band(G): Band based on (25/2⁻), $\alpha=+1/2$ (2006Ha46). This band interacts strongly with 1/2[541] band. At low-spins, the configuration may be (π $h_{9/2}$) $\otimes$ (first pair of $i_{13/2}$ neutrons). At higher spins ($J>35/2$), it seems to be a continuation of 1/2[541] band. Band crossing at $\hbar\omega\approx 0.37$ MeV due to second pair of $i_{13/2}$ neutrons.
- ^l Band(H): $\pi h_{9/2} \nu i_{13/2} \nu p_{3/2}?$ band (2006Ha46). J^π values are from figure 1 (proposed level scheme) of 2006Ha46 and reflect the authors' preference for 23/2⁺ over 21/2⁻ for the lowest-energy level observed in this band, as discussed in their text. The different values appearing in the summary of transition properties in table I of the original publication were based on the less-favored 21/2⁻ option; these were erroneous and were subsequently corrected in an erratum. Strong feeding to 1/2[541] band.
- ^m Band(I): Possible band fragment (1993Li15). 1993Li15 make no configuration assignment for this band. Levels are shown as uncertain here because band is observed only in ($^{19}\text{F}, 5n\gamma$). Subsequent detailed (HI, $xn\gamma$) studies should have observed it, but did not. Possibly it does not belong to ^{169}Ta .
- ⁿ Band(J): Band fragment (2006Ha46). This band is built as a side band above the 43/2⁺ state in 1/2[411] band.

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Ta})$								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. @	$\alpha^\&$	Comments
11.4	(1/2 ⁺)	(11.4)		0.0	(5/2 ⁺)			E_γ : from level energy difference; transition not observed.
27.5	(3/2 ⁺)	(16.1)		11.4	(1/2 ⁺)	[M1]	159.2 22	E_γ : from level energy difference; transition not observed.
96.50	(7/2 ⁺)	96.5 2	100 [#]	0.0	(5/2 ⁺)	(M1)	4.83 7	E_γ : weighted average of 96.6 2 from ¹⁶⁹ W ε decay and 96.4 2 from (⁵¹ V,6n γ). Mult.: M1,E2 from $\alpha(\text{exp})$ in ¹⁶⁹ W ε decay; D from $\gamma(\theta)$ in (⁵¹ V,6n γ).
135.75	(7/2 ⁺)	135.8 2	100	0.0	(5/2 ⁺)	M1	1.820 27	E_γ : weighted average of 136.0 3 from ¹⁶⁹ W ε decay and 135.7 2 from (⁵¹ V,6n γ). Mult., δ : from $\alpha(\text{exp})$ in ¹⁶⁹ W ε decay.
147.9+z?		147.9 ^{‡a}	100 [‡]	0.0+z?				
179.89	(5/2 ⁺)	152.4 2	≈ 100	27.5	(3/2 ⁺)	(M1+E2)	1.04 28	
		168.5 2	≈ 19	11.4	(1/2 ⁺)	(E2)	0.535 8	
180.11	(5/2 ⁺)	152.6 2	≈ 97	27.5	(3/2 ⁺)	[M1+E2]	1.03 27	B(M1)(W.u.)= $9 \times 10^{-5} + 8-5$ if M1, B(E2)(W.u.)= $2.2 + 20-13$ if E2.
		168.7 2	≈ 100	11.4	(1/2 ⁺)	[E2]	0.532 8	B(E2)(W.u.)= $1.3 + 15-8$ Mult.: D ($\Delta J=0$) or Q ($\Delta J=2$) to (1/2 ⁺) 11 level from (⁵¹ V,6n γ); not M2 from RUL.
191.94	(5/2 ⁻)	11.8 ^a	<2.4	180.11	(5/2 ⁺)			
		164.5 2	≈ 100	27.5	(3/2 ⁺)	D		E_γ : weighted average of 164.7 3 from ¹⁶⁹ W ε decay and 164.4 2 from (⁵¹ V,6n γ).
219.75	(9/2 ⁻)	123.1 2	100	96.50	(7/2 ⁺)	E1	0.2136 31	B(E1)(W.u.)= $3.5 \times 10^{-6} + 8-5$ E_γ : weighted average of 123.4 4 from ¹⁶⁹ W ε decay and 123.0 2 from (⁵¹ V,6n γ). Mult.: from $\alpha(\text{exp})$ in ¹⁶⁹ W ε decay.
233.36	(7/2 ⁺)	53.0 ^a 5		179.89	(5/2 ⁺)			
		205.8 2	100	27.5	(3/2 ⁺)			
244.79	(9/2 ⁺)	109.0 2	17.5 8	135.75	(7/2 ⁺)	D		
		148.4 2	100 3	96.50	(7/2 ⁺)	(M1+E2)	1.13 29	E_γ : weighted average of 148.6 4 from ¹⁶⁹ W ε decay and 148.3 2 from (⁵¹ V,6n γ). Mult.: D+Q from (¹⁹ F,4n γ) for intraband γ .
		244.7 2	19.2 14	0.0	(5/2 ⁺)			
298.04	(9/2 ⁺)	162.3 2	≈ 100	135.75	(7/2 ⁺)	(M1)	1.099 16	
		201.5 2	≈ 22	96.50	(7/2 ⁺)	D		
		298.0 2	≈ 37	0.0	(5/2 ⁺)	(E2)	0.0837 12	
299.51	(9/2 ⁻)	107.6 2	100	191.94	(5/2 ⁻)	[E2]	2.78 4	
301.2+z?		153.3 ^{‡a}	100 [‡]	147.9+z?				
336.64	(11/2 ⁻)	116.9 2	100	219.75	(9/2 ⁻)	(M1)	2.79 4	
348.46	(3/2 ⁻)	168.3 [#] 4	100	180.11	(5/2 ⁺)	[E1]	0.0947 14	
358.50	(5/2 ⁻ ,7/2,9/2 ⁺)	138.5 [#] 3	40 [#] 8	219.75	(9/2 ⁻)			

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Ta})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. @	$\alpha^\&$	Comments
358.50	(5/2 ⁻ , 7/2, 9/2 ⁺)	222.8 [#] 3	15 [#] 5	135.75	(7/2 ⁺)			
		262.0 [#] 4	100 [#] 40	96.50	(7/2 ⁺)			
		358.8 [#] 4	15 [#] 8	0.0	(5/2 ⁺)			
420.13	(11/2 ⁺)	122.1 2	7.7 8	298.04	(9/2 ⁺)			
		175.3 2	100.0 16	244.79	(9/2 ⁺)	(M1+E2)	0.68 21	
		323.7 2	44 3	96.50	(7/2 ⁺)	(E2)	0.0655 9	Other I γ : 115 6 in (¹⁹ F, 5n γ). Mult.: from $\gamma(\theta)$ for intraband γ in (¹⁹ F, 5n γ).
466.10	(9/2 ⁺)	232.6 2	96 8	233.36	(7/2 ⁺)	(M1)	0.404 6	
		286.3 2	100 8	179.89	(5/2 ⁺)			
468.68	(7/2 ⁻)	120.2 2	37 5	348.46	(3/2 ⁻)	[E2]	1.822 28	E_γ : weighted average of 120.1 3 from ¹⁶⁹ W ε decay and 120.3 2 from (⁵¹ V, 6n γ). I γ : other: 28 10 in ε decay.
		169.2 2	45 5	299.51	(9/2 ⁻)	[M1]	0.978 14	E_γ : weighted average of 169.5 3 from ¹⁶⁹ W ε decay and 169.1 2 from (⁵¹ V, 6n γ). Other I γ : $\approx$ 66 in ε decay.
		276.8 3	100 8	191.94	(5/2 ⁻)	[M1]	0.251 4	E_γ : weighted average of 277.3 4 from ¹⁶⁹ W ε decay and 276.7 2 from (⁵¹ V, 6n γ). Mult.: Q(+D) from (⁵¹ V, 6n γ).
487.70	(11/2 ⁺)	189.6 2	100 4	298.04	(9/2 ⁺)	(M1)	0.711 10	
		242.9 2	24.8 26	244.79	(9/2 ⁺)			
		352.0 2	73 4	135.75	(7/2 ⁺)	(E2)	0.0515 7	
506.77	(13/2 ⁻)	170.2 2	100 3	336.64	(11/2 ⁻)	(M1+E2)	0.74 22	
		287.0 2	29.5 18	219.75	(9/2 ⁻)	(E2)	0.0938 13	I γ : from (¹⁹ F, 5n γ). I(170 γ):I(287 γ)=100 4:25.5 21 in (⁵¹ V, 6n γ).
514.1+z?		212.9 ^{‡a}	100 [‡]	301.2+z?				
522.31	(13/2 ⁻)	185.5 2	2.7 3	336.64	(11/2 ⁻)			
		222.8 2	100 4	299.51	(9/2 ⁻)	(E2)	0.2082 30	Mult.: from $\gamma(\theta)$ for intraband γ in (¹⁹ F, 5n γ).
555.82		197.3 [#] 3	100 [#] 38	358.50	(5/2 ⁻ , 7/2, 9/2 ⁺)			
		420.1 [#] 4	38 [#] 25	135.75	(7/2 ⁺)			
568.45	(11/2 ⁺)	335.1 2	100	233.36	(7/2 ⁺)			
616.96	(13/2 ⁺)	129.2 2	6.9 5	487.70	(11/2 ⁺)			
		196.8 2	62.7 17	420.13	(11/2 ⁺)	(M1)	0.641 9	Other I γ : I(372 γ):I(197 γ)=100 4:76 6 in (¹⁹ F, 5n γ).
		372.2 2	100 3	244.79	(9/2 ⁺)			
692.44	(15/2 ⁻)	185.6 2	100 4	506.77	(13/2 ⁻)	(M1+E2)	0.57 19	
		355.9 2	55.4 24	336.64	(11/2 ⁻)	(E2)	0.0499 7	Other I γ : I(186 γ):I(356 γ)=100 5:68 3 in (¹⁹ F, 5n γ).
695.98	(13/2 ⁺)	208.4 2	53.8 27	487.70	(11/2 ⁺)	(M1+E2)	0.40 14	
		275.8 2	13.8 15	420.13	(11/2 ⁺)	D+Q		
		397.9 2	100 8	298.04	(9/2 ⁺)	(E2)	0.0366 5	

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Ta})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. @	$\alpha^\&$	Comments
723.53	(11/2 ⁻)	201.0 5	<10	522.31	(13/2 ⁻)			
		216.7 2	13.7 10	506.77	(13/2 ⁻)			
		254.9 2	100 7	468.68	(7/2 ⁻)			
		386.9 2	14.7 20	336.64	(11/2 ⁻)			
		424.0 2	85 6	299.51	(9/2 ⁻)			
744.6+z?		230.5 ^{‡a}	100 [‡]	514.1+z?				
795.53		575.6 [#] 4	100 [#] 23	219.75	(9/2 ⁻)			
		699.3 [#] 5	<15 [#]	96.50	(7/2 ⁺)			
835.94	(15/2 ⁺)	140.0 2	3.1 7	695.98	(13/2 ⁺)			
		218.9 2	46.3 19	616.96	(13/2 ⁺)	(M1+E2)	0.35 13	
		415.9 2	100 4	420.13	(11/2 ⁺)	(E2)	0.0325 5	Other I γ : I(416 γ):I(219 γ)=100 7:116 5 in (¹⁹ F,5n γ).
848.86	(13/2 ⁺)	280.4 2	30.9 24	568.45	(11/2 ⁺)	(M1)	0.2423 34	
		382.7 2	100 9	466.10	(9/2 ⁺)	(E2)	0.0407 6	
858.67	(17/2 ⁻)	336.4 2	100 4	522.31	(13/2 ⁻)	(E2)	0.0586 8	Mult.: from $\gamma(\theta)$ for intraband γ in (¹⁹ F,5n γ).
		352.1 2	1.82 20	506.77	(13/2 ⁻)			
924.90	(17/2 ⁻)	232.4 2	100 3	692.44	(15/2 ⁻)	(M1+E2)	0.29 11	Other E γ : 233.5 in (¹⁹ F,5n γ).
		418.1 2	89 4	506.77	(13/2 ⁻)	(E2)	0.0320 5	I γ : from (¹⁹ F,5n γ).
927.98	(15/2 ⁺)	232.0 2	43 3	695.98	(13/2 ⁺)	(M1+E2)	0.29 11	I γ : from (¹⁹ F,5n γ); 84 4 in (⁵¹ V,6n γ).
		311.0 2	25.2 21	616.96	(13/2 ⁺)	D+Q		
		440.2 2	100 7	487.70	(11/2 ⁺)			
999.42	(15/2 ⁺)	431.0 2	100	568.45	(11/2 ⁺)	(E2)	0.0295 4	
1069.68	(17/2 ⁺)	233.8 2	29.4 13	835.94	(15/2 ⁺)	(M1+E2)	0.29 11	Other I γ : I(234 γ):I(453 γ)=45 3:100 7 in (¹⁹ F,5n γ).
		452.8 2	100 4	616.96	(13/2 ⁺)	(E2)	0.0259 4	Mult.: D from $\gamma(\theta)$ for intraband γ in (¹⁹ F,5n γ).
1076.57	(15/2 ⁻)	353.0 2	100 5	723.53	(11/2 ⁻)	(E2)	0.0510 7	
		554.1 2	50 4	522.31	(13/2 ⁻)	D		I γ : from (¹⁹ F,5n γ). I(225 γ):I(458 γ)=64 4:100 3 in (⁵¹ V,6n γ).
								Mult.: from $\gamma(\theta)$ for intraband γ in (¹⁹ F,5n γ).
1081.0+z?		336.4 ^{‡a}	100 [‡]	744.6+z?				
1150.55	(19/2 ⁻)	225.6 2	64.2 21	924.90	(17/2 ⁻)	(M1)	0.439 6	Mult.: D from $\gamma(\theta)$ for intraband γ in (¹⁹ F,5n γ).
		458.2 2	100.0 20	692.44	(15/2 ⁻)	(E2)	0.02516 35	I γ : from (¹⁹ F,5n γ).
1170.58	(17/2 ⁺)	242.5 2	35.2 21	927.98	(15/2 ⁺)			
		334.7 2	13.4 14	835.94	(15/2 ⁺)			
		474.6 2	100 10	695.98	(13/2 ⁺)			γ anisotropy in (⁵¹ V,6n γ) is too low for $\Delta J=2$ required by level scheme.
1296.66	(21/2 ⁻)	438.1 2	100	858.67	(17/2 ⁻)	(E2)	0.0283 4	
1304.33	(17/2 ⁺)	304.8 2	10.0 8	999.42	(15/2 ⁺)			
		455.4 2	100 8	848.86	(13/2 ⁺)	(E2)	0.0256 4	
1321.20	(19/2 ⁺)	251.5 2	28.1 15	1069.68	(17/2 ⁺)	(M1+E2)	0.23 9	Other I γ : I(252 γ):I(485 γ)=17 3:100 3 in (¹⁹ F,5n γ).
		485.2 2	100 4	835.94	(15/2 ⁺)	(E2)	0.02173 31	Mult.: from $\gamma(\theta)$ in (¹⁹ F,5n γ).

Adopted Levels, Gammas (continued) $\gamma(^{169}\text{Ta})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. @	$\alpha\&$	Comments
1430.64	(21/2 ⁻)	280.1 2	83 3	1150.55	(19/2 ⁻)	(M1+E2)	0.17 7	Other I γ : I(280 γ):I(505 γ)=58 3:100 4 in (¹⁹ F,5n γ). Other E γ : 505.8 in (¹⁹ F,5n γ).
1432.90	(19/2 ⁺)	505.7 2	100 4	924.90	(17/2 ⁻)			
		262.2 2	31.3 25	1170.58	(17/2 ⁺)			
		363.3 2	17.1 21	1069.68	(17/2 ⁺)			
1493.59	(19/2 ⁺)	504.9 2	100 8	927.98	(15/2 ⁺)	(E2)	0.01967 28	
		494.3 2	100 9	999.42	(15/2 ⁺)			
		635.0 5	<3	858.67	(17/2 ⁻)			
1518.67	(19/2 ⁻)	441.9 2	100 6	1076.57	(15/2 ⁻)	(E2)	0.0276 4	
		660.1 2	35.3 24	858.67	(17/2 ⁻)	D		
1581.12	(21/2 ⁺)	259.8 2	28.2 13	1321.20	(19/2 ⁺)	(M1+E2)	0.21 9	Other I γ : I(260 γ):I(512 γ)=51.2 22:100 5 in (¹⁹ F,5n γ).
		511.5 2	100 4	1069.68	(17/2 ⁺)	(E2)	0.01904 27	
1683.13	(23/2 ⁻)	252.4 2	56.1 24	1430.64	(21/2 ⁻)	(M1+E2)	0.23 9	Other I γ : I(252 γ):I(533 γ)=47 3:100 4 in (¹⁹ F,5n γ).
		532.6 2	100 [‡] 4	1150.55	(19/2 ⁻)	(E2)	0.01724 24	Mult.: Q from $\gamma(\theta)$ in (¹⁹ F,5n γ).
1697.50	(21/2 ⁺)	264.6 2	20.7 23	1432.90	(19/2 ⁺)			
		376.4 2	12.0 13	1321.20	(19/2 ⁺)			
		527.0 2	100 7	1170.58	(17/2 ⁺)	(E2)	0.01769 25	
1789.22	(21/2 ⁺)	295.7 2	10.0 10	1493.59	(19/2 ⁺)			
		485.0 2	100 10	1304.33	(17/2 ⁺)	(E2)	0.02176 31	
1820.09	(25/2 ⁻)	523.4 2	100	1296.66	(21/2 ⁻)	(E2)	0.01799 25	
1855.07	(23/2 ⁺)	274.0 2	30.9 18	1581.12	(21/2 ⁺)	(M1)	0.258 4	Other I γ : I(274 γ):I(534 γ)=48 3:100 5 in (¹⁹ F,5n γ). Mult.: D from $\gamma(\theta)$ for intraband γ in (¹⁹ F,5n γ).
		533.8 2	100 9	1321.20	(19/2 ⁺)			
1875.02	(21/2 ⁺)	381.4 2	40 5	1493.59	(19/2 ⁺)			
		570.4 2	100 7	1304.33	(17/2 ⁺)	Q		
1977.08	(23/2 ⁺)	279.5 2	27 3	1697.50	(21/2 ⁺)			
		544.1 2	100 6	1432.90	(19/2 ⁺)			
1994.68	(25/2 ⁻)	311.5 2	68 3	1683.13	(23/2 ⁻)	(M1+E2)	0.13 5	
		564.1 2	100 3	1430.64	(21/2 ⁻)	(E2)	0.01500 21	
2017.38	(23/2 ⁺)	523.9 2	100 10	1493.59	(19/2 ⁺)	(E2)	0.01795 25	
		720.8 2	10.0 7	1296.66	(21/2 ⁻)			
2035.37	(23/2 ⁻)	516.6 2	100 14	1518.67	(19/2 ⁻)			
		738.8 2	31 4	1296.66	(21/2 ⁻)			
2129.83	(25/2 ⁺)	274.7 2	27.0 9	1855.07	(23/2 ⁺)			Other I γ : I(275 γ):I(549 γ)=42 3:100 5 in (¹⁹ F,5n γ).
		548.7 2	100 5	1581.12	(21/2 ⁺)			
2205.73	(25/2 ⁺)	330.5 2	18.5 20	1875.02	(21/2 ⁺)			
		416.5 2	100 6	1789.22	(21/2 ⁺)	Q		
		508.4 2	72 5	1697.50	(21/2 ⁺)			
		624.0 ^a 5	<6.6	1581.12	(21/2 ⁺)			
2217.68	(23/2 ⁺)	921.0 2	100	1296.66	(21/2 ⁻)			
2257.38	(25/2 ⁺)	280.2 2	45 4	1977.08	(23/2 ⁺)			
		560.0 2	100 6	1697.50	(21/2 ⁺)	(E2)	0.01526 21	

Adopted Levels, Gammas (continued) $\gamma(^{169}\text{Ta})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ †	I_γ †	E_f	J_f^π	Mult. @	$\alpha\&$	Comments
2262.15	(27/2 ⁻)	267.4 2	41.3 27	1994.68	(25/2 ⁻)	(M1+E2))	0.20 8	Other I_γ : I(267 γ):I(579 γ)=70 3:100 7 in ($^{19}\text{F}, 5n\gamma$).
		579.0 2	100 4	1683.13	(23/2 ⁻)	(E2)	0.01409 20	
2335.03	(25/2 ⁺)	459.9 2	66 6	1875.02	(21/2 ⁺)			Other I_γ : I(276 γ):I(550 γ)=42 4:100 5 in ($^{19}\text{F}, 5n\gamma$).
		546.0 2	100 8	1789.22	(21/2 ⁺)	(E2)	0.01622 23	
2405.44	(27/2 ⁺)	275.5 2	25.1 22	2129.83	(25/2 ⁺)			Other I_γ : I(276 γ):I(550 γ)=42 4:100 5 in ($^{19}\text{F}, 5n\gamma$).
		550.4 2	100 5	1855.07	(23/2 ⁺)			
2412.45	(29/2 ⁻)	592.3 2	100	1820.09	(25/2 ⁻)	(E2)	0.01336 19	
2498.92	(27/2 ⁺)	241.6 2	35 4	2257.38	(25/2 ⁺)			
		521.8 2	100 6	1977.08	(23/2 ⁺)	(E2)	0.01813 25	
2530.48	(27/2 ⁺)	513.3 2	100 9	2017.38	(23/2 ⁺)			
		710.2 2	16.4 14	1820.09	(25/2 ⁻)			
2541.56	(25/2 ⁻)	721.5 2	100	1820.09	(25/2 ⁻)			
2571.10	(29/2 ⁻)	309.0 2	60 4	2262.15	(27/2 ⁻)	(M1+E2)	0.13 6	
		576.5 2	100 4	1994.68	(25/2 ⁻)	(E2)	0.01424 20	
2602.88	(27/2 ⁻)	567.5 2	100 6	2035.37	(23/2 ⁻)	(E2)	0.01478 21	
		782.9 2	28.7 25	1820.09	(25/2 ⁻)			
2623.40	(27/2 ⁺)	405.7 2	86 14	2217.68	(23/2 ⁺)			
		803.4 2	100 14	1820.09	(25/2 ⁻)			
2634.80	(29/2 ⁺)	229.3 2	45.4 20	2405.44	(27/2 ⁺)	(M1)	0.420 6	
		429.0 2	10.0 14	2205.73	(25/2 ⁺)			
		504.9 2	100 6	2129.83	(25/2 ⁺)	(E2)	0.01967 28	
2667.51	(29/2 ⁺)	262.2 2	14.4 12	2405.44	(27/2 ⁺)			
		410.1 2	13.2 12	2257.38	(25/2 ⁺)			
		461.7 2	100 8	2205.73	(25/2 ⁺)	(E2)	0.02467 35	
2711.52	(29/2 ⁺)	305.9 2	16 2	2405.44	(27/2 ⁺)			
		377.0 5	<10	2335.03	(25/2 ⁺)			
		454 ^a	<10	2257.38	(25/2 ⁺)			
		581.8 2	100 8	2129.83	(25/2 ⁺)	Q		
2745.52	(29/2 ⁺)	410.5 2	100 8	2335.03	(25/2 ⁺)			
		488 ^a	<38	2257.38	(25/2 ⁺)			
2795.58	(31/2 ⁻)	224.6 2	65 5	2571.10	(29/2 ⁻)	(M1)	0.445 6	I_γ : from ($^{19}\text{F}, 5n\gamma$). Other I_γ : I(225 γ):I(533 γ)=55 7:100 7 in ($^{51}\text{V}, 6n\gamma$).
		533.3 2	100 5	2262.15	(27/2 ⁻)	(E2)	0.01718 24	Mult.: (Q) for intraband γ from $\gamma(\theta)$ in ($^{19}\text{F}, 5n\gamma$).
2845.01	(31/2 ⁺)	178		2667.51	(29/2 ⁺)			
		210.2 2	86 4	2634.80	(29/2 ⁺)	(M1)	0.534 8	Other I_γ : I(210 γ):I(439 γ)=110 10:100 4 in ($^{19}\text{F}, 5n\gamma$).
		439.6 2	100 5	2405.44	(27/2 ⁺)	(E2)	0.0280 4	Mult.: (D) from $\gamma(\theta)$ for intraband γ in ($^{19}\text{F}, 5n\gamma$).
2851.43	(29/2 ⁻)	309.9 2	57 9	2541.56	(25/2 ⁻)			Mult.: (Q) from $\gamma(\theta)$ for intraband γ in ($^{19}\text{F}, 5n\gamma$).
		438.9 2	100 13	2412.45	(29/2 ⁻)			
		1031.3 2	83 13	1820.09	(25/2 ⁻)			
2940.62	(31/2 ⁺)	441.7 2	100 8	2498.92	(27/2 ⁺)			

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Ta})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [@]	$\alpha^\&$	Comments
2940.62	(31/2 ⁺)	535	<13	2405.44	(27/2 ⁺)			
2986.52	(31/2 ⁺)	456.0 2	100 5	2530.48	(27/2 ⁺)	(E2)	0.0255 4	
		574.3 5	<6.4	2412.45	(29/2 ⁻)			
3003.7	(33/2 ⁻)	207.9 2	100 10	2795.58	(31/2 ⁻)			
		432.6 2	45.2 24	2571.10	(29/2 ⁻)	(E2)	0.0292 4	Other I γ : I(433 γ):I(208 γ)=164 8:100 15 in (¹⁹ F,5n γ).
3053.77	(33/2 ⁺)	208.8 2	75 11	2845.01	(31/2 ⁺)			I γ : weighted average of 66 10 from (¹⁹ F,5n γ) and 88 12 from (⁵¹ V,6n γ).
		418.8 2	100 6	2634.80	(29/2 ⁺)	(E2)	0.0319 4	
3053.79	(33/2 ⁻)	641.4 2	100	2412.45	(29/2 ⁻)	(E2)	0.01110 16	
3074.64	(31/2 ⁺)	451.3 2	59 8	2623.40	(27/2 ⁺)			
		544.2 2	36 5	2530.48	(27/2 ⁺)			
		662.2 2	100 11	2412.45	(29/2 ⁻)			
3150.13	(33/2 ⁺)	438.6 2	100	2711.52	(29/2 ⁺)			
3152.46	(31/2 ⁻)	549.7 2	100 7	2602.88	(27/2 ⁻)	(E2)	0.01596 22	
		739.9 2	20 4	2412.45	(29/2 ⁻)			
3173.41	(33/2 ⁺)	428 ^a	<10	2745.52	(29/2 ⁺)	(E2)	0.0301 4	
		505.8 2	100 9	2667.51	(29/2 ⁺)			
3176.71	(33/2 ⁺)	431 ^a	<7	2745.52	(29/2 ⁺)			
		509.3 2	100 14	2667.51	(29/2 ⁺)	(E2)	0.01925 27	
		542 ^a	<7	2634.80	(29/2 ⁺)			
3210.7	(35/2 ⁻)	206.9 2	100 13	3003.7	(33/2 ⁻)	(M1)	0.558 8	Mult.: from $\gamma(\theta)$ in (¹⁹ F,5n γ).
		415.3 2	60.0 25	2795.58	(31/2 ⁻)	(E2)	0.0326 5	Other I γ : I(415 γ):I(207 γ)=132 12:100 9 in (¹⁹ F,5n γ).
3237.5?		570 ^{‡a}	100 [‡]	2667.51	(29/2 ⁺)			
3241.82	(33/2 ⁻)	390.3 2	63 8	2851.43	(29/2 ⁻)			
		829.4 2	100 10	2412.45	(29/2 ⁻)	Q		
3296.89	(35/2 ⁺)	243.1 2	97 4	3053.77	(33/2 ⁺)	(M1)	0.358 5	Other I γ : I(243 γ):I(452 γ)=115 7:100 14 in (¹⁹ F,5n γ).
		451.9 2	100 4	2845.01	(31/2 ⁺)	(E2)	0.0261 4	Mult.: D from $\gamma(\theta)$ for intraband γ in (¹⁹ F,5n γ).
3402.3	(35/2 ⁺)	461.7 2	100	2940.62	(31/2 ⁺)	(E2)	0.02467 35	Mult.: (Q) from $\gamma(\theta)$ for intraband γ in (¹⁹ F,5n γ).
3440.4	(37/2 ⁻)	229.6 2	100 6	3210.7	(35/2 ⁻)	(M1+E2)	0.30 11	
		436.7 2	52 3	3003.7	(33/2 ⁻)	(E2)	0.0285 4	Other E γ : 437.7 in (¹⁹ F,5n γ).
								Other I γ : I(437 γ):I(230 γ)=130 8:100 12 in (¹⁹ F,5n γ).
3461.8	(35/2 ⁺)	475.3 2	100	2986.52	(31/2 ⁺)	(E2)	0.02290 32	
3541.17	(37/2 ⁺)	244.3 2	59 6	3296.89	(35/2 ⁺)			Other I γ : I(244 γ):I(487 γ)=123 12:100 12 in (¹⁹ F,5n γ).
		487.4 2	100 7	3053.77	(33/2 ⁺)	(E2)	0.02149 30	Mult.: from $\gamma(\theta)$ for intraband γ in (¹⁹ F,5n γ).
3620.5	(35/2 ⁻)	468.0 2	100	3152.46	(31/2 ⁻)	(E2)	0.02383 33	
3622.01	(35/2 ⁺)	547.5 2	100 13	3074.64	(31/2 ⁺)			
		568.1 2	31 5	3053.77	(33/2 ⁺)			
3652.8	(37/2 ⁺)	502.7 2	100	3150.13	(33/2 ⁺)			
3663.23	(37/2 ⁻)	421.4 2	8.6 5	3241.82	(33/2 ⁻)			
		609.4 2	100 8	3053.79	(33/2 ⁻)	(E2)	0.01250 18	

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Ta})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. @	$\alpha\&$	Comments
3689.31	(37/2 ⁺)	512.6 2	55 7	3176.71 (33/2 ⁺)				
		515.9 2	100 11	3173.41 (33/2 ⁺)				
3698.7	(39/2 ⁻)	258.0 2	100 7	3440.4 (37/2 ⁻)	(M1+E2)	0.22 9		
		488.0 2	70 4	3210.7 (35/2 ⁻)	(E2)	0.02142 30		
3741.81	(37/2 ⁺)	565.2 2	100 7	3176.71 (33/2 ⁺)				
		568.3 2	55 6	3173.41 (33/2 ⁺)	Q			
3795.28	(37/2 ⁻)	553.4 2	77 7	3241.82 (33/2 ⁻)				
		741.6 2	100 11	3053.79 (33/2 ⁻)				
3829.81	(39/2 ⁺)	288.6 2	53 6	3541.17 (37/2 ⁺)	(M1+E2)	0.16 7		Other I γ : I(289 γ):I(533 γ)=133 8:100 13 in (¹⁹ F,5n γ).
		532.9 2	100 4	3296.89 (35/2 ⁺)	(E2)	0.01721 24		Mult.: (Q) from $\gamma(\theta)$ for intraband γ in (¹⁹ F,5n γ).
3952.1	(39/2 ⁺)	549.8 2	100	3402.3 (35/2 ⁺)	(E2)	0.01595 22		
3974.2	(41/2 ⁻)	275.4 2	100 6	3698.7 (39/2 ⁻)	(M1+E2)	0.18 7		Other E γ : 276.4 in (¹⁹ F,5n γ).
		534.0 2	56 6	3440.4 (37/2 ⁻)	(E2)	0.01713 24		I γ : from (¹⁹ F,5n γ). 65 10 in (⁵¹ V,6n γ).
								Mult.: (Q) from $\gamma(\theta)$ for intraband γ in (¹⁹ F,5n γ).
4019.8	(39/2 ⁺)	558.0 2	100	3461.8 (35/2 ⁺)				
4110.13	(41/2 ⁺)	280.4 2	35 5	3829.81 (39/2 ⁺)	(M1)	0.2423 34		Other I γ : I(280 γ):I(569 γ)=81 12:100 12 in (¹⁹ F,5n γ).
		569.0 2	100 7	3541.17 (37/2 ⁺)	(E2)	0.01469 21		
4137.3	(39/2 ⁻)	516.8 2	100	3620.5 (35/2 ⁻)				
4225.01	(39/2 ⁺)	603.0 2	100	3622.01 (35/2 ⁺)				
4230.8	(41/2 ⁻)	567.6 2	100	3663.23 (37/2 ⁻)	(E2)	0.01478 21		
4240.3	(41/2 ⁺)	587.5 2	100	3652.8 (37/2 ⁺)				
4281.7	(43/2 ⁻)	307.4 2	87 4	3974.2 (41/2 ⁻)	(M1+E2)	0.13 6		Other I γ : I(307 γ):I(583 γ)=175 12:100 12 in (¹⁹ F,5n γ).
		583.0 2	100 13	3698.7 (39/2 ⁻)	(E2)	0.01387 19		
4285.6	(41/2 ⁺)	596.3 2	100	3689.31 (37/2 ⁺)				
4360.9	(41/2 ⁺)	619.1 2	100	3741.81 (37/2 ⁺)				
4438.84	(43/2 ⁺)	328.8 2	42 5	4110.13 (41/2 ⁺)	(M1)	0.1577 22		Other I γ : I(329 γ):I(609 γ)=67 13:100 13 in (¹⁹ F,5n γ).
		608.9 2	100 4	3829.81 (39/2 ⁺)	(E2)	0.01252 18		
4503.5	(41/2 ⁻)	708.3 2	100 11	3795.28 (37/2 ⁻)	(E2)	0.00888 12		
		840.0 ^a 5	<16	3663.23 (37/2 ⁻)				
4582.1	(43/2 ⁺)	630.0 2	100	3952.1 (39/2 ⁺)				
4601.5	(45/2 ⁻)	319.8 2	91 5	4281.7 (43/2 ⁻)	(M1)	0.1699 24		Other I γ : I(320 γ):I(627 γ)=154 18:100 18 in (¹⁹ F,5n γ).
		627.4 2	100 6	3974.2 (41/2 ⁻)	(E2)	0.01168 16		
4651.4	(43/2 ⁺)	631.6 2	100	4019.8 (39/2 ⁺)				
4728.8	(43/2 ⁻)	591.5 2	100	4137.3 (39/2 ⁻)				
4750.68	(45/2 ⁺)	311.8 2	38 7	4438.84 (43/2 ⁺)				Other I γ : I(312 γ):I(641 γ)=67 21:100 13 in (¹⁹ F,5n γ).
		640.6 2	100 8	4110.13 (41/2 ⁺)	(E2)	0.01114 16		
4860.6	(45/2 ⁻)	629.8 2	100	4230.8 (41/2 ⁻)	(E2)	0.01158 16		
4883.5	(43/2 ⁺)	658.5 2	100	4225.01 (39/2 ⁺)				
4903.1	(45/2 ⁺)	662.8 2	100	4240.3 (41/2 ⁺)				
4946.8	(47/2 ⁻)	345.4 2	96 6	4601.5 (45/2 ⁻)	(M1)	0.1382 19		

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Ta})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. @	$\alpha\&$	Comments
4946.8	(47/2 ⁻)	665.1 2	100 6	4281.7	(43/2 ⁻)	(E2)	0.01022 14	
4948.2	(45/2 ⁺)	662.6 2	100	4285.6	(41/2 ⁺)			
5031.0	(45/2 ⁺)	670.1 2	100	4360.9	(41/2 ⁺)			
5111.35	(47/2 ⁺)	360.6 2	29 5	4750.68	(45/2 ⁺)	(M1+E2)	0.09 4	Other I γ : I(361 γ):I(673 γ)=70 9:100 17 in (¹⁹ F,5n γ).
		672.5 2	100 5	4438.84	(43/2 ⁺)	(E2)	0.00997 14	
5245.1	(45/2 ⁻)	741.6 2	100	4503.5	(41/2 ⁻)			
5279.0	(47/2 ⁺)	696.9 2	100	4582.1	(43/2 ⁺)			
5305.7	(49/2 ⁻)	358.8 2	81 4	4946.8	(47/2 ⁻)	(M1)	0.1248 18	Other E γ : 360.0 in (¹⁹ F,5n γ).
		704.1 2	100 5	4601.5	(45/2 ⁻)	(E2)	0.00900 13	Other E γ : 705.9 in (¹⁹ F,5n γ).
5316.8	(47/2 ⁺)	665.4 2	100	4651.4	(43/2 ⁺)			
5354.7	(47/2 ⁺)	703.3 2	100	4651.4	(43/2 ⁺)			
5391.3	(47/2 ⁻)	662.5 2	100	4728.8	(43/2 ⁻)			
5450.0	(49/2 ⁺)	338.6 2	26 6	5111.35	(47/2 ⁺)			Other I γ : I(339 γ):I(699 γ)=60 8:100 12 in (¹⁹ F,5n γ).
		699.4 2	100 7	4750.68	(45/2 ⁺)			
5556.7	(49/2 ⁻)	696.1 2	100	4860.6	(45/2 ⁻)	(E2)	0.00923 13	Other E γ : 697.5 in (¹⁹ F,5n γ).
5591.8	(47/2 ⁺)	708.3 2	100	4883.5	(43/2 ⁺)			
5627.4	(49/2 ⁺)	724.3 2	100	4903.1	(45/2 ⁺)			
5642.3	(49/2 ⁺)	694.1 2	100	4948.2	(45/2 ⁺)			
5679.1	(51/2 ⁻)	373.4 2	55 4	5305.7	(49/2 ⁻)			Other E γ : 372.3 in (¹⁹ F,5n γ).
		732.4 2	100 5	4946.8	(47/2 ⁻)			
5746.7	(49/2 ⁺)	715.7 2	100	5031.0	(45/2 ⁺)			
5834.8	(51/2 ⁺)	384.8 2	31 4	5450.0	(49/2 ⁺)	(M1)	0.1036 15	Other I γ : I(385 γ):I(723 γ)=81 10:100 14 in (¹⁹ F,5n γ).
		723.4 2	100 8	5111.35	(47/2 ⁺)	(E2)	0.00848 12	
5987.8	(49/2 ⁻)	742.7 2	100	5245.1	(45/2 ⁻)			
6003.5	(51/2 ⁺)	686.7 5	100	5316.8	(47/2 ⁺)			
6024.3	(51/2 ⁺)	745.3 2	100	5279.0	(47/2 ⁺)			
6073.9	(53/2 ⁻)	394.6 2	66 5	5679.1	(51/2 ⁻)			Other I γ : I(395 γ):I(768 γ)=139 10:100 21 in (¹⁹ F,5n γ).
		768.2 2	100 5	5305.7	(49/2 ⁻)			
6104.0	(51/2 ⁺)	749.3 2	100	5354.7	(47/2 ⁺)			
6111.3?	(51/2 ⁻)	720.0 ^a 5	100	5391.3	(47/2 ⁻)			
6195.1	(53/2 ⁺)	360.3 2	32 5	5834.8	(51/2 ⁺)			Other I γ : I(360 γ):I(745 γ)=71 10:100 14 in (¹⁹ F,5n γ).
		745.1 2	100 14	5450.0	(49/2 ⁺)			
6315.1	(53/2 ⁻)	758.4 2	100	5556.7	(49/2 ⁻)	(E2)	0.00765 11	
6351.3	(53/2 ⁺)	709.0 5	100	5642.3	(49/2 ⁺)			
6391.2	(53/2 ⁺)	763.8 2	100	5627.4	(49/2 ⁺)			
6467.2	(55/2 ⁻)	392.0 ^{‡a}	86 [‡] 43	6073.9	(53/2 ⁻)			I γ : from (¹⁹ F,5n γ).
		788.4 2	100 43	5679.1	(51/2 ⁻)			
6521.4	(53/2 ⁺)	774.7 2	100	5746.7	(49/2 ⁺)			
6599.5	(55/2 ⁺)	404.0 ^a 5	<28	6195.1	(53/2 ⁺)			Other E γ : 405.2 in (¹⁹ F,5n γ).
								Other I γ : I(404 γ):I(765 γ)=222 24:100 42 in (¹⁹ F,5n γ).

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Ta})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Comments
6599.5	(55/2 ⁺)	764.6 2	100 14	5834.8	(51/2 ⁺)	
6742.7	(55/2 ⁺)	739.2 5	100	6003.5	(51/2 ⁺)	
6812.5	(55/2 ⁺)	788.2 5	100	6024.3	(51/2 ⁺)	
6887.7	(55/2 ⁺)	783.7 5	100	6104.0	(51/2 ⁺)	
6901.3	(57/2 ⁻)	435.0 ^{‡a}	75.0 [‡] 38	6467.2	(55/2 ⁻)	
		827.3 2	100 50	6073.9	(53/2 ⁻)	I _γ : from (¹⁹ F,5nγ).
6978.2	(57/2 ⁺)	378.0 ^{‡a}	100.0 [‡] 15	6599.5	(55/2 ⁺)	
		783.3 2	53 23	6195.1	(53/2 ⁺)	I _γ : from (¹⁹ F,5nγ).
7128.7	(57/2 ⁻)	813.6 2	100	6315.1	(53/2 ⁻)	
7194.9	(57/2 ⁺)	803.7 5	100	6391.2	(53/2 ⁺)	
7309.5	(59/2 ⁻)	407.0 ^{‡a}		6901.3	(57/2 ⁻)	
		842.3 2	100 6	6467.2	(55/2 ⁻)	
7327.7	(57/2 ⁺)	806.3 5	100	6521.4	(53/2 ⁺)	
7409.5	(59/2 ⁺)	810.0 2	100	6599.5	(55/2 ⁺)	
7789.9	(61/2 ⁻)	888.6 2	100	6901.3	(57/2 ⁻)	
7809.8	(61/2 ⁺)	831.6 2	100	6978.2	(57/2 ⁺)	
7993.5	(61/2 ⁻)	864.8 2	100	7128.7	(57/2 ⁻)	
8182.3	(61/2 ⁺)	854.6 5	100	7327.7	(57/2 ⁺)	
8206.7	(63/2 ⁻)	897.2 2	100	7309.5	(59/2 ⁻)	
8279.5?	(63/2 ⁺)	870.0 ^a 5	100	7409.5	(59/2 ⁺)	
8694.9	(65/2 ⁺)	885.0 2	100	7809.8	(61/2 ⁺)	
8745.5	(65/2 ⁻)	955.6 5	100	7789.9	(61/2 ⁻)	
8913.1	(65/2 ⁻)	919.6 5	100	7993.5	(61/2 ⁻)	
9085.3	(65/2 ⁺)	903.0 5	100	8182.3	(61/2 ⁺)	
9157.8	(67/2 ⁻)	951.1 5	100	8206.7	(63/2 ⁻)	
9634.9	(69/2 ⁺)	940.0 5	100	8694.9	(65/2 ⁺)	
9886.8	(69/2 ⁻)	973.6 5	100	8913.1	(65/2 ⁻)	
10154.4	(71/2 ⁻)	996.6 5	100	9157.8	(67/2 ⁻)	
10916.6	(73/2 ⁻)	1029.8 5	100	9886.8	(69/2 ⁻)	
11992.6?	(77/2 ⁻)	1076.0 ^a 5	100	10916.6	(73/2 ⁻)	

[†] From ¹²⁴Sn(⁵¹V,6nγ), except as noted.

[‡] From ¹⁵⁵Gd(¹⁹F,5nγ), uncertainty unstated for E_γ by authors.

From ¹⁶⁹W ε decay.

@ From γ asymmetry in (⁵¹V,6nγ), except as noted, assigning Δπ=(no) for intraband transitions.

& Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with “Frozen Orbitals” approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

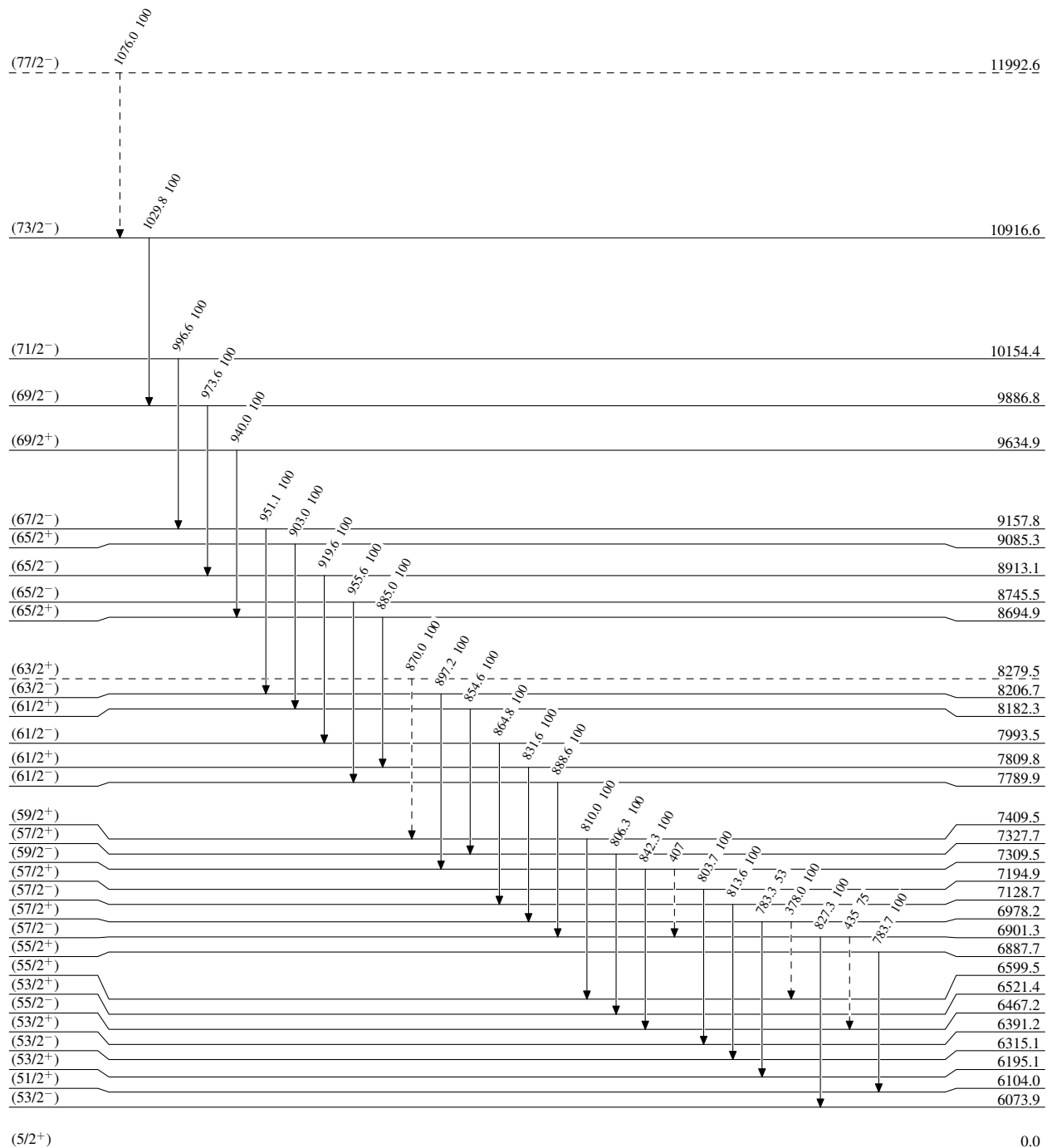
^a Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

 - - - - - $\rightarrow$ γ Decay (Uncertain)


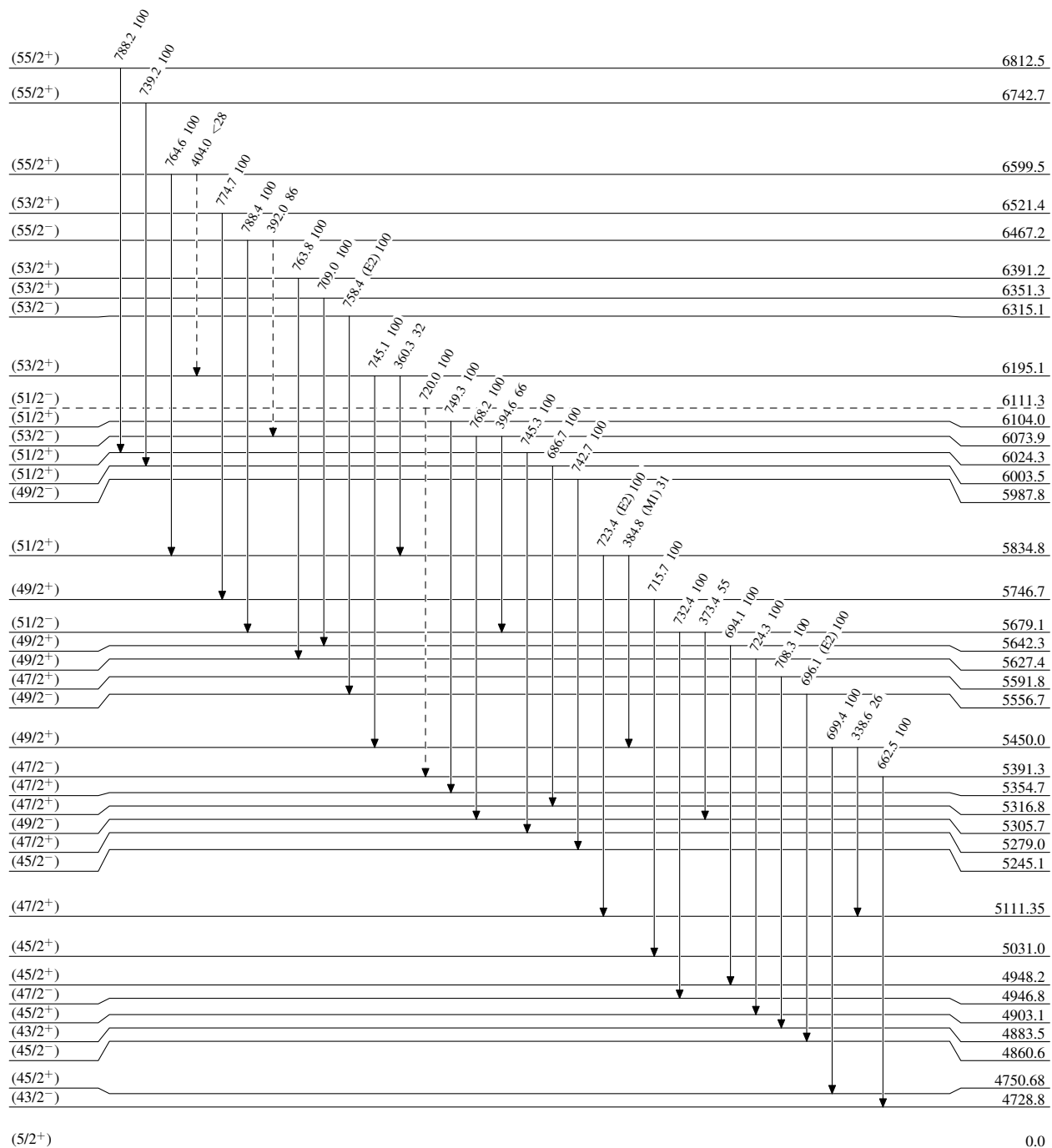
4.9 min 5

Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

 ----- ► γ Decay (Uncertain)


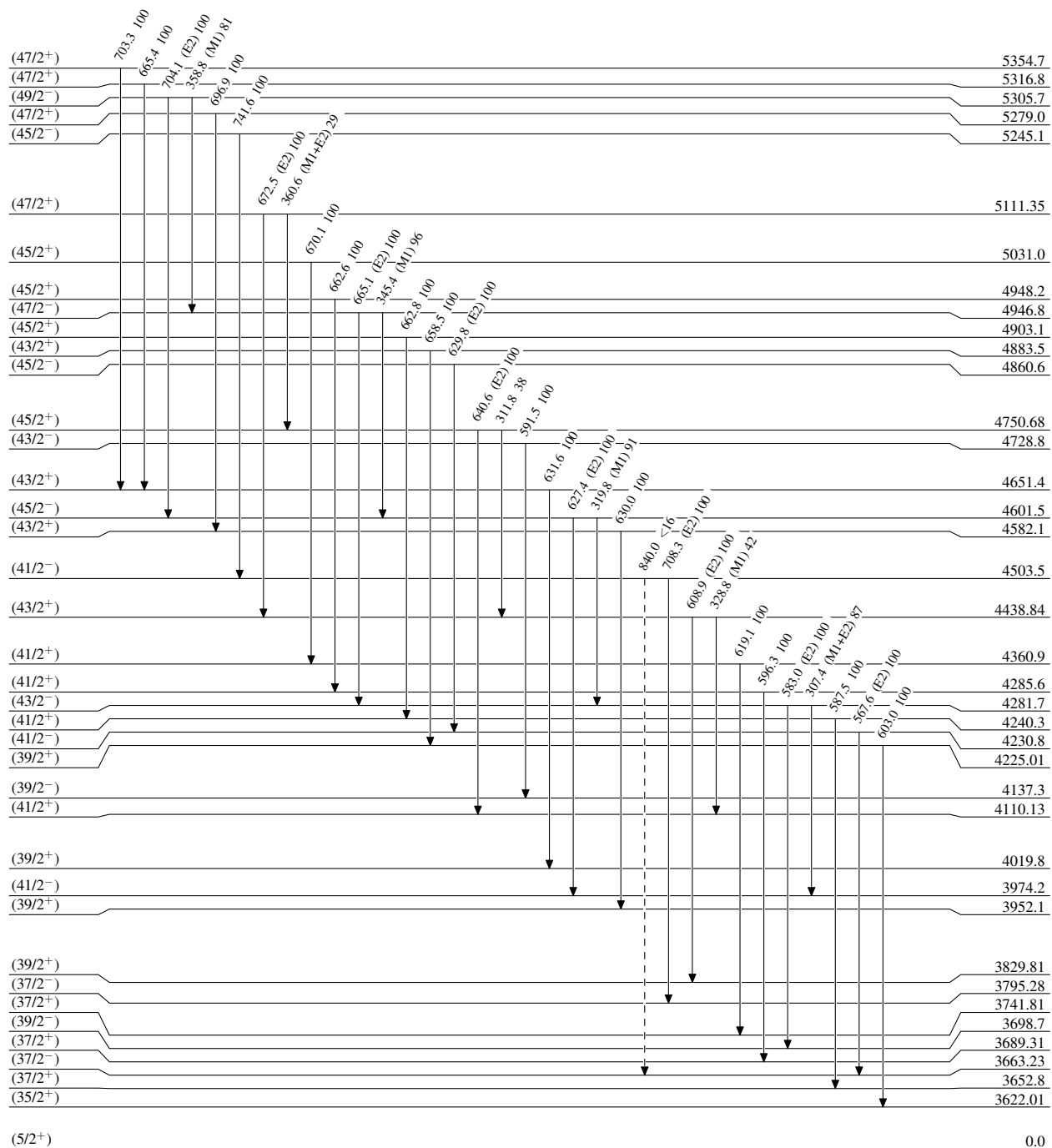
4.9 min 5

Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

 ----- ► γ Decay (Uncertain)

 (5/2⁺)

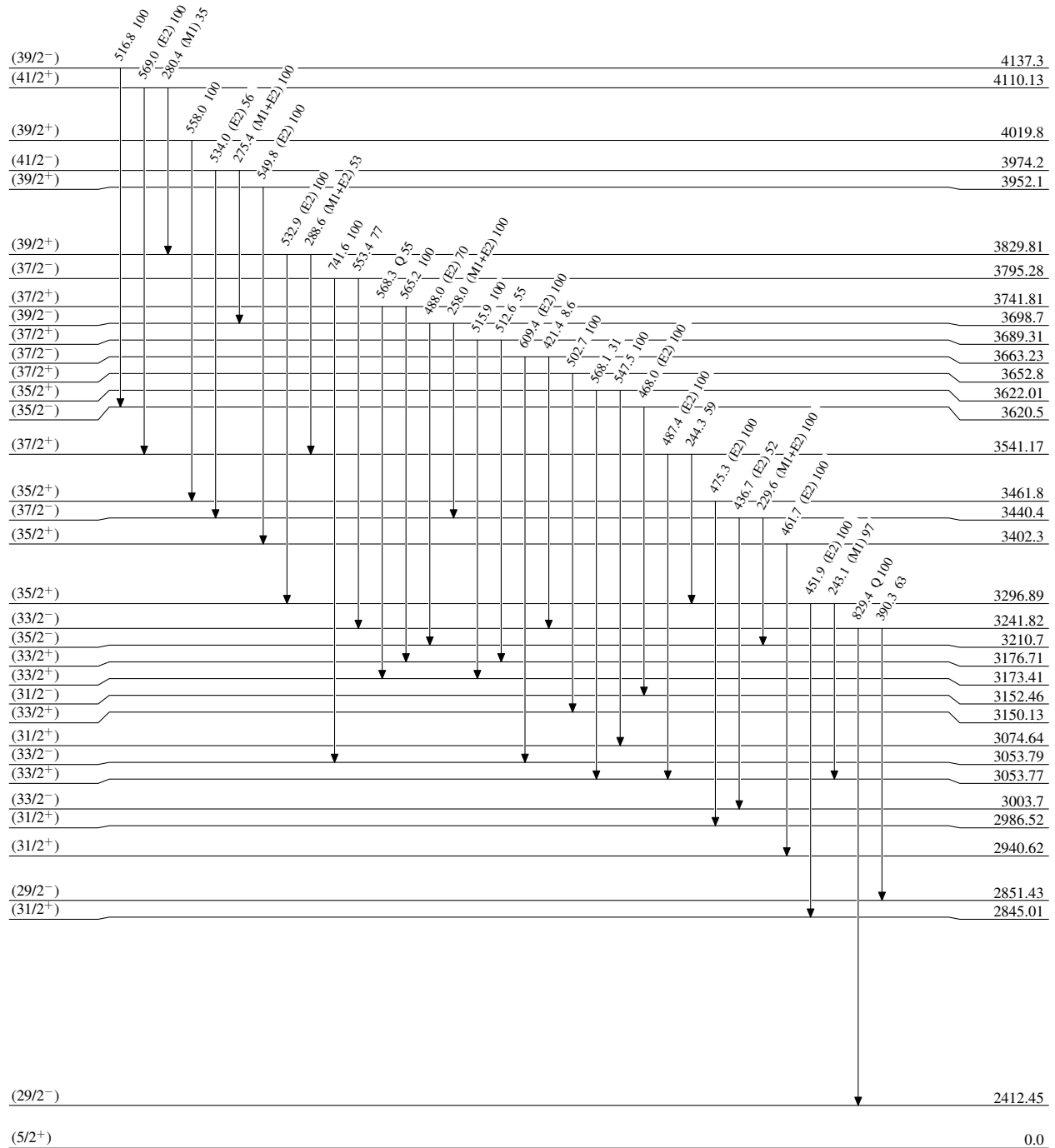
0.0

4.9 min 5

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

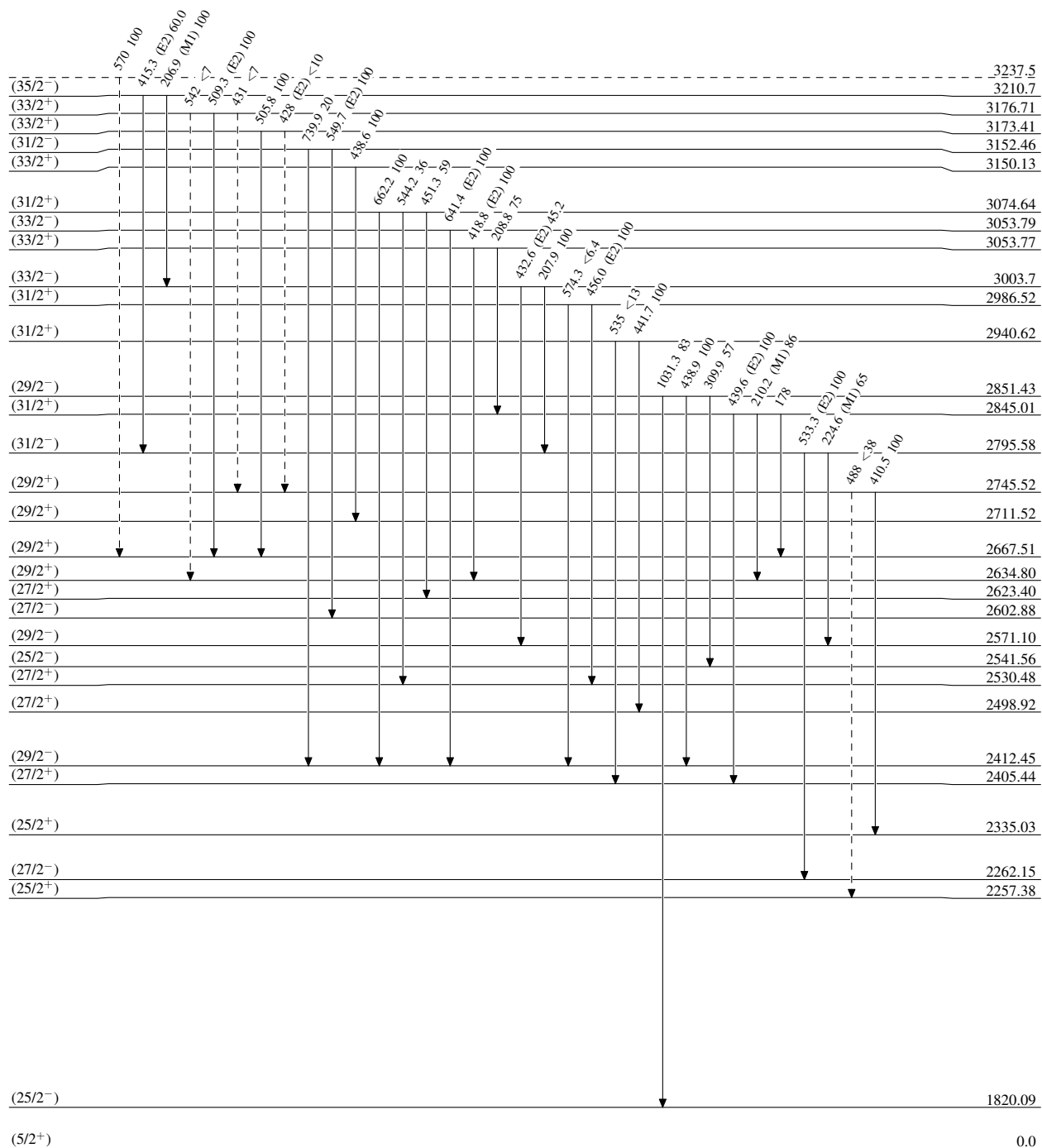


Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

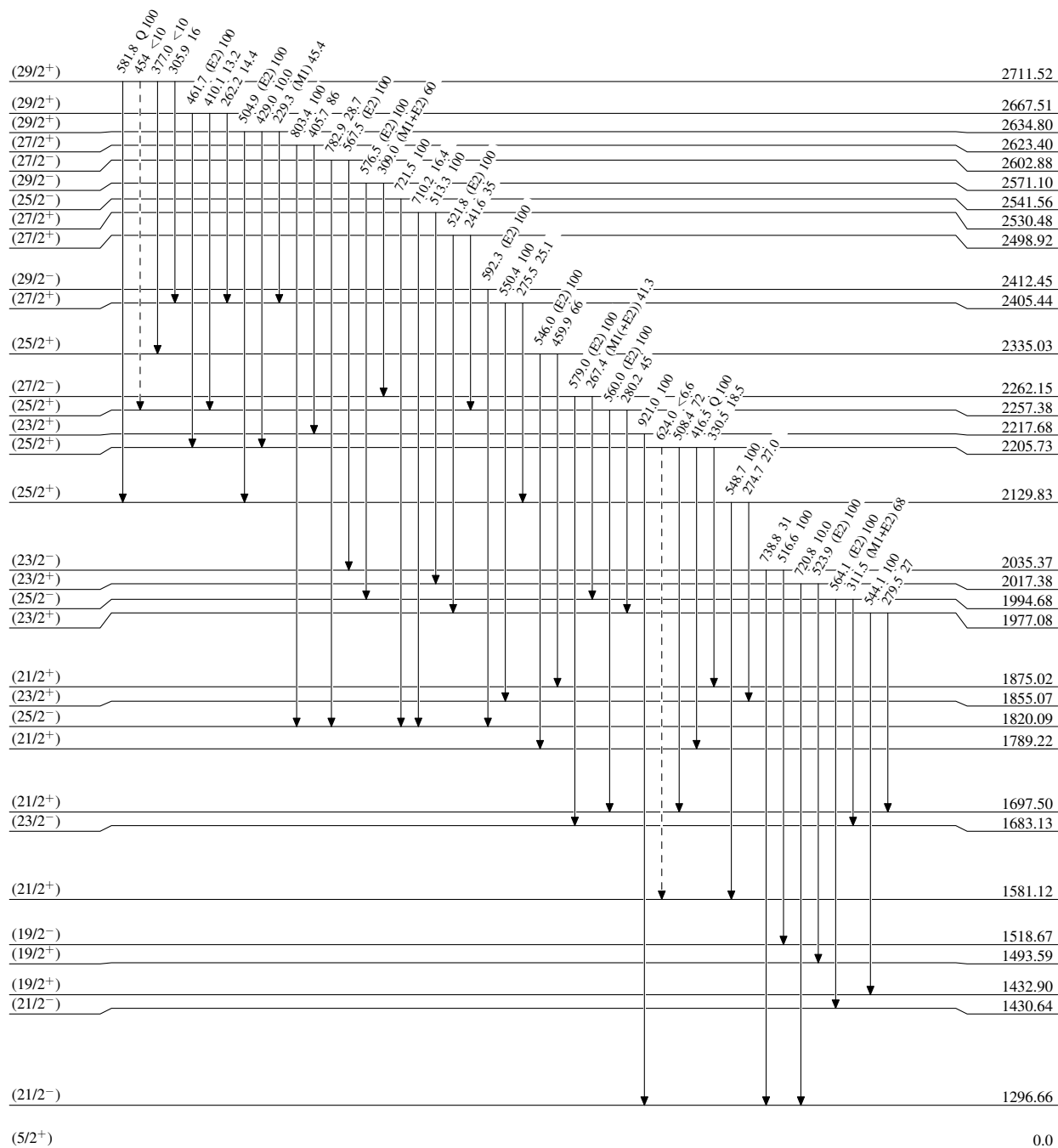
 ----- ▶ γ Decay (Uncertain)


Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

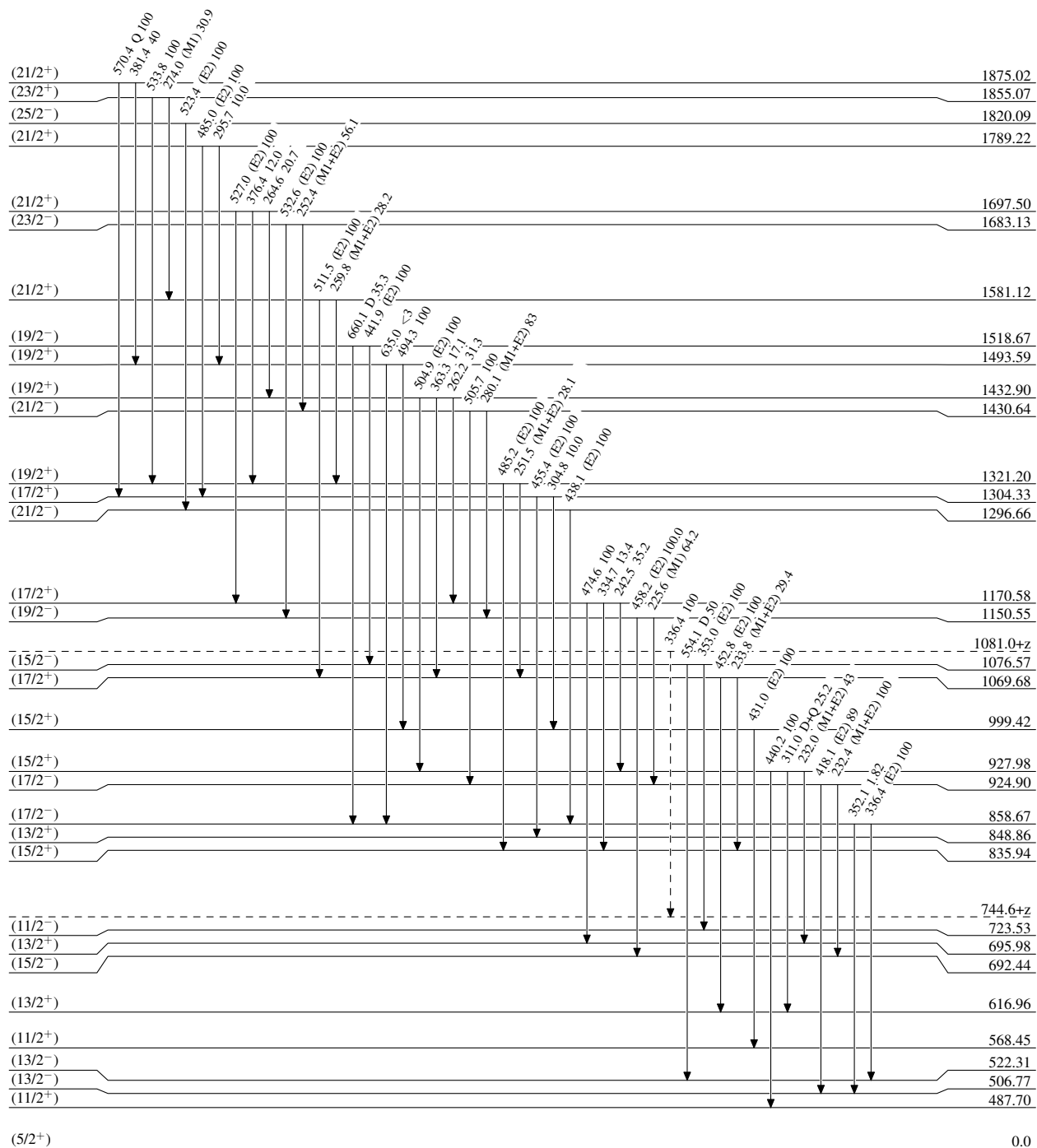
-----> γ Decay (Uncertain)


Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

 ----- ► γ Decay (Uncertain)


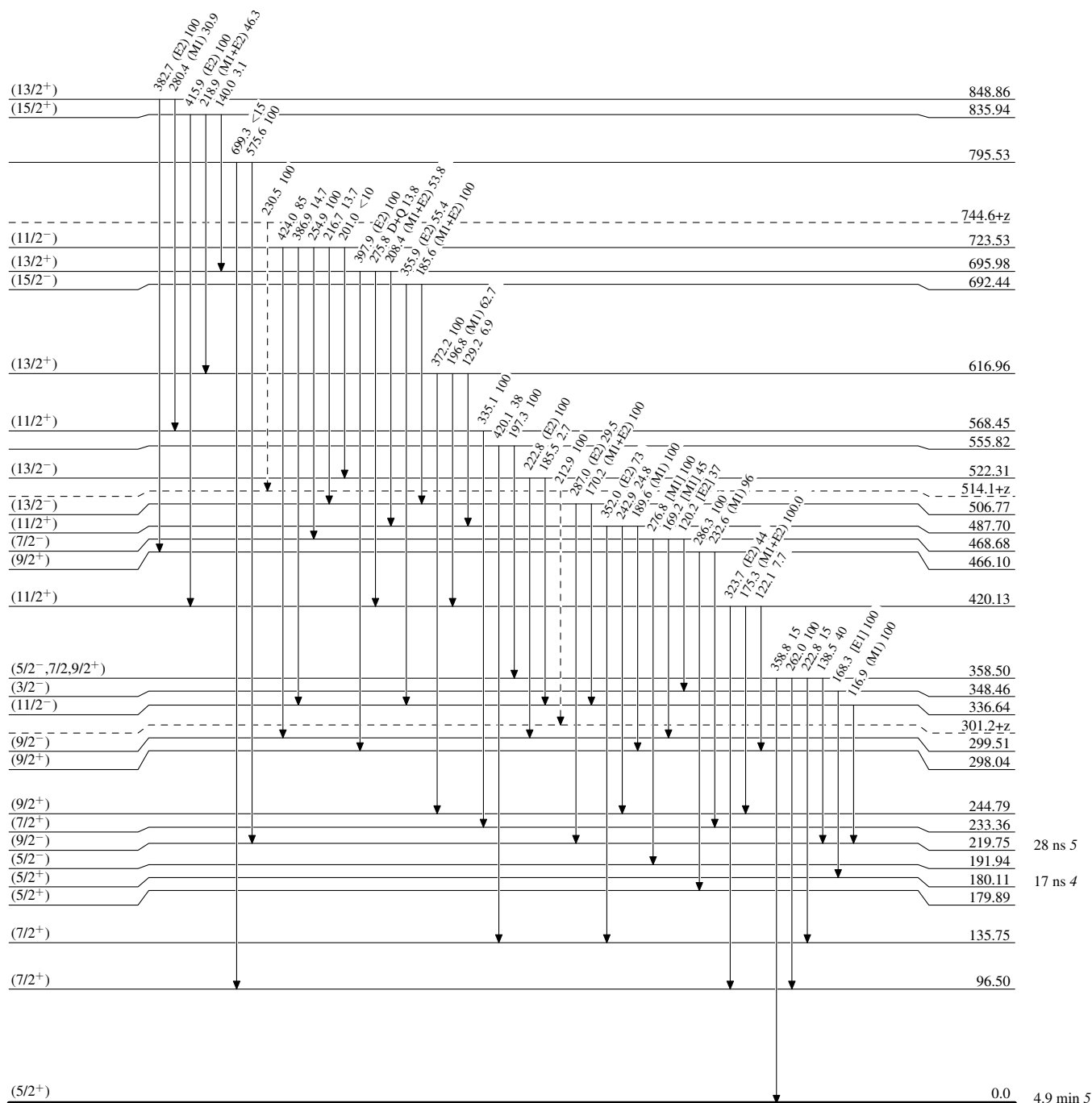
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

-----► γ Decay (Uncertain)

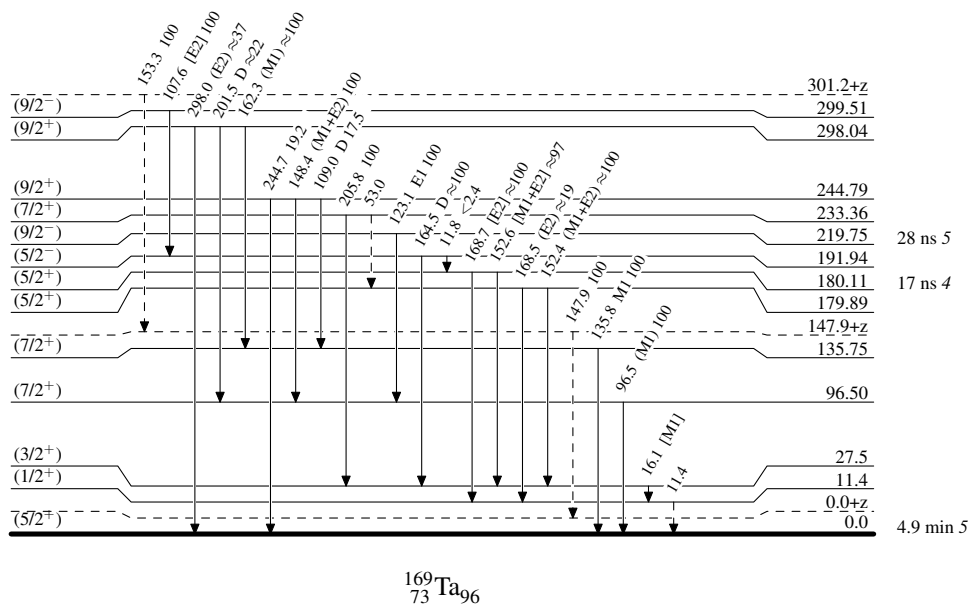


Adopted Levels, Gammas

Legend

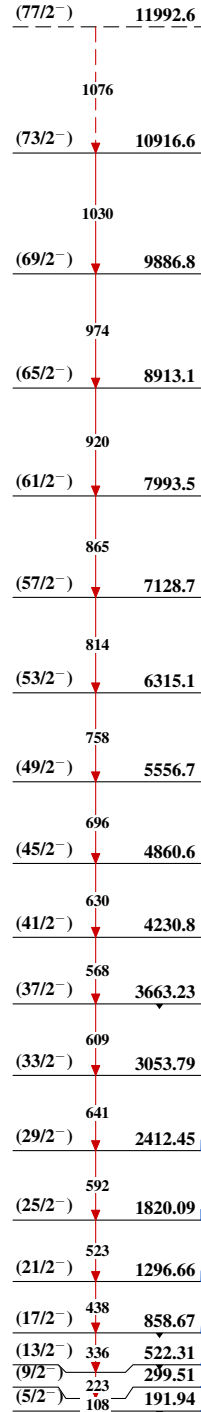
Level Scheme (continued)

Intensities: Relative photon branching from each level

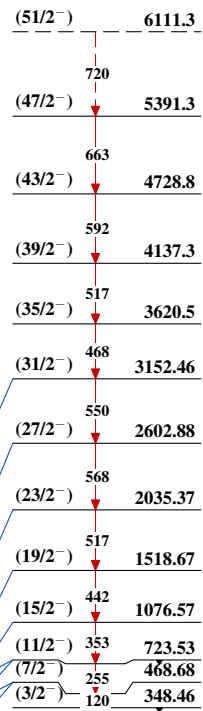
 ----- ► γ Decay (Uncertain)


Adopted Levels, Gammas

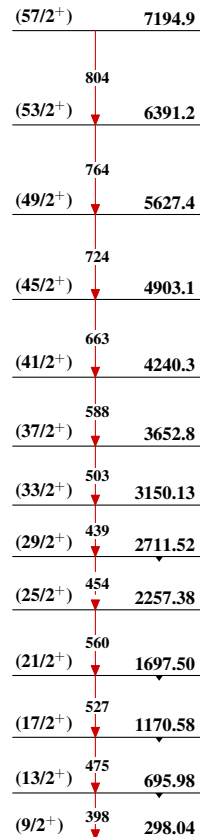
Band(A): $1/2[541]$,
 $\alpha=+1/2$ band (2006Ha46)



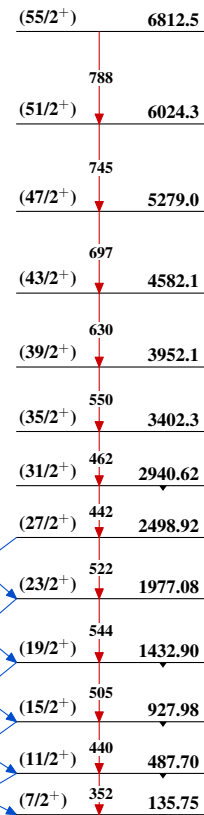
Band(a): $\pi 1/2[541]$,
 $\alpha=-1/2$ band (2006Ha46)



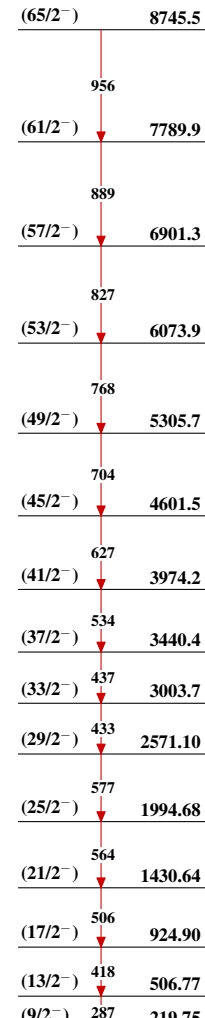
Band(B): $\pi 7/2[404]$,
 $\alpha=+1/2$ band (2006Ha46)



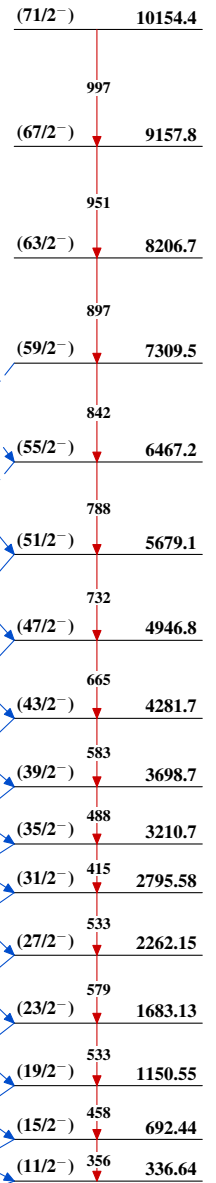
Band(b): $\pi 7/2[404]$,
 $\alpha=-1/2$ band (2006Ha46)



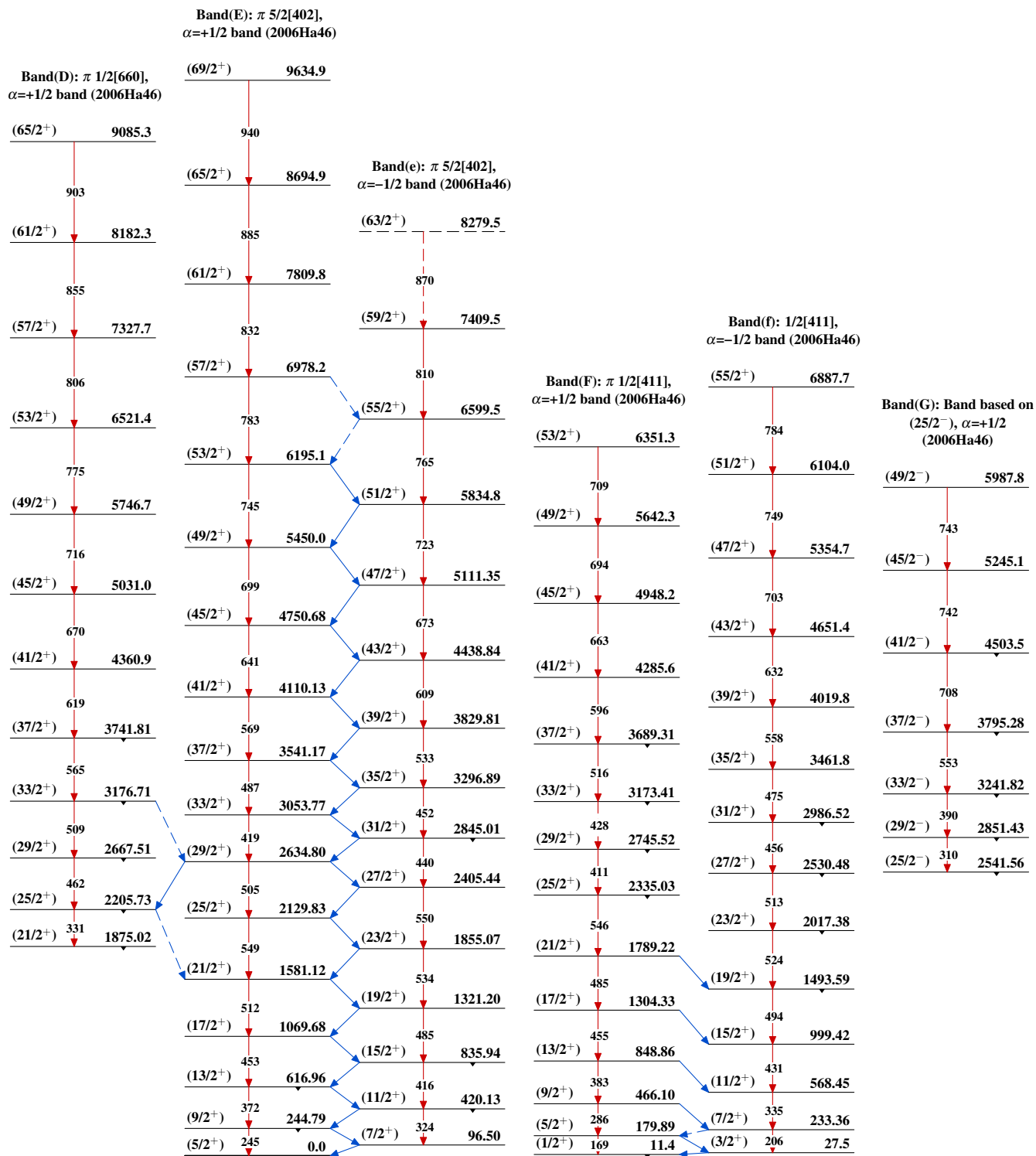
Band(C): $\pi 9/2[514]$,
 $\alpha=+1/2$ band (2006Ha46)



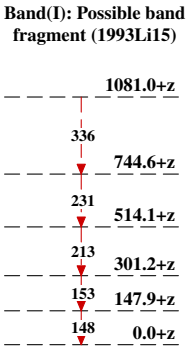
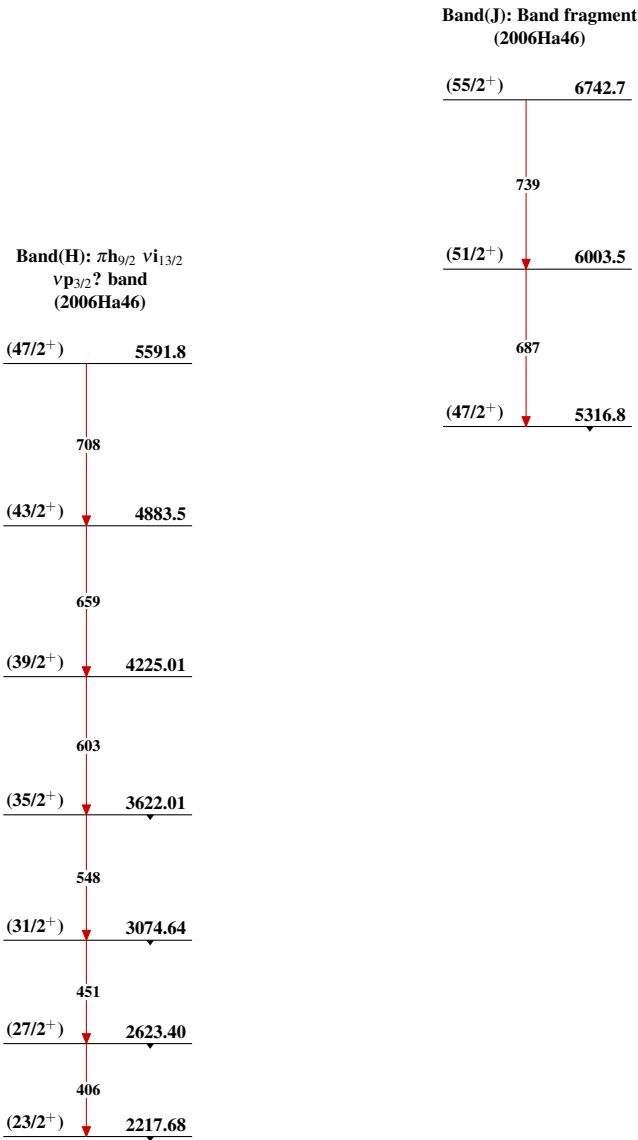
Band(c): $\pi 9/2[514]$,
 $\alpha=-1/2$ band (2006Ha46)



Adopted Levels, Gammas (continued)



Adopted Levels, Gammas (continued)



¹⁶⁹Ta₇₃⁻²⁷₉₆

^{169}W $\varepsilon+\beta^+$ decay (75 s) 1990Me12

Parent: ^{169}W : $E=0.0$; $J^\pi=(5/2^-)$; $T_{1/2}=75$ s 6; $Q(\varepsilon)=5370$ 30; $\% \varepsilon + \% \beta^+$ decay=100.0

^{169}W - J^π , $T_{1/2}$: from ^{169}W Adopted Levels.

^{169}W - $Q(\varepsilon)$: from 2021Wa16.

Others: 1987Es08, 1992HeZV (sources from Gd(Ne,xn)).

1990Me12: ^{169}W sources from $^{138}\text{Ba}(^{36}\text{Ar},\text{xn})$, $E=191$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ coin, γ -K x ray coin.

The decay scheme is that of 1990Me12 with the addition of unplaced 107.5γ , 153.4γ and 169.5γ from 1990Me12; the latter were placed by the evaluator as in Adopted Levels, Gammas. The decay scheme cannot be normalized; several placed gammas of unknown multipolarity are low enough in energy for significant internal conversion to occur, and the unknown deexcitations of the 11 and 27 levels probably take place via transitions which are almost entirely converted. $\varepsilon+\beta^+$ feeding to the g.s. is unknown; it would be expected to be $<5\%$ were this feeding first forbidden (as might be expected given that many $N=95$ isotones have $5/2[523]$ g.s. configurations). However, allowed $\varepsilon+\beta^+$ feeding to the ^{169}Ta g.s. cannot be ruled out entirely given that the pairing selfconsistent cranking model calculations of 1985Re06 indicate that the $3/2[651]$ and $5/2[642]$ bandheads are only 15 and 30 keV above a $5/2[523]$ bandhead in W. The apparent ε feeding to $(5/2^+)$ 181, $(9/2^-)$ 220 and $(7/2^-)$ 469 levels seems inconsistent with a $5/2^-$ parent but might simply result from a very incomplete decay scheme. Alternatively, placements suggested by analogy with Adopted Levels, Gammas may not be correct. The expected ν $5/2[523]$ to π $7/2[523]$ allowed unhindered decay has yet to be identified. More experimental work on ^{169}W ε decay is required.

 ^{169}Ta Levels

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$T_{1/2}^\ddagger$	Comments
0.0	$(5/2^+)$	4.9 min 5	
11.4 3	$(1/2^+)$		
27.5 3	$(3/2^+)$		$E(\text{level})$: from Adopted Levels; E held fixed for least-squares fit.
96.64 18	$(7/2^+)$		
135.96 23	$(7/2^+)$		
180.91 20	$(5/2^+)$	17 ns 4	Level not proposed in 1990Me12. Unplaced 153.4γ and 169.5γ in 1990Me12 are placed from this level as of the adopted dataset.
192.19 27	$(5/2^-)$		
220.18 28	$(9/2^-)$	28 ns 5	
245.2 4	$(9/2^+)$		
298.4 5	$(9/2^+)$		
299.76 35	$(9/2^-)$		Level not proposed in 1990Me12. Unplaced 107.5γ in 1990Me12 is placed from this level as of the adopted dataset.
349.23 34	$(3/2^-)$		
358.72 22	$(5/2^-, 7/2, 9/2^+)$		
469.34 33	$(7/2^-)$		
556.03 31			
795.8 4			

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

‡ From Adopted Levels.

¹⁶⁹W $\varepsilon+\beta^+$ decay (75 s) 1990Me12 (continued)

$\gamma(^{169}\text{Ta})$									Comments
E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. @	α &	$I_{(\gamma+ce)}$	
(11.2 4)		192.19	(5/2 ⁻)	180.91	(5/2 ⁺)	[E1]		1.5×10^2 12	E_γ : from level energy difference; transition not observed. $I_{(\gamma+ce)}$: at least 33 12 and no more than 267 30 to avoid negative ε feeding to 192 and 180 levels, respectively.
(11.4)		11.4	(1/2 ⁺)	0.0	(5/2 ⁺)	[E2]		≥ 308	E_γ : from level energy difference; transition not observed. $I_{(\gamma+ce)}$: lower limit required to avoid negative ε feeding to 11 level.
(16.1)		27.5	(3/2 ⁺)	11.4	(1/2 ⁺)	[M1]	159.2 22	≥ 184	E_γ : from level energy difference; transition not observed. $I_{(\gamma+ce)}$: lower limit required to avoid negative ε feeding to 27 level.
96.6 ‡ 2	40 4	96.64	(7/2 ⁺)	0.0	(5/2 ⁺)	(M1)	4.82 7		Mult.: M1,E2 from $\alpha(\text{exp})=7$ 4 (1990Me12); (M1) from Adopted Gammas.
107.5 # 3	6 3	299.76	(9/2 ⁻)	192.19	(5/2 ⁻)	[E2]	2.79 5		E_γ : Gamma in coincidences with 170 γ , 153 γ and possibly 165 γ . Coincident with 153 γ , 165 γ , 170 γ . Coincident with 153 γ , 170 γ . Mult.: from $\alpha(\text{exp})=0.5$ 2 (1990Me12). Mult.: from $\alpha(\text{exp})=2.1$ 5 (1990Me12).
^x 109.0 3	9 3								
120.1 3	8 3	469.34	(7/2 ⁻)	349.23	(3/2 ⁻)	[E2]	1.828 31		
123.4 4	167 28	220.18	(9/2 ⁻)	96.64	(7/2 ⁺)	E1	0.2123 35		
136.0 ‡ 3	29 3	135.96	(7/2 ⁺)	0.0	(5/2 ⁺)	M1	1.812 28		
138.5 3	16 3	358.72	(5/2 ⁻ , 7/2, 9/2 ⁺)	220.18	(9/2 ⁻)				
148.6 4	8 3	245.2	(9/2 ⁺)	96.64	(7/2 ⁺)	[M1]	1.410 22		Coincident with 97 γ .
153.4 # 3	79 8	180.91	(5/2 ⁺)	27.5	(3/2 ⁺)	[M1+E2]	1.02 27		
162.4 4	9 3	298.4	(9/2 ⁺)	135.96	(7/2 ⁺)	(M1)	1.097 17		
164.7 3	24 3	192.19	(5/2 ⁻)	27.5	(3/2 ⁺)	[E1]	0.1002 15		Coincidences with 109 γ , 168 γ , 277 γ and possibly 108 γ . Coincident with 109 γ , 153 γ , 165 γ , 170 γ .
168.3 4	12 2	349.23	(3/2 ⁻)	180.91	(5/2 ⁺)	[E1]	0.0947 14		
169.5 a # ‡ 3	≈ 81 a	180.91	(5/2 ⁺)	11.4	(1/2 ⁺)	[E2]	0.524 8		I_γ : 100 for doubly-placed γ ; intensity divided based on adopted branching from 180.1 level.
169.5 a 3	19 a	469.34	(7/2 ⁻)	299.76	(9/2 ⁻)	[M1]	0.973 14		I_γ : 100 for doubly-placed γ ; intensity divided based on adopted branching from 180.1 level. Coincident with 109 γ , 153 γ , 165 γ , 170 γ .
197.3 3	8 3	556.03		358.72	(5/2 ⁻ , 7/2, 9/2 ⁺)				
222.8 3	6 2	358.72	(5/2 ⁻ , 7/2, 9/2 ⁺)	135.96	(7/2 ⁺)				
262.0 4	40 16	358.72	(5/2 ⁻ , 7/2, 9/2 ⁺)	96.64	(7/2 ⁺)				
277.3 4	29 3	469.34	(7/2 ⁻)	192.19	(5/2 ⁻)	[M1]	0.250 4		Coincident with 153 γ , 165 γ , 170 γ .

¹⁶⁹W ε+β⁺ decay (75 s) [1990Me12](#) (continued)

γ(¹⁶⁹Ta) (continued)

<u>E_γ[†]</u>	<u>I_γ[†]</u>	<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>
358.8 4	6 3	358.72	(5/2 ⁻ , 7/2, 9/2 ⁺)	0.0	(5/2 ⁺)
420.1 4	3 2	556.03		135.96	(7/2 ⁺)
575.6 4	26 6	795.8		220.18	(9/2 ⁻)
699.3 5	<4	795.8		96.64	(7/2 ⁺)

[†] From [1990Me12](#).

[‡] Also reported in [1987Es08](#).

Placed as of the Adopted Levels, unplaced in [1990Me12](#).

@ From Adopted Gammas.

& Total theoretical internal conversion coefficients, calculated using the BrIcc code ([2008Ki07](#)) with “Frozen Orbitals” approximation based on γ-ray energies, assigned multiplicities, and mixing ratios, unless otherwise specified.

^a Multiply placed with intensity suitably divided.

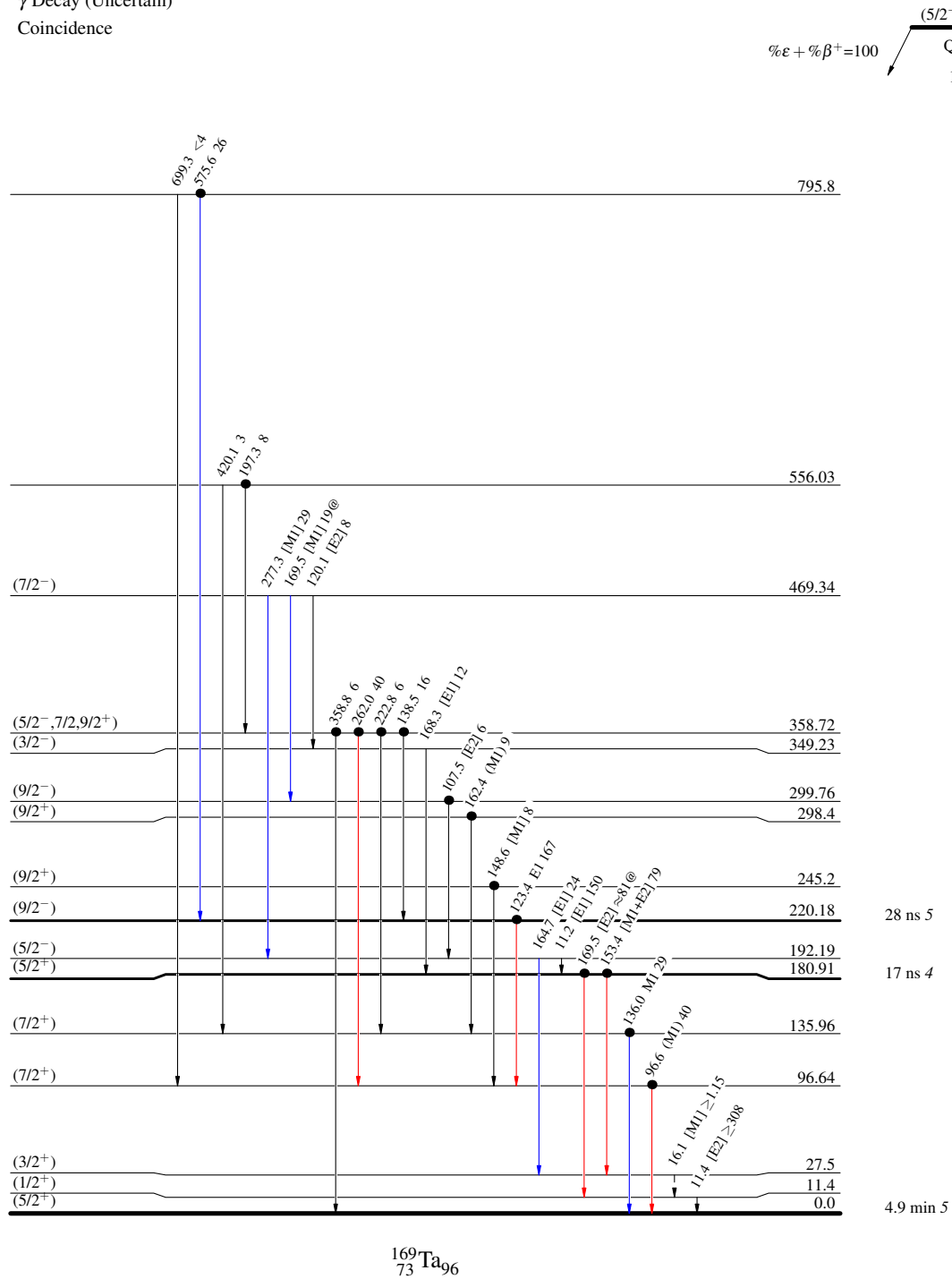
^x γ ray not placed in level scheme.

^{169}W $\varepsilon + \beta^+$ decay (75 s) 1990Me12

Decay Scheme

- Legend
- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 - $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 - $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 - $\cdots \longrightarrow$ γ Decay (Uncertain)
 - $\bullet$ Coincidence

Intensities: Relative I_γ
@ Multiply placed: intensity suitably divided



$^{124}\text{Sn}(^{51}\text{V}, 6n\gamma)$ 2006Ha46

Slightly edited the dataset from the previous evaluation (2008Ba31) by C.M. Baglin, but no significant changes were made.

Self-supporting ^{124}Sn target, ^{51}V beam, $E=228$ MeV, from ATLAS facility at Argon National Laboratory. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(\theta)$ using GAMMASPHERE array (100 Compton-suppressed HPGe detectors) and a 80 ns software gate on prompt γ rays. Interpreted rotational band structures based on cranked shell model calculations.

 ^{169}Ta Levels

$E(\text{level})^{\dagger}$	$J^{\pi\ddagger}$	Comments
0.0 ^d	5/2 ⁺	
11.3 ^f 4	1/2 ⁺	E(level): other: 11.2 in 2006Ha46.
27.4 ^g 3	3/2 ⁺	E(level): other: 27.3 in 2006Ha46.
96.44 ^e 13	7/2 ⁺	
135.68 ^b 13	7/2 ⁺	
179.8 ^f 3	5/2 ⁺	
180.0 [@] 4	1/2 ⁻ #	
191.8 [@] 3	5/2 ⁻	
219.54 ^j 22	9/2 ⁻	
233.3 ^g 3	7/2 ⁺	
244.71 ^d 13	9/2 ⁺	
297.98 ^a 13	9/2 ⁺	
299.4 [@] 3	9/2 ⁻	
336.48 ^k 24	11/2 ⁻	
348.2 ^{&} 4	(3/2 ⁻)	
420.05 ^e 14	11/2 ⁺	
466.0 ^f 3	9/2 ⁺	
468.5 ^{&} 3	(7/2 ⁻)	
487.62 ^b 14	11/2 ⁺	
506.61 ^j 24	13/2 ⁻	
522.2 [@] 3	13/2 ⁻	
568.4 ^g 3	11/2 ⁺	
616.86 ^d 15	13/2 ⁺	
692.3 ^k 3	15/2 ⁻	
695.89 ^a 15	13/2 ⁺	
723.37 ^{&} 25	(11/2 ⁻)	
835.84 ^e 16	15/2 ⁺	
848.8 ^f 3	13/2 ⁺	
858.6 [@] 3	17/2 ⁻	
924.7 ^j 3	17/2 ⁻	
927.89 ^b 17	15/2 ⁺	
999.4 ^g 3	15/2 ⁺	
1069.57 ^d 18	17/2 ⁺	
1076.4 ^{&} 3	15/2 ⁻	
1150.4 ^k 3	19/2 ⁻	
1170.48 ^a 17	17/2 ⁺	
1296.6 [@] 3	21/2 ⁻	
1304.25 ^f 25	17/2 ⁺	
1321.07 ^e 19	19/2 ⁺	
1430.5 ^j 3	21/2 ⁻	

Continued on next page (footnotes at end of table)

$^{124}\text{Sn}(^{51}\text{V},6n\gamma)$ **2006Ha46** (continued) ^{169}Ta Levels (continued)

E(level) [†]	J^π [‡]	E(level) [†]	J^π [‡]	E(level) [†]	J^π [‡]	E(level) [†]	J^π [‡]
1432.80 ^b 18	19/2 ⁺	2940.5 ^b 4	31/2 ⁺	4285.5 ^f 4	(41/2 ⁺)	6111.3? ^{&} 8	(51/2 ⁻)
1493.52 ^g 25	19/2 ⁺	2986.5 ^g 4	31/2 ⁺	4360.8 ^c 4	41/2 ⁺	6194.9 ^d 4	(53/2 ⁺)
1518.6 ^{&} 3	19/2 ⁻	3003.5 ^j 4	33/2 ⁻	4438.6 ^e 4	43/2 ⁺	6315.2 [@] 6	53/2 ⁻
1580.96 ^d 21	21/2 ⁺	3053.5 ^d 3	33/2 ⁺	4503.7 ^h 4	41/2 ⁻	6351.2 ^f 7	(53/2 ⁺)
1683.0 ^k 4	23/2 ⁻	3053.9 [@] 4	33/2 ⁻	4582.0 ^b 5	(43/2 ⁺)	6391.1 ^a 6	(53/2 ⁺)
1697.39 ^a 19	21/2 ⁺	3074.7 ⁱ 3	(31/2 ⁺)	4601.4 ^j 5	45/2 ⁻	6467.4 ^k 5	(55/2 ⁻)
1789.14 ^f 24	21/2 ⁺	3150.0 ^a 4	33/2 ⁺	4651.4 ^g 5	43/2 ⁺	6521.3 ^c 5	(53/2 ⁺)
1820.1 [@] 3	25/2 ⁻	3152.5 ^{&} 4	31/2 ⁻	4728.8 ^{&} 5	(43/2 ⁻)	6599.2 ^e 5	(55/2 ⁺)
1854.92 ^e 22	23/2 ⁺	3173.3 ^f 3	(33/2 ⁺)	4750.4 ^d 4	45/2 ⁺	6742.7 ^l 9	(55/2 ⁺)
1874.94 ^c 24	21/2 ⁺	3176.6 ^c 3	33/2 ⁺	4860.7 [@] 5	45/2 ⁻	6812.4 ^b 8	(55/2 ⁺)
1976.97 ^b 21	23/2 ⁺	3210.6 ^k 4	35/2 ⁻	4883.6 ⁱ 5	(43/2 ⁺)	6887.7 ^g 8	(55/2 ⁺)
1994.5 ^j 4	25/2 ⁻	3241.9 ^h 4	33/2 ⁻	4903.0 ^a 5	(45/2 ⁺)	6900.9 ^j 6	(57/2 ⁻)
2017.3 ^g 3	23/2 ⁺	3296.7 ^e 3	35/2 ⁺	4946.7 ^k 5	47/2 ⁻	6978.2 ^d 5	(57/2 ⁺)
2035.3 ^{&} 3	23/2 ⁻	3402.2 ^b 4	35/2 ⁺	4948.1 ^f 5	(45/2 ⁺)	7128.8 [@] 6	(57/2 ⁻)
2129.67 ^d 22	25/2 ⁺	3440.2 ^j 4	37/2 ⁻	5030.9 ^c 5	45/2 ⁺	7194.8 ^a 8	(57/2 ⁺)
2205.64 ^c 21	25/2 ⁺	3461.8 ^g 4	35/2 ⁺	5111.1 ^e 4	(47/2 ⁺)	7309.7 ^k 6	(59/2 ⁻)
2217.7 ⁱ 3	(23/2 ⁺)	3540.9 ^d 3	37/2 ⁺	5245.3 ^h 5	(45/2 ⁻)	7327.6 ^c 7	(57/2 ⁺)
2257.27 ^a 22	25/2 ⁺	3620.5 ^{&} 4	35/2 ⁻	5278.9 ^b 6	(47/2 ⁺)	7409.2 ^e 5	(59/2 ⁺)
2262.0 ^k 4	27/2 ⁻	3622.1 ⁱ 4	(35/2 ⁺)	5305.5 ^j 5	49/2 ⁻	7789.6 ^j 6	(61/2 ⁻)
2334.9 ^f 3	25/2 ⁺	3652.7 ^a 4	(37/2 ⁺)	5316.8 ^l 6	(47/2 ⁺)	7809.8 ^d 5	(61/2 ⁺)
2405.28 ^e 22	27/2 ⁺	3663.3 [@] 4	37/2 ⁻	5354.7 ^g 6	(47/2 ⁺)	7993.6 [@] 6	(61/2 ⁻)
2412.5 [@] 3	29/2 ⁻	3689.2 ^f 3	(37/2 ⁺)	5391.3 ^{&} 6	(47/2 ⁻)	8182.2 ^c 9	(61/2 ⁺)
2498.82 ^b 25	27/2 ⁺	3698.5 ^k 4	39/2 ⁻	5449.8 ^d 4	(49/2 ⁺)	8206.9 ^k 6	(63/2 ⁻)
2530.5 ^g 3	27/2 ⁺	3741.7 ^c 3	37/2 ⁺	5556.8 [@] 5	49/2 ⁻	8279.2? ^e 7	(63/2 ⁺)
2541.6 ^h 4	(25/2 ⁻)	3795.4 ^h 4	37/2 ⁻	5591.9 ⁱ 5	(47/2 ⁺)	8694.8 ^d 6	(65/2 ⁺)
2570.9 ^j 4	29/2 ⁻	3829.6 ^e 3	39/2 ⁺	5627.3 ^a 6	(49/2 ⁺)	8745.2 ^j 8	(65/2 ⁻)
2602.9 ^{&} 3	27/2 ⁻	3952.0 ^b 5	39/2 ⁺	5642.2 ^f 5	(49/2 ⁺)	8913.2 [@] 8	(65/2 ⁻)
2623.4 ⁱ 3	(27/2 ⁺)	3974.0 ^j 5	41/2 ⁻	5679.0 ^k 5	(51/2 ⁻)	9085.2 ^c 10	(65/2 ⁺)
2634.62 ^d 23	29/2 ⁺	4019.8 ^g 5	39/2 ⁺	5746.6 ^c 5	(49/2 ⁺)	9158.0 ^k 8	(67/2 ⁻)
2667.39 ^c 23	29/2 ⁺	4109.9 ^d 4	41/2 ⁺	5834.5 ^e 4	(51/2 ⁺)	9635.0 ^d 8	(69/2 ⁺)
2711.37 ^a 25	29/2 ⁺	4137.3 ^{&} 5	(39/2 ⁻)	5988.0 ^h 5	(49/2 ⁻)	9886.8 [@] 10	(69/2 ⁻)
2745.4 ^f 4	(29/2 ⁺)	4225.1 ⁱ 4	(39/2 ⁺)	6003.5 ^l 8	(51/2 ⁺)	10154.6 ^k 10	(71/2 ⁻)
2795.4 ^k 4	31/2 ⁻	4230.9 [@] 4	41/2 ⁻	6024.2 ^b 6	(51/2 ⁺)	10916.6 [@] 11	(73/2 ⁻)
2844.80 ^e 25	31/2 ⁺	4240.2 ^a 5	(41/2 ⁺)	6073.6 ^j 5	(53/2 ⁻)	11992.6? [@] 12	(77/2 ⁻)
2851.5 ^h 3	(29/2 ⁻)	4281.5 ^k 5	43/2 ⁻	6104.0 ^g 6	(51/2 ⁺)		

[†] From least-squares fit to E_γ .[‡] Authors' values, based on deduced band structures and transition multipolarities, and alignment and band-crossing frequency arguments. These differ from adopted values only insofar as all adopted values are given in parentheses.# Differs from adopted $J^\pi=(5/2^+)$; see discussion in Adopted Levels.[@] Band(A): π 1/2[541], $\alpha=+1/2$ band. Band crossing at $\hbar\omega=0.30$ MeV due to first pair of $i_{13/2}$ neutrons. Steady gain in alignment suggests subsequent crossing by a second pair of $i_{13/2}$ neutrons.[&] Band(a): π 1/2[541], $\alpha=-1/2$ band. Band crossing at $\hbar\omega=0.26$ MeV due to first pair of $i_{13/2}$ neutrons. Steady gain in alignment

Continued on next page (footnotes at end of table)

¹²⁴Sn(⁵¹V,6nγ) **2006Ha46 (continued)**

¹⁶⁹Ta Levels (continued)

suggests subsequent crossing by a second pair of i_{13/2} neutrons.

^a Band(B): π 7/2[404], α=+1/2 band. First crossing at ħω=0.238 MeV due to first pair of i_{13/2} neutrons, second crossing at ħω=0.37 MeV due to second pair of i_{13/2} neutrons. Above the first crossing there is mixing of 5/2[402] and 7/2[404] configurations.

^b Band(b): π 7/2[404], α=-1/2 band. See comment on signature partner band.

^c Band(C): π 1/2[660], α=+1/2 band. Decoupled band. No evidence of wobbling mode of excitation is suggested, although the population intensity of this band is weak.

^d Band(D): π 5/2[402], α=+1/2 band. First crossing at ħω=0.242 MeV due to first pair of i_{13/2} neutrons, second crossing at ħω=0.37 MeV due to second pair of i_{13/2} neutrons. Above the first crossing there is mixing of 5/2[402] and 7/2[404] configurations.

^e Band(d): π 5/2[402], α=-1/2 band. See comment on signature partner band.

^f Band(E): π 1/2[411], α=+1/2 band. First crossing at ħω=0.24 MeV due to first pair of i_{13/2} neutrons, second crossing at ħω=0.37 MeV due to second pair of i_{13/2} neutrons.

^g Band(e): π 1/2[411], α=-1/2 band. See comment on signature partner band.

^h Band(F): Band based on (25/2⁻), α=+1/2. This band interacts strongly with 1/2[541] band. At low-spins the configuration may be π h_{9/2}(first pair of i_{13/2} neutrons). At higher spins (J>35/2), it seems to be a continuation of 1/2[541] band. Band crossing at ħω≈0.37 MeV due to second pair of i_{13/2} neutrons.

ⁱ Band(G): π h_{9/2} v i_{13/2} v p_{3/2}? band. J^π values are from figure 1 (proposed level scheme) of **2006Ha46** and reflect the authors' preference for 23/2⁺ over 21/2⁻ for the lowest-energy level observed in this band, as discussed in their text. The different values appearing in the summary of transition properties in table I of the original publication were based on the less-favored 21/2⁻ option; these were erroneous and were subsequently corrected in an erratum. Strong feeding to 1/2[541] band.

^j Band(H): π 9/2[514], α=+1/2 band. Band crossing at ħω=0.24 MeV due to first pair of i_{13/2} neutrons. Steady gain in alignment suggests crossing by a second pair of i_{13/2} neutrons.

^k Band(h): π 9/2[514], α=-1/2 band. See comment for α=+1/2 signature partner band.

^l Band(I): Band fragment. This band is built as a side band above the 43/2⁺ state in 1/2[411] band.

γ(¹⁶⁹Ta)

E _γ [†]	I _γ	E _i (level)	J _i ^π	E _f	J _f ^π	Mult.&	Comments
11.8 ^a	<1	191.8	5/2 ⁻	180.0	1/2 ⁻		
53.0 ^a 5		233.3	7/2 ⁺	179.8	5/2 ⁺		
96.4 2	≈45 [@]	96.44	7/2 ⁺	0.0	5/2 ⁺	D	R _{γγ(θ)} =0.55 9.
107.6 2	36 2	299.4	9/2 ⁻	191.8	5/2 ⁻		R _{γγ(θ)} =0.63 4; far too low for ΔJ=2 γ required by level scheme.
109.0 2	10.3 [#] 5	244.71	9/2 ⁺	135.68	7/2 ⁺	D	R _{γγ(θ)} =0.53 9.
116.9 2	≈62 [#]	336.48	11/2 ⁻	219.54	9/2 ⁻	D	R _{γγ(θ)} =0.67 2.
120.3 2	1.4 2	468.5	(7/2 ⁻)	348.2	(3/2 ⁻)		
122.1 2	4.8 5	420.05	11/2 ⁺	297.98	9/2 ⁺		
123.0 2		219.54	9/2 ⁻	96.44	7/2 ⁺	D	R _{γγ(θ)} =0.79 5.
129.2 2	4.1 3	616.86	13/2 ⁺	487.62	11/2 ⁺		
135.7 2	≈45 [@]	135.68	7/2 ⁺	0.0	5/2 ⁺	D	R _{γγ(θ)} =0.64 3.
140.0 2	1.7 4	835.84	15/2 ⁺	695.89	13/2 ⁺		
148.3 2	59 [#] 2	244.71	9/2 ⁺	96.44	7/2 ⁺	D	R _{γγ(θ)} =0.68 4.
152.4 2	≈26 [#]	179.8	5/2 ⁺	27.4	3/2 ⁺	D+Q	R _{γγ(θ)} =0.71 5.
152.6 2	≈37 [@]	180.0	1/2 ⁻	27.4	3/2 ⁺		R _{γγ(θ)} =0.88 6; too high for ΔJ=1, Δπ=yes transition implied by placement in level scheme.
162.3 2	≈30 [#]	297.98	9/2 ⁺	135.68	7/2 ⁺	D	R _{γγ(θ)} =0.64 4.
164.4 2	≈42 [@]	191.8	5/2 ⁻	27.4	3/2 ⁺	D	R _{γγ(θ)} =0.66 4.
168.2 5	<1	348.2	(3/2 ⁻)	180.0	1/2 ⁻		
168.5 2	≈5 [#]	179.8	5/2 ⁺	11.3	1/2 ⁺	(Q)	R _{γγ(θ)} =0.9 2.

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¹²⁴Sn(⁵¹V,6nγ) **2006Ha46** (continued)

γ(¹⁶⁹Ta) (continued)

E _γ [†]	I _γ	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. ^{&}	Comments
168.7 2	≈38 [@]	180.0	1/2 ⁻	11.3	1/2 ⁺		R _{γγ(θ)} =0.90 5; interpreted by authors as D, ΔJ=0.
169.1 2	1.7 2	468.5	(7/2 ⁻)	299.4	9/2 ⁻		
170.2 2	92 4	506.61	13/2 ⁻	336.48	11/2 ⁻	D+Q	R _{γγ(θ)} =0.75 3.
175.3 2	62 1	420.05	11/2 ⁺	244.71	9/2 ⁺	D+Q	R _{γγ(θ)} =0.73 4.
178		2844.80	31/2 ⁺	2667.39	29/2 ⁺		E _γ : from fig. 1 of 2006Ha46 ; absent in table I.
185.5 2	2.7 3	522.2	13/2 ⁻	336.48	11/2 ⁻		R _{γγ(θ)} =0.86 9.
185.6 2	83 3	692.3	15/2 ⁻	506.61	13/2 ⁻	D+Q	R _{γγ(θ)} =0.74 2.
189.6 2	23 [#] 1	487.62	11/2 ⁺	297.98	9/2 ⁺	D	R _{γγ(θ)} =0.70 4.
196.8 2	37 1	616.86	13/2 ⁺	420.05	11/2 ⁺	D	R _{γγ(θ)} =0.69 4.
201.0 5	<1	723.37	(11/2 ⁻)	522.2	13/2 ⁻		
201.5 2	≈6.6 [#]	297.98	9/2 ⁺	96.44	7/2 ⁺	D	R _{γγ(θ)} =0.71 6.
205.8 2	49 [#]	233.3	7/2 ⁺	27.4	3/2 ⁺		R _{γγ(θ)} =0.80 5.
206.9 2	40 5	3210.6	35/2 ⁻	3003.5	33/2 ⁻		R _{γγ(θ)} =0.68 2 for 207.9γ+206.9γ.
207.9 2	42 4	3003.5	33/2 ⁻	2795.4	31/2 ⁻		R _{γγ(θ)} =0.68 4 for 207.9γ+206.9γ.
208.4 2	14.0 7	695.89	13/2 ⁺	487.62	11/2 ⁺	D+Q	R _{γγ(θ)} =0.77 5.
208.8 2	15 2	3053.5	33/2 ⁺	2844.80	31/2 ⁺		R _{γγ(θ)} =0.69 3 for 208.8γ+210.2γ.
210.2 2	17.1 8	2844.80	31/2 ⁺	2634.62	29/2 ⁺		R _{γγ(θ)} =0.69 3 for 208.8γ+210.2γ.
216.7 2	1.4 1	723.37	(11/2 ⁻)	506.61	13/2 ⁻		
218.9 2	25 1	835.84	15/2 ⁺	616.86	13/2 ⁺	D+Q	R _{γγ(θ)} =0.74 4.
222.8 2	100 4	522.2	13/2 ⁻	299.4	9/2 ⁻		R _{γγ(θ)} =0.81 3.
224.6 2	33 4	2795.4	31/2 ⁻	2570.9	29/2 ⁻		R _{γγ(θ)} =0.74 2 for 224.6γ+225.6γ.
225.6 2	58 4	1150.4	19/2 ⁻	924.7	17/2 ⁻		R _{γγ(θ)} =0.74 2 for 224.6γ+225.6γ.
229.3 2	15.9 7	2634.62	29/2 ⁺	2405.28	27/2 ⁺	D	R _{γγ(θ)} =0.68 6.
229.6 2	33 2	3440.2	37/2 ⁻	3210.6	35/2 ⁻	D+Q	R _{γγ(θ)} =0.72 5.
232.0 2	12.6 9	927.89	15/2 ⁺	695.89	13/2 ⁺	D+Q	R _{γγ(θ)} =0.72 5.
232.4 2	70 3	924.7	17/2 ⁻	692.3	15/2 ⁻	D+Q	R _{γγ(θ)} =0.85 4.
232.6 2	25 2	466.0	9/2 ⁺	233.3	7/2 ⁺	D	R _{γγ(θ)} =0.61 4.
233.8 2	15.3 7	1069.57	17/2 ⁺	835.84	15/2 ⁺	D+Q	R _{γγ(θ)} =0.83 5.
241.6 2	4.9 5	2498.82	27/2 ⁺	2257.27	25/2 ⁺		R _{γγ(θ)} =0.85 5 for 241.6γ+242.5γ+242.9γ.
242.5 2	10.2 6	1170.48	17/2 ⁺	927.89	15/2 ⁺		R _{γγ(θ)} =0.85 5 for 241.6γ+242.5γ+242.9γ.
242.9 2	5.7 [#] 6	487.62	11/2 ⁺	244.71	9/2 ⁺		R _{γγ(θ)} =0.85 5 for 241.6γ+242.5γ+242.9γ.
243.1 2	13.1 6	3296.7	35/2 ⁺	3053.5	33/2 ⁺		R _{γγ(θ)} =0.69 3 for 243.1γ+244.3γ.
244.3 2	8.3 8	3540.9	37/2 ⁺	3296.7	35/2 ⁺		R _{γγ(θ)} =0.69 3 for 243.1γ+244.3γ.
244.7 2	11.3 [#] 8	244.71	9/2 ⁺	0.0	5/2 ⁺		
251.5 2	13.2 7	1321.07	19/2 ⁺	1069.57	17/2 ⁺	D+Q	R _{γγ(θ)} =0.78 5.
252.4 2	46 2	1683.0	23/2 ⁻	1430.5	21/2 ⁻	D+Q	R _{γγ(θ)} =0.76 3.
254.9 2	10.2 7	723.37	(11/2 ⁻)	468.5	(7/2 ⁻)		R _{γγ(θ)} =0.85 4.
258.0 2	27 2	3698.5	39/2 ⁻	3440.2	37/2 ⁻	D+Q	R _{γγ(θ)} =0.71 3.
259.8 2	12.7 6	1580.96	21/2 ⁺	1321.07	19/2 ⁺	D+Q	R _{γγ(θ)} =0.73 5.
262.2 2	7.5 6	1432.80	19/2 ⁺	1170.48	17/2 ⁺		R _{γγ(θ)} =0.69 7 for 264.6γ+262.2γ.
262.2 2	3.6 3	2667.39	29/2 ⁺	2405.28	27/2 ⁺		
264.6 2	6.2 7	1697.39	21/2 ⁺	1432.80	19/2 ⁺		R _{γγ(θ)} =0.69 7 for 264.6γ+262.2γ.
267.4 2	31 2	2262.0	27/2 ⁻	1994.5	25/2 ⁻	D(+Q)	R _{γγ(θ)} =0.69 3.
274.0 2	13.6 8	1854.92	23/2 ⁺	1580.96	21/2 ⁺		R _{γγ(θ)} =0.54 4 for 274.0γ+274.7γ+275.5γ.
274.7 2	11.6 4	2129.67	25/2 ⁺	1854.92	23/2 ⁺		R _{γγ(θ)} =0.54 4 for 274.0γ+274.7γ+275.5γ.
275.4 2	20 1	3974.0	41/2 ⁻	3698.5	39/2 ⁻	D+Q	R _{γγ(θ)} =0.75 5.
275.5 2	10.3 9	2405.28	27/2 ⁺	2129.67	25/2 ⁺		R _{γγ(θ)} =0.54 4 for 274.0γ+274.7γ+275.5γ.
275.8 2	3.6 4	695.89	13/2 ⁺	420.05	11/2 ⁺	D+Q	R _{γγ(θ)} =0.84 6.
276.7 2	3.8 3	468.5	(7/2 ⁻)	191.8	5/2 ⁻		R _{γγ(θ)} =0.95 6 implies Q(+D) for the (7/2 ⁻) to 5/2 ⁻ transition.
279.5 2	4.9 5	1976.97	23/2 ⁺	1697.39	21/2 ⁺		R _{γγ(θ)} =0.79 5 for 280.2γ+279.5γ.
280.1 2	57 2	1430.5	21/2 ⁻	1150.4	19/2 ⁻	D+Q	R _{γγ(θ)} =0.82 5.
280.2 2	6.2 6	2257.27	25/2 ⁺	1976.97	23/2 ⁺		R _{γγ(θ)} =0.79 5 for 280.2γ+279.5γ.
280.4 2	10.2 8	848.8	13/2 ⁺	568.4	11/2 ⁺	D	R _{γγ(θ)} =0.65 6.

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$^{124}\text{Sn}(^{51}\text{V},6n\gamma)$ **2006Ha46** (continued) $\gamma(^{169}\text{Ta})$ (continued)

E_γ †	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. &	Comments
280.4 2	5.3 8	4109.9	41/2 ⁺	3829.6	39/2 ⁺	D	$R_{\gamma\gamma(\theta)}=0.63$ 5.
286.3 2	26 2	466.0	9/2 ⁺	179.8	5/2 ⁺		$R_{\gamma\gamma(\theta)}=0.80$ 4.
287.0 2	24 2	506.61	13/2 ⁻	219.54	9/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.2$ 1.
288.6 2	6.7 7	3829.6	39/2 ⁺	3540.9	37/2 ⁺	D+Q	$R_{\gamma\gamma(\theta)}=0.67$ 6.
295.7 2	2.1 2	1789.14	21/2 ⁺	1493.52	19/2 ⁺		
298.0 2	≈ 11 #	297.98	9/2 ⁺	0.0	5/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=1.00$ 6.
304.8 2	2.6 2	1304.25	17/2 ⁺	999.4	15/2 ⁺		
305.9 2	1.6 2	2711.37	29/2 ⁺	2405.28	27/2 ⁺		
307.4 2	13.9 7	4281.5	43/2 ⁻	3974.0	41/2 ⁻	D+Q	$R_{\gamma\gamma(\theta)}=0.72$ 2.
309.0 2	32 2	2570.9	29/2 ⁻	2262.0	27/2 ⁻	D+Q	$R_{\gamma\gamma(\theta)}=0.72$ 4.
309.9 2	1.3 2	2851.5	(29/2 ⁻)	2541.6	(25/2 ⁻)		
311.0 2	7.3 6	927.89	15/2 ⁺	616.86	13/2 ⁺	D+Q	$R_{\gamma\gamma(\theta)}=0.80$ 9.
311.5 2	41 2	1994.5	25/2 ⁻	1683.0	23/2 ⁻	D+Q	$R_{\gamma\gamma(\theta)}=0.82$ 4.
311.8 2	4.5 8	4750.4	45/2 ⁺	4438.6	43/2 ⁺		
319.8 2	10.4 6	4601.4	45/2 ⁻	4281.5	43/2 ⁻	D	$R_{\gamma\gamma(\theta)}=0.65$ 4.
323.7 2	27 2	420.05	11/2 ⁺	96.44	7/2 ⁺		$R_{\gamma\gamma(\theta)}=0.81$ 5.
328.8 2	5.3 6	4438.6	43/2 ⁺	4109.9	41/2 ⁺	D	$R_{\gamma\gamma(\theta)}=0.61$ 6.
330.5 2	2.8 3	2205.64	25/2 ⁺	1874.94	21/2 ⁺		
334.7 2	3.9 4	1170.48	17/2 ⁺	835.84	15/2 ⁺		
335.1 2	44 3	568.4	11/2 ⁺	233.3	7/2 ⁺		$R_{\gamma\gamma(\theta)}=0.83$ 4.
336.4 2	99 4	858.6	17/2 ⁻	522.2	13/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=0.89$ 3.
338.6 2	2.7 6	5449.8	(49/2 ⁺)	5111.1	(47/2 ⁺)		
345.4 2	7.6 5	4946.7	47/2 ⁻	4601.4	45/2 ⁻	D	$R_{\gamma\gamma(\theta)}=0.55$ 4.
352.0 2	16.8 # 9	487.62	11/2 ⁺	135.68	7/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=0.92$ 5.
352.1 2	1.8 2	858.6	17/2 ⁻	506.61	13/2 ⁻		
353.0 2	13.9 7	1076.4	15/2 ⁻	723.37	(11/2 ⁻)	Q	$R_{\gamma\gamma(\theta)}=0.99$ 5.
355.9 2	46 2	692.3	15/2 ⁻	336.48	11/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=0.94$ 2.
358.8 2	6.2 3	5305.5	49/2 ⁻	4946.7	47/2 ⁻	D	$R_{\gamma\gamma(\theta)}=0.61$ 5.
360.3 2	1.8 3	6194.9	(53/2 ⁺)	5834.5	(51/2 ⁺)		
360.6 2	3.1 5	5111.1	(47/2 ⁺)	4750.4	45/2 ⁺	D+Q	$R_{\gamma\gamma(\theta)}=0.76$ 5.
363.3 2	4.1 5	1432.80	19/2 ⁺	1069.57	17/2 ⁺		
372.2 2	59 2	616.86	13/2 ⁺	244.71	9/2 ⁺		$R_{\gamma\gamma(\theta)}=0.85$ 4.
373.4 2	3.1 2	5679.0	(51/2 ⁻)	5305.5	49/2 ⁻		
376.4 2	3.6 4	1697.39	21/2 ⁺	1321.07	19/2 ⁺		
377.0 5	<1	2711.37	29/2 ⁺	2334.9	25/2 ⁺		
381.4 2	1.7 2	1874.94	21/2 ⁺	1493.52	19/2 ⁺		
382.7 2	33 3	848.8	13/2 ⁺	466.0	9/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=0.90$ 5.
384.8 2	2.2 3	5834.5	(51/2 ⁺)	5449.8	(49/2 ⁺)	D	$R_{\gamma\gamma(\theta)}=0.59$ 5.
386.9 2	1.5 2	723.37	(11/2 ⁻)	336.48	11/2 ⁻		
390.3 2	3.1 4	3241.9	33/2 ⁻	2851.5	(29/2 ⁻)		
394.6 2	2.7 2	6073.6	(53/2 ⁻)	5679.0	(51/2 ⁻)		
397.9 2	26 2	695.89	13/2 ⁺	297.98	9/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=0.91$ 5.
404.0 ^a 5	<1	6599.2	(55/2 ⁺)	6194.9	(53/2 ⁺)		
405.7 2	1.2 2	2623.4	(27/2 ⁺)	2217.7	(23/2 ⁺)		
410.1 2	3.3 3	2667.39	29/2 ⁺	2257.27	25/2 ⁺		
410.5 2	2.6 2	2745.4	(29/2 ⁺)	2334.9	25/2 ⁺		
415.3 2	24 1	3210.6	35/2 ⁻	2795.4	31/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.07$ 4.
415.9 2	54 2	835.84	15/2 ⁺	420.05	11/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=0.96$ 5.
416.5 2	15.1 9	2205.64	25/2 ⁺	1789.14	21/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=0.95$ 4.
418.1 2	59 3	924.7	17/2 ⁻	506.61	13/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=0.97$ 3.
418.8 2	17 1	3053.5	33/2 ⁺	2634.62	29/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=1.0$ 1.
421.4 2	3.2 2	3663.3	37/2 ⁻	3241.9	33/2 ⁻		
424.0 2	8.7 6	723.37	(11/2 ⁻)	299.4	9/2 ⁻		$R_{\gamma\gamma(\theta)}=0.90$ 5.
428 ^a	<1	3173.3	(33/2 ⁺)	2745.4	(29/2 ⁺)	Q	$R_{\gamma\gamma(\theta)}=0.97$ 9.
429.0 2	3.5 5	2634.62	29/2 ⁺	2205.64	25/2 ⁺		

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$^{124}\text{Sn}(^{51}\text{V},6n\gamma)$ **2006Ha46** (continued) $\gamma(^{169}\text{Ta})$ (continued)

E_γ †	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. &	Comments
431.0 2	37 3	999.4	15/2 ⁺	568.4	11/2 ⁺	(Q)	$R_{\gamma\gamma(\theta)}=0.89$ 4.
431 ^a	<1	3176.6	33/2 ⁺	2745.4	(29/2 ⁺)		
432.6 2	19 1	3003.5	33/2 ⁻	2570.9	29/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=0.92$ 5.
436.7 2	17 1	3440.2	37/2 ⁻	3003.5	33/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.03$ 7.
438.1 2	94 4	1296.6	21/2 ⁻	858.6	17/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=0.97$ 3.
438.6 2	7.1 6	3150.0	33/2 ⁺	2711.37	29/2 ⁺		$R_{\gamma\gamma(\theta)}=1.03$ 6 for 438.6 γ +440.2 γ +441.7 γ .
438.9 2	2.3 3	2851.5	(29/2 ⁻)	2412.5	29/2 ⁻		
439.6 2	20 1	2844.80	31/2 ⁺	2405.28	27/2 ⁺		$R_{\gamma\gamma(\theta)}=1.11$ 6 for an unresolved doublet.
440.2 2	29 2	927.89	15/2 ⁺	487.62	11/2 ⁺		$R_{\gamma\gamma(\theta)}=1.03$ 6 for 438.6 γ +440.2 γ +441.7 γ .
441.7 2	7.9 6	2940.5	31/2 ⁺	2498.82	27/2 ⁺		$R_{\gamma\gamma(\theta)}=1.03$ 6 for 438.6 γ +440.2 γ +441.7 γ .
441.9 2	17 1	1518.6	19/2 ⁻	1076.4	15/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=0.97$ 3.
451.3 2	3.9 5	3074.7	(31/2 ⁺)	2623.4	(27/2 ⁺)		
451.9 2	13.5 6	3296.7	35/2 ⁺	2844.80	31/2 ⁺		$R_{\gamma\gamma(\theta)}=0.98$ 4 for 451.9 γ +452.8 γ .
452.8 2	52 2	1069.57	17/2 ⁺	616.86	13/2 ⁺		$R_{\gamma\gamma(\theta)}=0.98$ 4 for 452.8 γ +451.9 γ .
454 ^a	<1	2711.37	29/2 ⁺	2257.27	25/2 ⁺		
455.4 2	26 2	1304.25	17/2 ⁺	848.8	13/2 ⁺	(Q)	$R_{\gamma\gamma(\theta)}=0.90$ 4.
456.0 2	15.6 8	2986.5	31/2 ⁺	2530.5	27/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=1.11$ 9.
458.2 2	90 3	1150.4	19/2 ⁻	692.3	15/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=0.93$ 3.
459.9 2	3.3 3	2334.9	25/2 ⁺	1874.94	21/2 ⁺		
461.7 2	25 2	2667.39	29/2 ⁺	2205.64	25/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=0.98$ 5.
461.7 2	4.4 3	3402.2	35/2 ⁺	2940.5	31/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=0.97$ 5.
468.0 2	4.9 3	3620.5	35/2 ⁻	3152.5	31/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.2$ 1.
474.6 2	29 3	1170.48	17/2 ⁺	695.89	13/2 ⁺		$R_{\gamma\gamma(\theta)}=0.70$ 5; too low for $\Delta J=2$ required by level scheme.
475.3 2	13.5 7	3461.8	35/2 ⁺	2986.5	31/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=1.19$ 8.
485.0 2	21 2	1789.14	21/2 ⁺	1304.25	17/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=0.99$ 5.
485.2 2	47 2	1321.07	19/2 ⁺	835.84	15/2 ⁺		$R_{\gamma\gamma(\theta)}=1.15$ 4 for an unresolved doublet.
487.4 2	14 1	3540.9	37/2 ⁺	3053.5	33/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=1.15$ 8.
488 ^a	<1	2745.4	(29/2 ⁺)	2257.27	25/2 ⁺		
488.0 2	19 1	3698.5	39/2 ⁻	3210.6	35/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.1$ 1.
494.3 2	34 3	1493.52	19/2 ⁺	999.4	15/2 ⁺		$R_{\gamma\gamma(\theta)}=0.86$ 6.
502.7 2	6.4 7	3652.7	(37/2 ⁺)	3150.0	33/2 ⁺		
504.9 2	24 2	1432.80	19/2 ⁺	927.89	15/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=1.02$ 5.
504.9 2	35 2	2634.62	29/2 ⁺	2129.67	25/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=0.97$ 5.
505.7 2	69 3	1430.5	21/2 ⁻	924.7	17/2 ⁻		$R_{\gamma\gamma(\theta)}=0.87$ 4.
505.8 2	10.1 9	3173.3	(33/2 ⁺)	2667.39	29/2 ⁺		
508.4 2	10.8 8	2205.64	25/2 ⁺	1697.39	21/2 ⁺		$R_{\gamma\gamma(\theta)}=1.0$ 1 for an unresolved doublet.
509.3 2	14 2	3176.6	33/2 ⁺	2667.39	29/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=1.05$ 9.
511.5 2	45 2	1580.96	21/2 ⁺	1069.57	17/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=0.96$ 4.
512.6 2	3.1 4	3689.2	(37/2 ⁺)	3176.6	33/2 ⁺		
513.3 2	22 2	2530.5	27/2 ⁺	2017.3	23/2 ⁺		$R_{\gamma\gamma(\theta)}=0.86$ 5.
515.9 2	5.6 6	3689.2	(37/2 ⁺)	3173.3	(33/2 ⁺)		
516.6 2	14 2	2035.3	23/2 ⁻	1518.6	19/2 ⁻		$R_{\gamma\gamma(\theta)}=0.75$ 4 for an unresolved doublet.
516.8 2	3.1 5	4137.3	(39/2 ⁻)	3620.5	35/2 ⁻		
521.8 2	14.2 9	2498.82	27/2 ⁺	1976.97	23/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=1.2$ 1.
523.4 2	87 5	1820.1	25/2 ⁻	1296.6	21/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.04$ 3.
523.9 2	29 3	2017.3	23/2 ⁺	1493.52	19/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=0.94$ 5.
527.0 2	30 2	1697.39	21/2 ⁺	1170.48	17/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=1.01$ 4.
532.6 2	82 5	1683.0	23/2 ⁻	1150.4	19/2 ⁻		$R_{\gamma\gamma(\theta)}=1.02$ 2 for 532.6 γ +533.3 γ .
532.9 2	12.7 5	3829.6	39/2 ⁺	3296.7	35/2 ⁺		$R_{\gamma\gamma(\theta)}=1.06$ 5. for 532.9 γ +533.8 γ .
533.3 2	60 4	2795.4	31/2 ⁻	2262.0	27/2 ⁻		$R_{\gamma\gamma(\theta)}=1.02$ 2 for 532.6 γ +533.3 γ .
533.8 2	44 4	1854.92	23/2 ⁺	1321.07	19/2 ⁺		$R_{\gamma\gamma(\theta)}=1.06$ 5 for 532.9 γ +533.8 γ .
534.0 2	13 2	3974.0	41/2 ⁻	3440.2	37/2 ⁻		$R_{\gamma\gamma(\theta)}=0.96$ 6 for an unresolved doublet.
535 ^a	<1	2940.5	31/2 ⁺	2405.28	27/2 ⁺		
542 ^a	<1	3176.6	33/2 ⁺	2634.62	29/2 ⁺		

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$^{124}\text{Sn}(^{51}\text{V},6n\gamma)$ **2006Ha46** (continued) $\gamma(^{169}\text{Ta})$ (continued)

E_γ †	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. &	Comments
544.1 2	18 1	1976.97	23/2 ⁺	1432.80	19/2 ⁺		$R_{\gamma\gamma(\theta)}=0.89$ 6.
544.2 2	2.4 3	3074.7	(31/2 ⁺)	2530.5	27/2 ⁺		
546.0 2	5.0 4	2334.9	25/2 ⁺	1789.14	21/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=1.0$ 1.
547.5 2	3.9 5	3622.1	(35/2 ⁺)	3074.7	(31/2 ⁺)		
548.7 2	43 2	2129.67	25/2 ⁺	1580.96	21/2 ⁺		$R_{\gamma\gamma(\theta)}=1.08$ 5 for 548.7 γ +550.4 γ . x.
549.7 2	8.3 6	3152.5	31/2 ⁻	2602.9	27/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.06$ 8.
549.8 2	3.8 3	3952.0	39/2 ⁺	3402.2	35/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=0.98$ 5.
550.4 2	41 2	2405.28	27/2 ⁺	1854.92	23/2 ⁺		$R_{\gamma\gamma(\theta)}=1.08$ 5 for 548.7 γ +550.4 γ .
553.4 2	4.3 4	3795.4	37/2 ⁻	3241.9	33/2 ⁻		
554.1 2	6.9 5	1076.4	15/2 ⁻	522.2	13/2 ⁻	D	$R_{\gamma\gamma(\theta)}=0.64$ 6.
558.0 2	9.8 6	4019.8	39/2 ⁺	3461.8	35/2 ⁺		$R_{\gamma\gamma(\theta)}=1.4$ 1.
560.0 2	13.9 9	2257.27	25/2 ⁺	1697.39	21/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=1.00$ 5.
564.1 2	60 2	1994.5	25/2 ⁻	1430.5	21/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=0.96$ 6.
565.2 2	10.2 7	3741.7	37/2 ⁺	3176.6	33/2 ⁺		$R_{\gamma\gamma(\theta)}=0.8$ 1.
567.5 2	12.2 7	2602.9	27/2 ⁻	2035.3	23/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.2$ 1.
567.6 2	22 1	4230.9	41/2 ⁻	3663.3	37/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=0.91$ 3.
568.1 2	1.2 2	3622.1	(35/2 ⁺)	3053.9	33/2 ⁻		
568.3 2	5.6 6	3741.7	37/2 ⁺	3173.3	(33/2 ⁺)	Q	$R_{\gamma\gamma(\theta)}=1.2$ 2.
569.0 2	15 1	4109.9	41/2 ⁺	3540.9	37/2 ⁺	(Q)	$R_{\gamma\gamma(\theta)}=0.87$ 8.
570.4 2	4.3 3	1874.94	21/2 ⁺	1304.25	17/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=0.94$ 9.
574.3 5	<1	2986.5	31/2 ⁺	2412.5	29/2 ⁻		
576.5 2	53 2	2570.9	29/2 ⁻	1994.5	25/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.06$ 5.
579.0 2	75 3	2262.0	27/2 ⁻	1683.0	23/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.00$ 3.
581.8 2	10.0 8	2711.37	29/2 ⁺	2129.67	25/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=1.2$ 1.
583.0 2	16 2	4281.5	43/2 ⁻	3698.5	39/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=0.97$ 4.
587.5 2	4.1 4	4240.2	(41/2 ⁺)	3652.7	(37/2 ⁺)		
591.5 2	2.6 3	4728.8	(43/2 ⁻)	4137.3	(39/2 ⁻)		
592.3 2	79 4	2412.5	29/2 ⁻	1820.1	25/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=0.98$ 3.
596.3 2	6.0 5	4285.5	(41/2 ⁺)	3689.2	(37/2 ⁺)		
603.0 2	4.2 5	4225.1	(39/2 ⁺)	3622.1	(35/2 ⁺)		
608.9 2	12.7 5	4438.6	43/2 ⁺	3829.6	39/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=0.92$ 6.
609.4 2	37 3	3663.3	37/2 ⁻	3053.9	33/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.13$ 4.
619.1 2	10.5 7	4360.8	41/2 ⁺	3741.7	37/2 ⁺		$R_{\gamma\gamma(\theta)}=0.82$ 8.
624.0 ^a 5	<1	2205.64	25/2 ⁺	1580.96	21/2 ⁺		
627.4 2	11.4 7	4601.4	45/2 ⁻	3974.0	41/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.3$ 1.
629.8 2	14.4 7	4860.7	45/2 ⁻	4230.9	41/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.07$ 6.
630.0 2	3.1 3	4582.0	(43/2 ⁺)	3952.0	39/2 ⁺		
631.6 2	5.6 5	4651.4	43/2 ⁺	4019.8	39/2 ⁺		
635.0 5	<1	1493.52	19/2 ⁺	858.6	17/2 ⁻		
640.6 2	11.8 9	4750.4	45/2 ⁺	4109.9	41/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=1.14$ 8.
641.4 2	48 3	3053.9	33/2 ⁻	2412.5	29/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.12$ 4.
658.5 2	2.1 3	4883.6	(43/2 ⁺)	4225.1	(39/2 ⁺)		
660.1 2	6.0 4	1518.6	19/2 ⁻	858.6	17/2 ⁻	D	$R_{\gamma\gamma(\theta)}=0.58$ 6.
662.2 2	6.6 7	3074.7	(31/2 ⁺)	2412.5	29/2 ⁻		
662.5 2	1.7 2	5391.3	(47/2 ⁻)	4728.8	(43/2 ⁻)		
662.6 2	3.1 3	4948.1	(45/2 ⁺)	4285.5	(41/2 ⁺)		
662.8 2	3.6 3	4903.0	(45/2 ⁺)	4240.2	(41/2 ⁺)		
665.1 2	7.9 5	4946.7	47/2 ⁻	4281.5	43/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.2$ 1.
665.4 [‡] 2	2.7 [‡] 2	5316.8	(47/2 ⁺)	4651.4	43/2 ⁺		
670.1 2	7.4 6	5030.9	45/2 ⁺	4360.8	41/2 ⁺		$R_{\gamma\gamma(\theta)}=0.8$ 1.
672.5 2	10.7 5	5111.1	(47/2 ⁺)	4438.6	43/2 ⁺	Q	$R_{\gamma\gamma(\theta)}=1.10$ 8.
686.7 [‡] 5	<1 [‡]	6003.5	(51/2 ⁺)	5316.8	(47/2 ⁺)		
694.1 2	1.4 2	5642.2	(49/2 ⁺)	4948.1	(45/2 ⁺)		
696.1 2	9.4 5	5556.8	49/2 ⁻	4860.7	45/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.18$ 8.

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$^{124}\text{Sn}(^{51}\text{V},6n\gamma)$ **2006Ha46** (continued) $\gamma(^{169}\text{Ta})$ (continued)

E_γ †	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. &	Comments
696.9 2	2.1 2	5278.9	(47/2 ⁺)	4582.0	(43/2 ⁺)		
699.4 2	10.3 7	5449.8	(49/2 ⁺)	4750.4	45/2 ⁺		
703.3 2	2.1 2	5354.7	(47/2 ⁺)	4651.4	43/2 ⁺		
704.1 2	7.7 4	5305.5	49/2 ⁻	4601.4	45/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=0.96$ 5.
708.3 2	6.3 7	4503.7	41/2 ⁻	3795.4	37/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.1$ 1.
708.3 2	1.4 2	5591.9	(47/2 ⁺)	4883.6	(43/2 ⁺)		
709.0 5	<1	6351.2	(53/2 ⁺)	5642.2	(49/2 ⁺)		
710.2 2	3.6 3	2530.5	27/2 ⁺	1820.1	25/2 ⁻		
715.7 2	6.1 5	5746.6	(49/2 ⁺)	5030.9	45/2 ⁺		
720.0 ^a 5	<1	6111.3?	(51/2 ⁻)	5391.3	(47/2 ⁻)		
720.8 2	2.9 2	2017.3	23/2 ⁺	1296.6	21/2 ⁻		
721.5 2	2.1 3	2541.6	(25/2 ⁻)	1820.1	25/2 ⁻		
723.4 2	7.1 6	5834.5	(51/2 ⁺)	5111.1	(47/2 ⁺)	Q	$R_{\gamma\gamma(\theta)}=1.04$ 9.
724.3 2	2.9 3	5627.3	(49/2 ⁺)	4903.0	(45/2 ⁺)		
732.4 2	5.6 3	5679.0	(51/2 ⁻)	4946.7	47/2 ⁻		
738.8 2	4.3 6	2035.3	23/2 ⁻	1296.6	21/2 ⁻		
739.2 [‡] 5	<1 [‡]	6742.7	(55/2 ⁺)	6003.5	(51/2 ⁺)		
739.9 2	1.7 3	3152.5	31/2 ⁻	2412.5	29/2 ⁻		
741.6 2	5.6 6	3795.4	37/2 ⁻	3053.9	33/2 ⁻		$R_{\gamma\gamma(\theta)}=1.1$ 1 for an unresolved doublet.
741.6 2	3.5 6	5245.3	(45/2 ⁻)	4503.7	41/2 ⁻		
742.7 2	1.7 4	5988.0	(49/2 ⁻)	5245.3	(45/2 ⁻)		
745.1 2	5.6 8	6194.9	(53/2 ⁺)	5449.8	(49/2 ⁺)		
745.3 2	1.0 2	6024.2	(51/2 ⁺)	5278.9	(47/2 ⁺)		
749.3 2	1.1 2	6104.0	(51/2 ⁺)	5354.7	(47/2 ⁺)		
758.4 2	4.7 4	6315.2	53/2 ⁻	5556.8	49/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.2$ 1.
763.8 2	2.1 2	6391.1	(53/2 ⁺)	5627.3	(49/2 ⁺)		
764.6 2	3.6 5	6599.2	(55/2 ⁺)	5834.5	(51/2 ⁺)		
768.2 2	4.1 2	6073.6	(53/2 ⁻)	5305.5	49/2 ⁻		
774.7 2	2.2 2	6521.3	(53/2 ⁺)	5746.6	(49/2 ⁺)		
782.9 2	3.5 3	2602.9	27/2 ⁻	1820.1	25/2 ⁻		
783.3 2	4.2 7	6978.2	(57/2 ⁺)	6194.9	(53/2 ⁺)		
783.7 5	<1	6887.7	(55/2 ⁺)	6104.0	(51/2 ⁺)		
788.2 5	<1	6812.4	(55/2 ⁺)	6024.2	(51/2 ⁺)		
788.4 2	3.3 2	6467.4	(55/2 ⁻)	5679.0	(51/2 ⁻)		
803.4 2	1.4 2	2623.4	(27/2 ⁺)	1820.1	25/2 ⁻		
803.7 5	<1	7194.8	(57/2 ⁺)	6391.1	(53/2 ⁺)		
806.3 5	<1	7327.6	(57/2 ⁺)	6521.3	(53/2 ⁺)		
810.0 2	1.1 2	7409.2	(59/2 ⁺)	6599.2	(55/2 ⁺)		
813.6 2	2.8 4	7128.8	(57/2 ⁻)	6315.2	53/2 ⁻		
827.3 2	3.3 1	6900.9	(57/2 ⁻)	6073.6	(53/2 ⁻)		
829.4 2	4.9 5	3241.9	33/2 ⁻	2412.5	29/2 ⁻	Q	$R_{\gamma\gamma(\theta)}=1.0$ 1.
831.6 2	2.7 6	7809.8	(61/2 ⁺)	6978.2	(57/2 ⁺)		
840.0 ^a 5	<1	4503.7	41/2 ⁻	3663.3	37/2 ⁻		
842.3 2	3.1 2	7309.7	(59/2 ⁻)	6467.4	(55/2 ⁻)		
854.6 5	<1	8182.2	(61/2 ⁺)	7327.6	(57/2 ⁺)		
864.8 2	1.5 1	7993.6	(61/2 ⁻)	7128.8	(57/2 ⁻)		
870.0 ^a 5	<1	8279.2?	(63/2 ⁺)	7409.2	(59/2 ⁺)		
885.0 2	1.6 3	8694.8	(65/2 ⁺)	7809.8	(61/2 ⁺)		
888.6 2	1.8 1	7789.6	(61/2 ⁻)	6900.9	(57/2 ⁻)		
897.2 2	1.4 1	8206.9	(63/2 ⁻)	7309.7	(59/2 ⁻)		
903.0 5	<1	9085.2	(65/2 ⁺)	8182.2	(61/2 ⁺)		
919.6 5	<1	8913.2	(65/2 ⁻)	7993.6	(61/2 ⁻)		
921.0 2	1.4 2	2217.7	(23/2 ⁺)	1296.6	21/2 ⁻		
940.0 5	<1	9635.0	(69/2 ⁺)	8694.8	(65/2 ⁺)		
951.1 5	<1	9158.0	(67/2 ⁻)	8206.9	(63/2 ⁻)		

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$^{124}\text{Sn}(^{51}\text{V},6n\gamma)$ **2006Ha46** (continued) $\gamma(^{169}\text{Ta})$ (continued)

$E_\gamma^\dagger$	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π
955.6 5	<1	8745.2	(65/2 ⁻)	7789.6	(61/2 ⁻)
973.6 5	<1	9886.8	(69/2 ⁻)	8913.2	(65/2 ⁻)
996.6 5	<1	10154.6	(71/2 ⁻)	9158.0	(67/2 ⁻)
1029.8 5	<1	10916.6	(73/2 ⁻)	9886.8	(69/2 ⁻)
1031.3 2	1.9 3	2851.5	(29/2 ⁻)	1820.1	25/2 ⁻
1076.0 ^a 5	<1	11992.6?	(77/2 ⁻)	10916.6	(73/2 ⁻)

[†] Uncertainty=0.2 keV for most γ rays, 0.5 keV for $I_\gamma<1$, as stated in **2006Ha46**. The transition energies shown in parentheses in table I (summary of transition properties) (**2006Ha46**) are interpreted by the evaluator as being for tentatively-placed transitions. Details for the 665 γ , 687 γ and 739 γ shown in the proposed level scheme in fig.1, absent in the summary of transition properties in table I of **2006Ha46**, are taken from an e-mail response to B. Singh on Dec 3, 2006 from D.J. Hartley.

[‡] Absent in table I (summary of transition properties) from **2006Ha46**; see general comment on E_γ data.

[#] Estimated value in **2006Ha46** from intensity balance and branching ratio. For $\Delta J=1$, $\Delta\pi=\text{no transitions}$, pure M1 assumed (as communicated to B. Singh in an e-mail reply, Dec 3, 2006 from D. J. Hartley).

[@] Estimated value from intensity balance (**2006Ha46**). For $\Delta J=1$, $\Delta\pi=\text{no transitions}$, pure M1 assumed (as communicated to B. Singh in an e-mail reply, Dec 3, 2006 from D. J. Hartley).

[&] Assigned by the evaluator (consistent with authors' conclusions) based on measured $R_{\gamma\gamma(\theta)}=W(\theta_f,\phi)/W(\theta_{90^\circ},\phi)$, where $W(\theta_f,\phi)$ is the intensity observed in forward detectors ($\theta=122^\circ, 130^\circ, 143^\circ, 148^\circ$ and 163°) and $W(\theta_{90^\circ},\phi)$ is the intensity observed in Gammasphere rings near 90° ($\theta=79^\circ, 81^\circ, 90^\circ, 99^\circ$ and 101°); Normalized ratios of approximately 0.6 and 1.0 were observed for known stretched D and stretched Q transitions, respectively.

^a Placement of transition in the level scheme is uncertain.

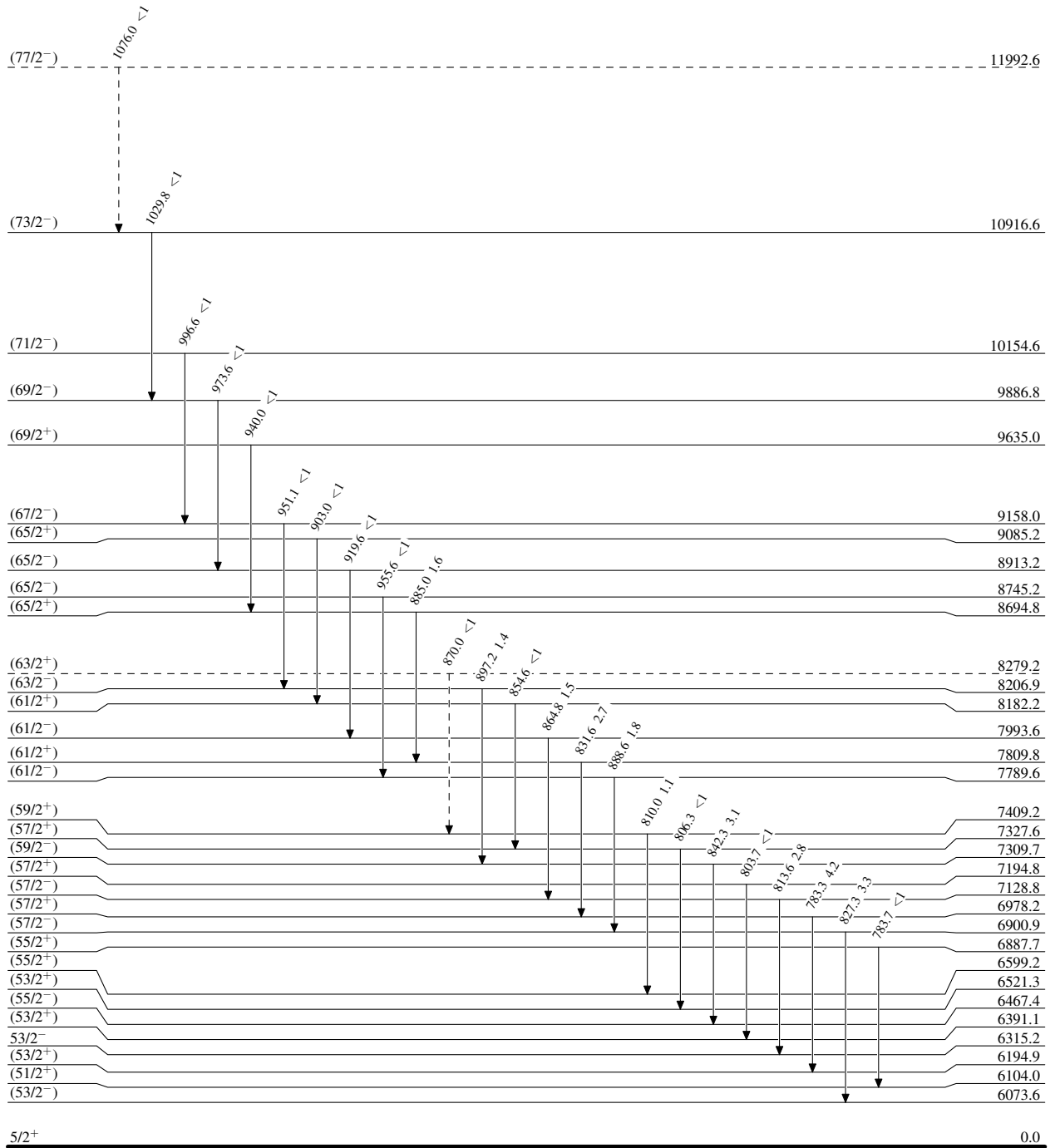
$^{124}\text{Sn}(^{51}\text{V}, 6n\gamma)$ 2006Ha46

Legend

Level Scheme

Intensities: Relative I_γ

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\cdots$ γ Decay (Uncertain)



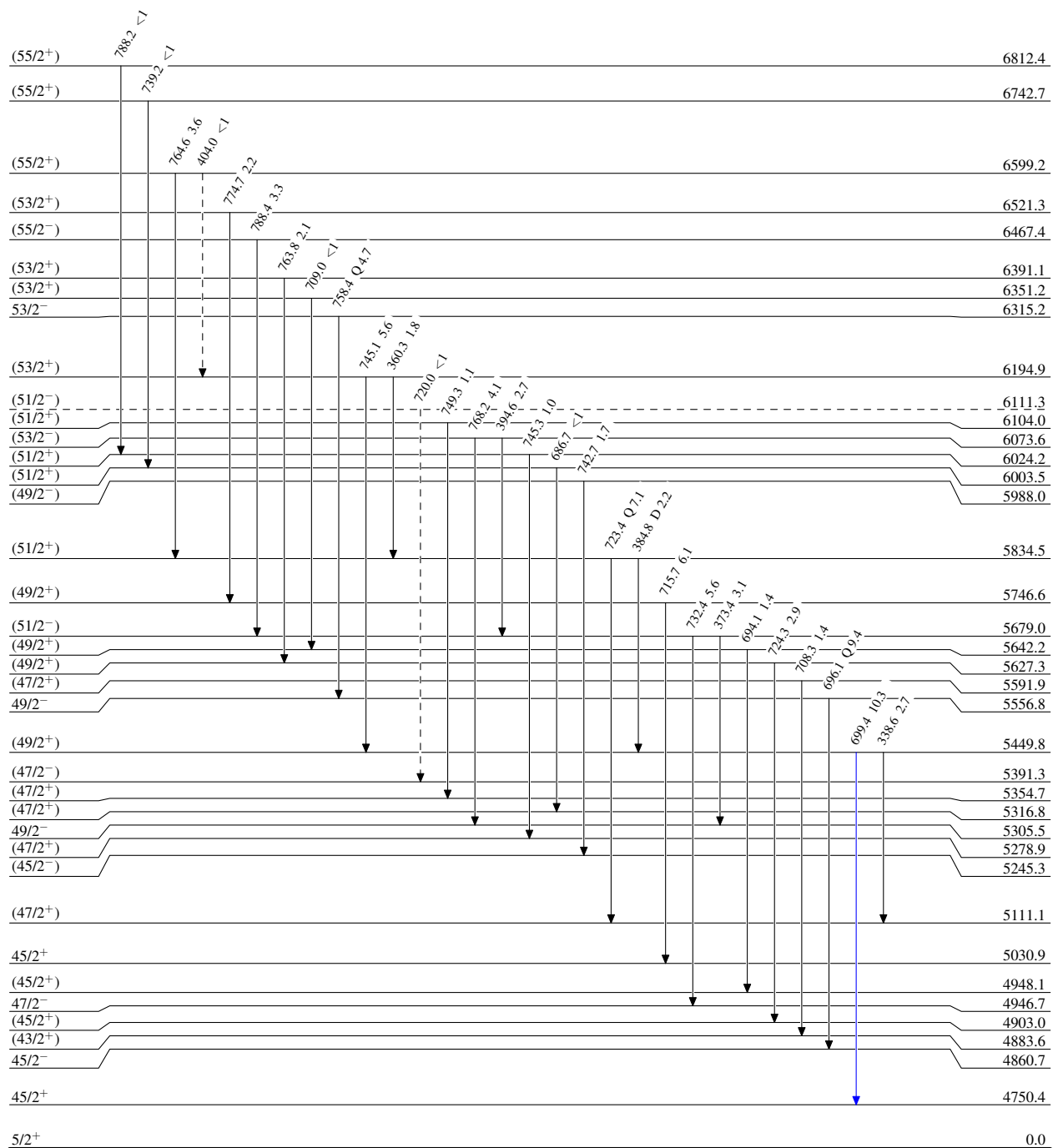
$^{124}\text{Sn}(^{51}\text{V},6n\gamma)$ 2006Ha46

Legend

Level Scheme (continued)

Intensities: Relative I_γ

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\cdots\cdots\cdots$ γ Decay (Uncertain)



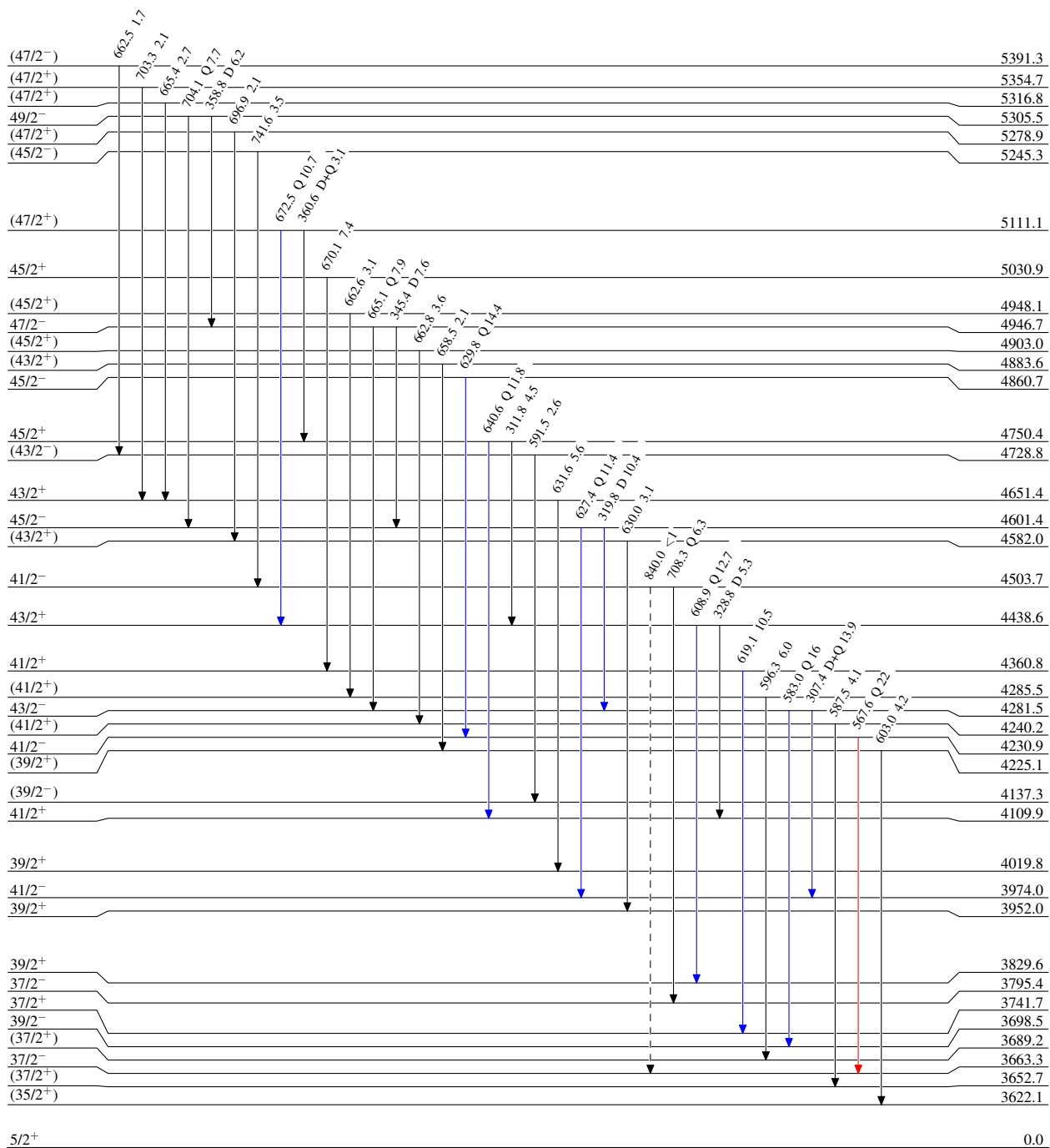
$^{124}\text{Sn}(^{51}\text{V},6n\gamma)$ 2006Ha46

Legend

Level Scheme (continued)

Intensities: Relative I_γ

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\cdots\cdots\cdots$ γ Decay (Uncertain)



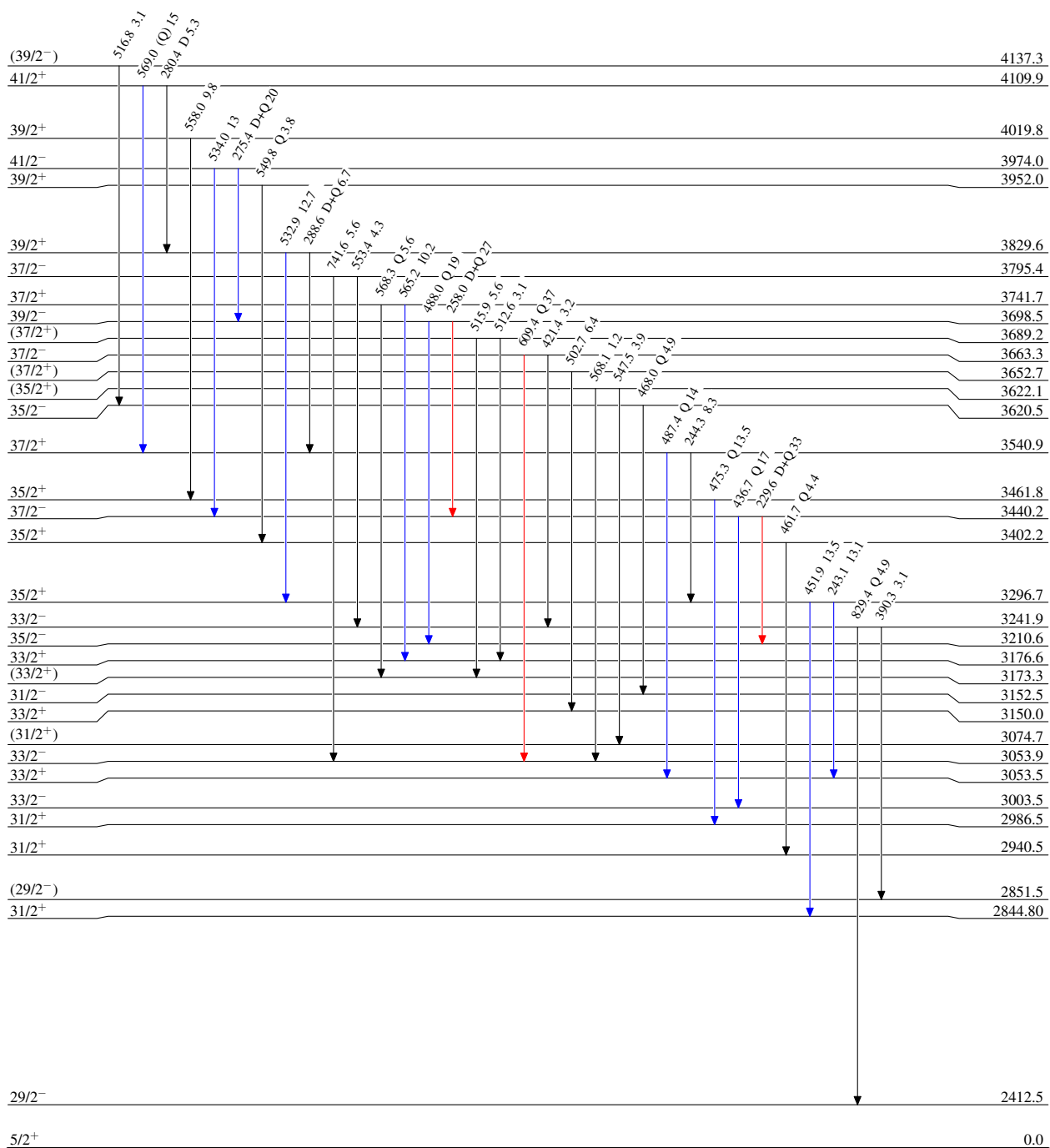
$^{124}\text{Sn}(^{51}\text{V},6n\gamma)$ 2006Ha46

Level Scheme (continued)

Intensities: Relative I_γ

Legend

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$



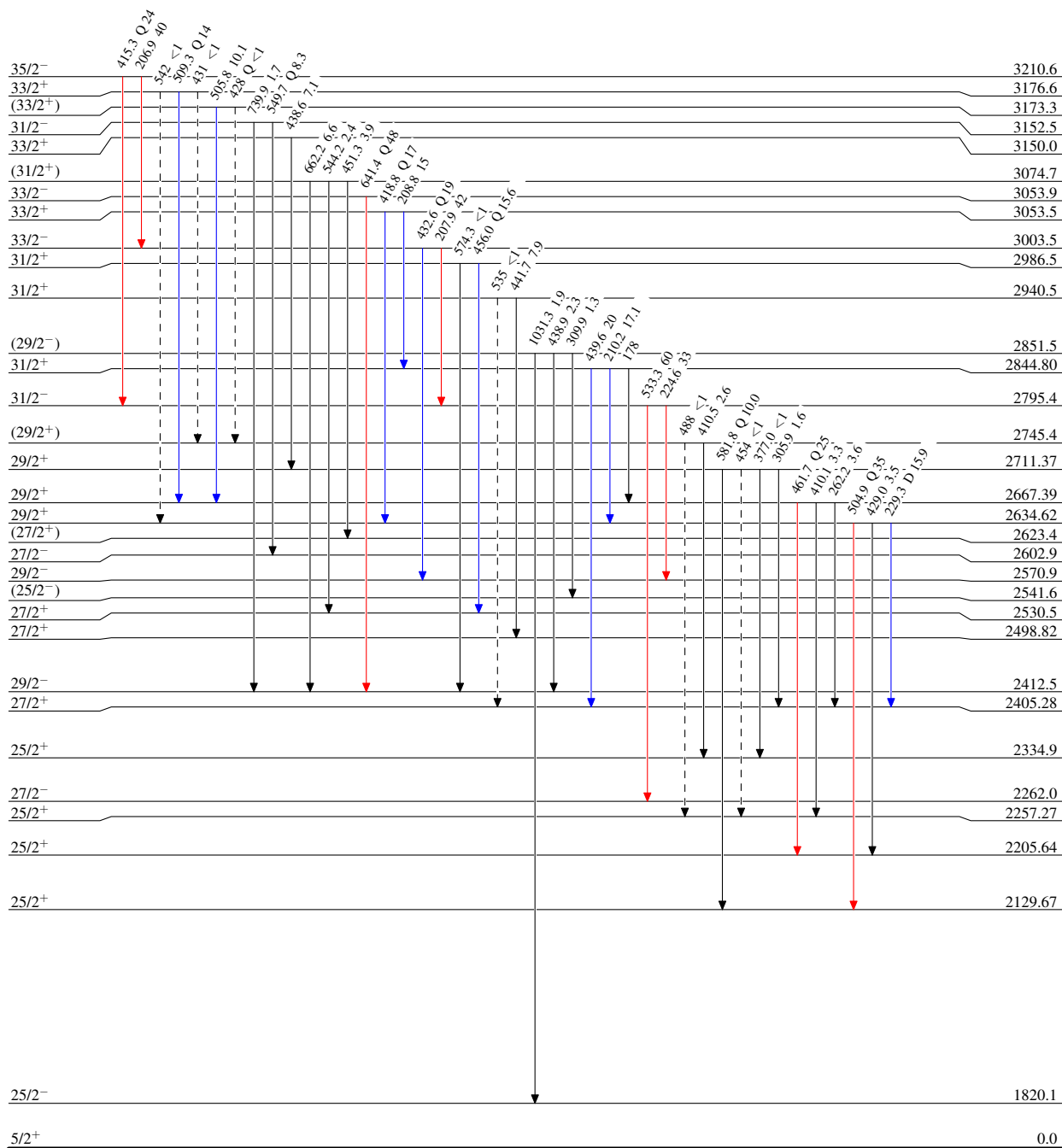
$^{124}\text{Sn}(^{51}\text{V},6n\gamma)$ 2006Ha46

Legend

Level Scheme (continued)

 Intensities: Relative I_γ

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$
- - - - -→ γ Decay (Uncertain)



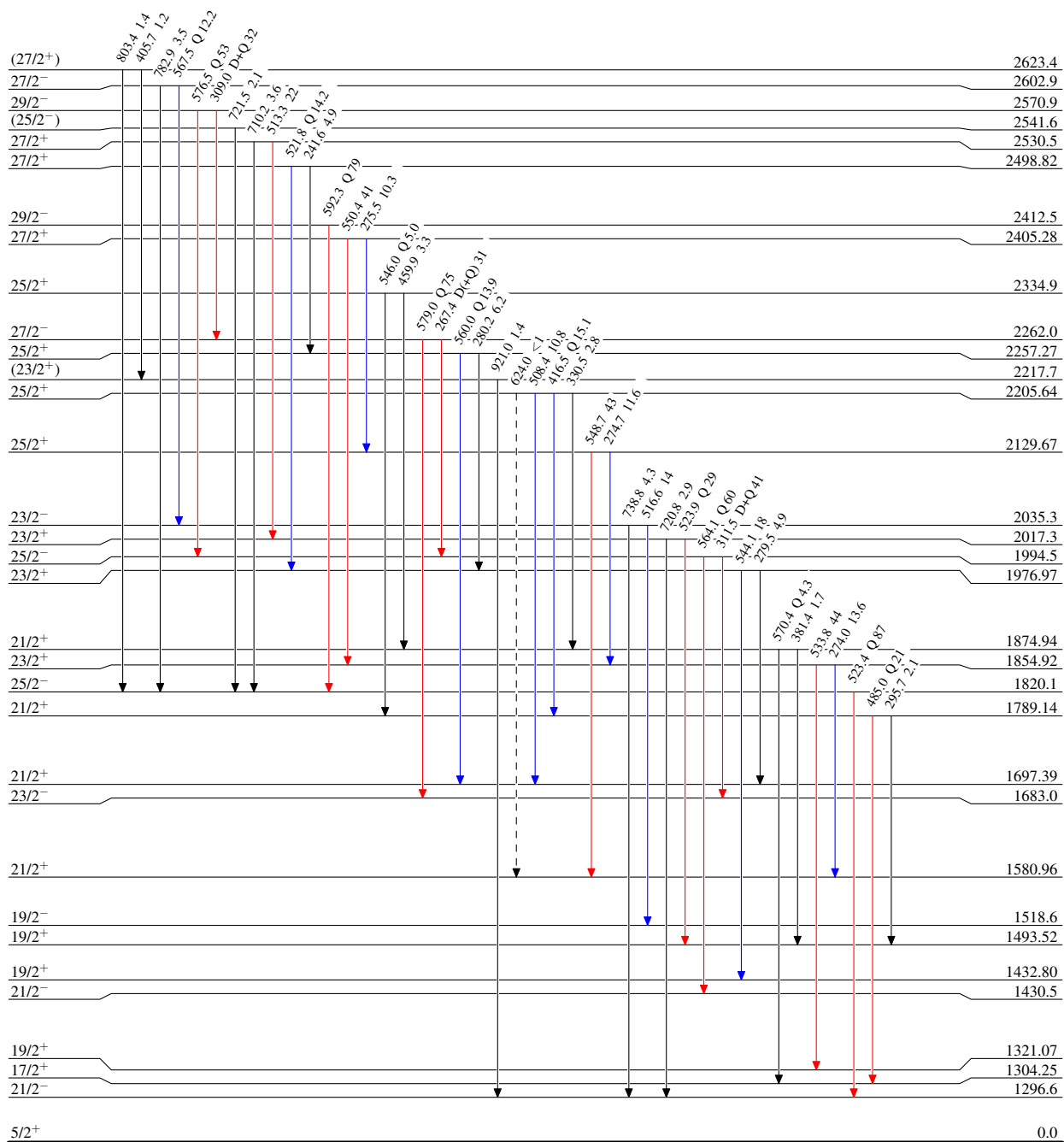
$^{124}\text{Sn}(^{51}\text{V}, 6n\gamma)$ 2006Ha46

Legend

Level Scheme (continued)

Intensities: Relative I_γ

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\cdots\cdots\cdots$ γ Decay (Uncertain)



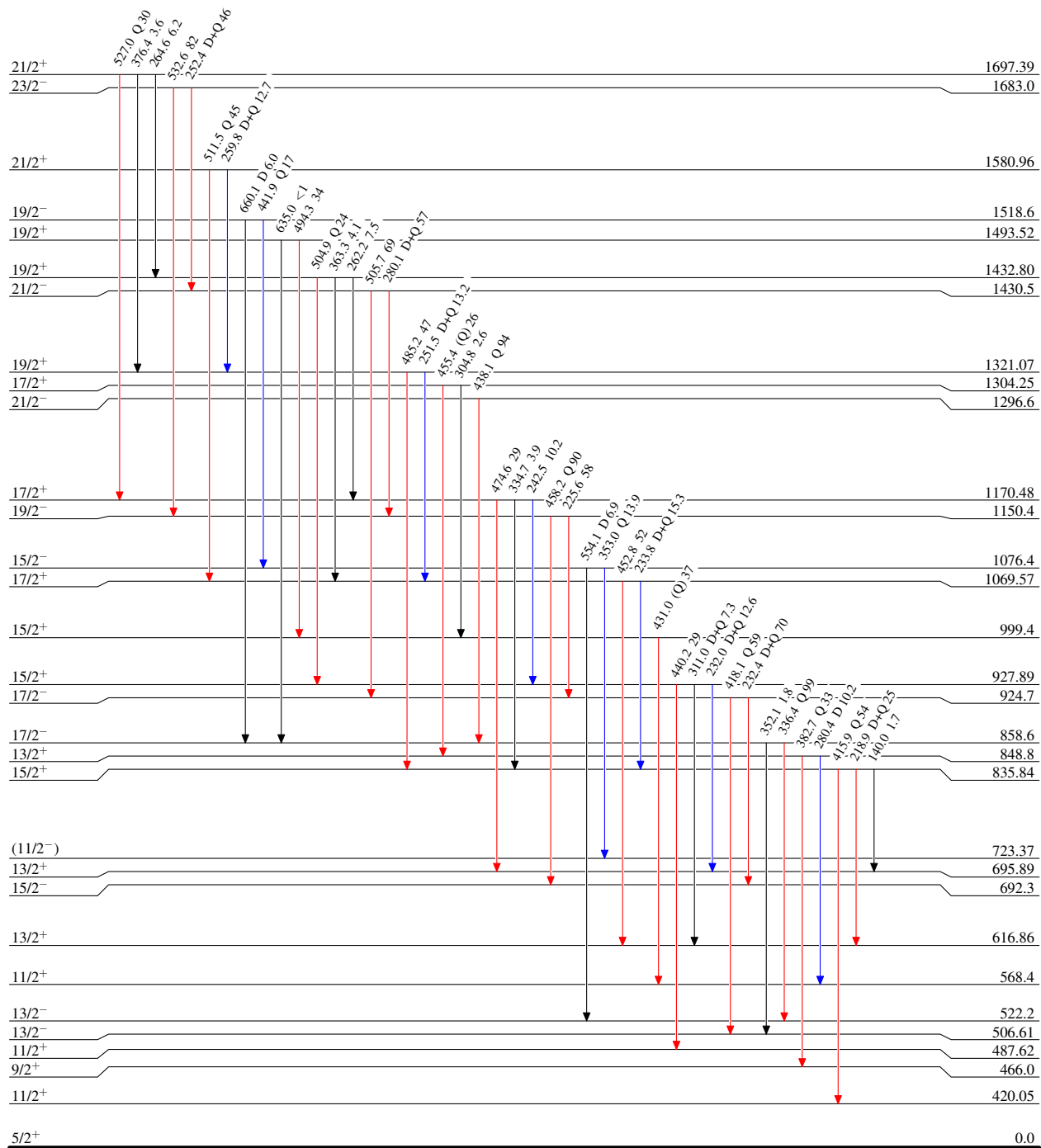
$^{124}\text{Sn}(^{51}\text{V},6n\gamma)$ 2006Ha46

Level Scheme (continued)

Intensities: Relative I_γ

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$



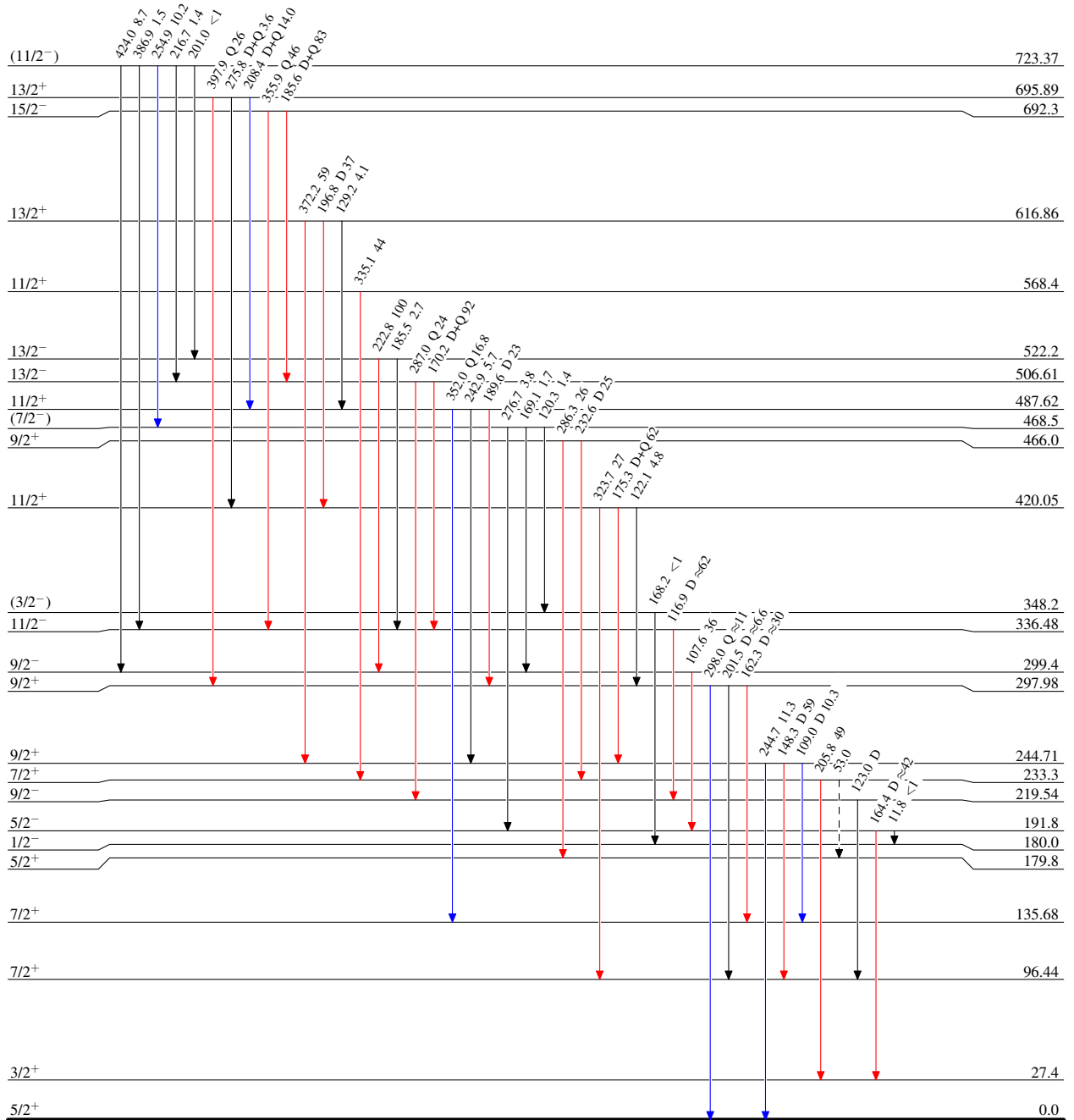
$^{124}\text{Sn}(^{51}\text{V},6n\gamma)$ 2006Ha46

Level Scheme (continued)

Intensities: Relative I_γ

Legend

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$
- - - - -→ γ Decay (Uncertain)



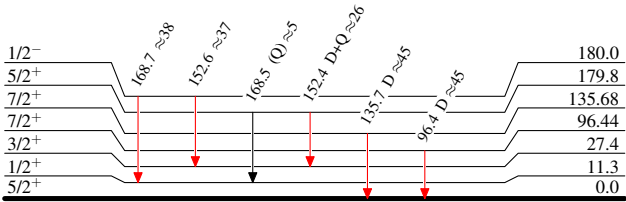
$^{124}\text{Sn}(\text{}^{51}\text{V}, 6\text{n}\gamma)$ 2006Ha46

Level Scheme (continued)

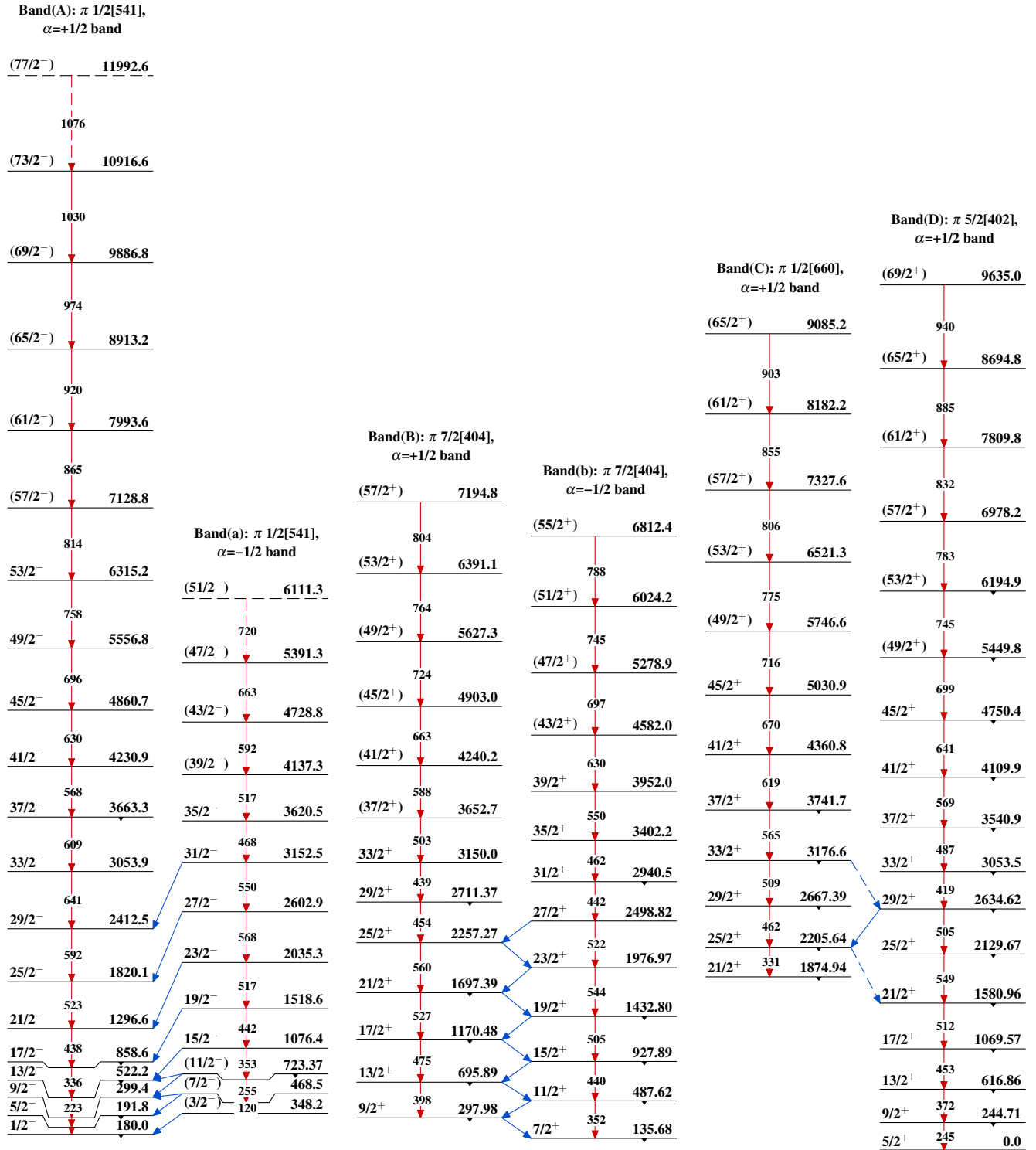
Intensities: Relative I_γ

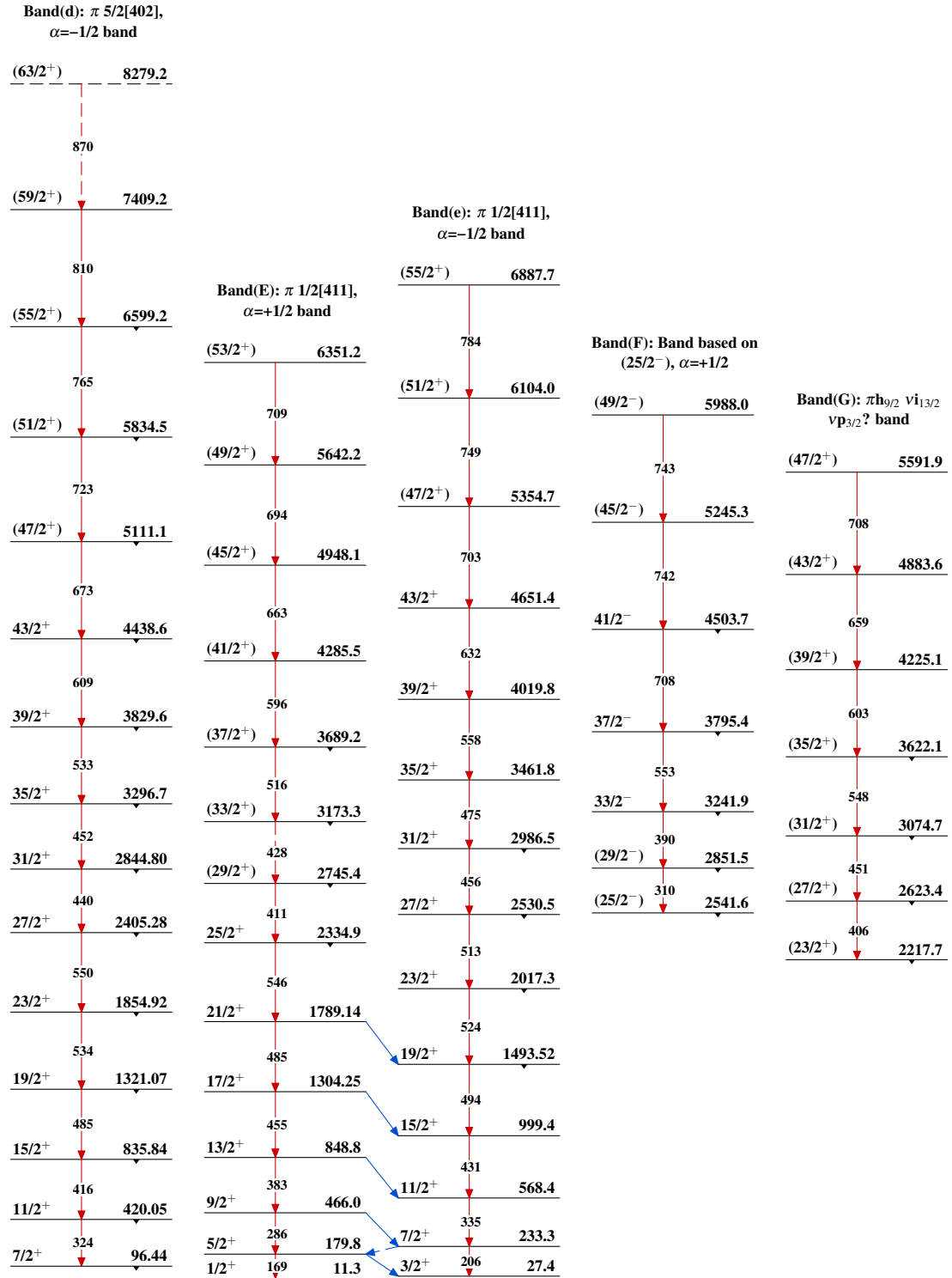
Legend

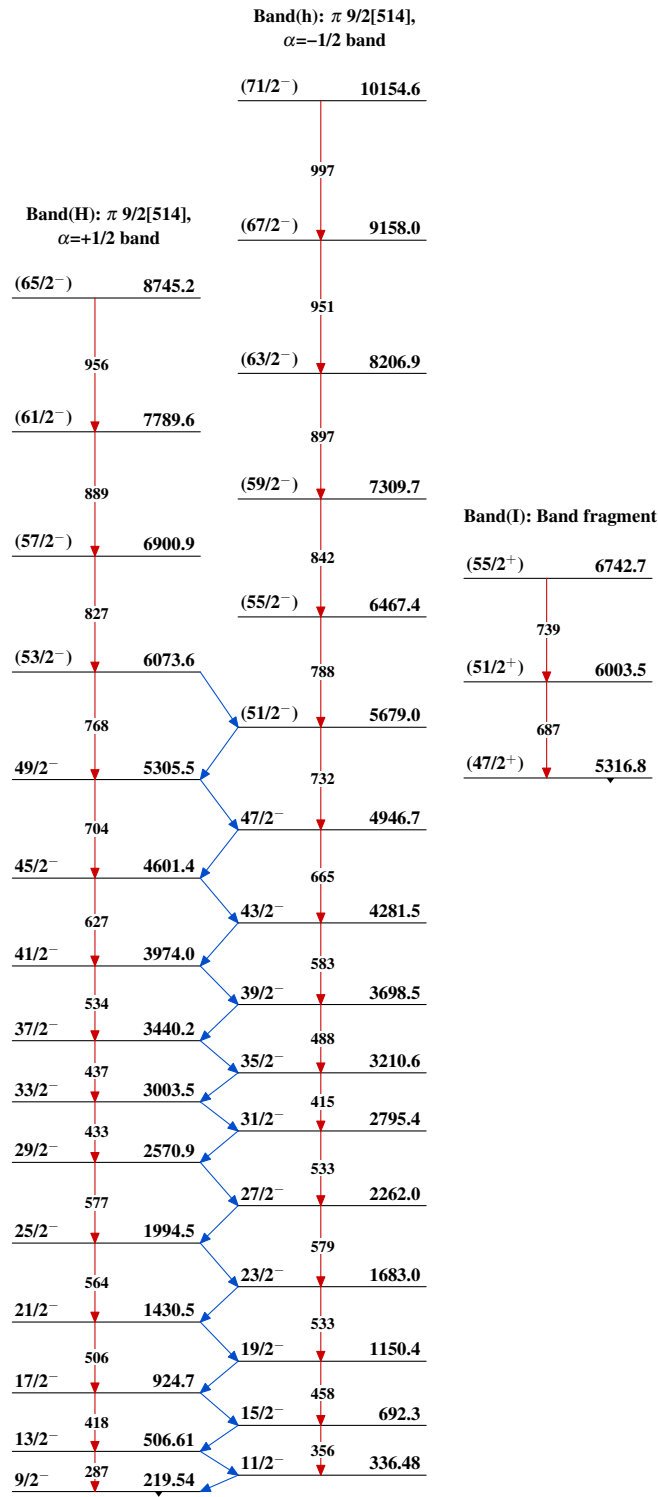
- $I_\gamma < 2\% \times I_\gamma^{\text{max}}$
- $I_\gamma < 10\% \times I_\gamma^{\text{max}}$
- $I_\gamma > 10\% \times I_\gamma^{\text{max}}$



$^{169}_{73}\text{Ta}_{96}$

$^{124}\text{Sn}(^{51}\text{V}, 6n\gamma)$ 2006Ha46

$^{124}\text{Sn}(^{51}\text{V}, 6n\gamma)$ 2006Ha46 (continued)

$^{124}\text{Sn}(^{51}\text{V},6n\gamma)$ 2006Ha46 (continued) $^{169}_{73}\text{Ta}_{96}$

¹⁵⁵Gd(¹⁹F,5nγ), ¹²²Sn(⁵¹V,4nγ) **1993Li15,2003So08**

1993Li15 supersedes 1988Yu02 and 1989Yu03.

1993Li15: ¹⁵⁵Gd(¹⁹F,5nγ): E(¹⁹F)=85.5-100 MeV; Gd targets enriched to 91% in ¹⁵⁵Gd; 4 intrinsic Ge detectors; measured Eγ, Iγ, γγ coin, γ(θ) (θ=15°, 35°, 55°, 70°, 90°) at E(¹⁹F)=95 MeV; measured excitation functions (E(¹⁹F)=85.5-100 MeV).

1993Li15: ¹²²Sn(⁵¹V,4nγ): E(⁵¹V)=223 MeV; ESSA30 detector array (29 escape-suppressed Ge detectors); measured Eγ, Iγ, γ(θ), γγ coin, (mass-separated recoil)-γ coin used to verify assignments to ¹⁶⁹Ta; used cranked shell model to interpret level structure.

2003So08: ¹⁵⁵Gd(¹⁹F,5nγ): E(¹⁹F)=97 MeV; 61.61% ¹⁵⁵Gd target; 11 HPGe-BGO Compton suppressed detectors and a planar HPGe detector; measured Eγ, γγ coin.

¹⁶⁹Ta Levels

E(level) [†]	J ^π [#]	Comments
0.0 ^b	5/2 ⁺	
0.0+z ^f		E(level): from Adopted Level. Excitation energy was not mentioned in 1993Li15.
27.5 ^e 3	(3/2 ⁺)	E(level): from Adopted Level. Excitation energy not mentioned in 1993Li15. In the previous evaluation it was listed as 0.0+y (2008Ba31).
136.2 ^c 4	7/2 ⁺	Adopted assignment for this level is to 7/2[404] band, not to the 5/2[402] band (as suggested in 1993Li15 and shown here).
147.9+z ^f 5		
179.6 ^d 4	5/2 ⁺	
191.9 [@] 3	5/2 ⁻	E(level): from Adopted Level (rounded to a tenth of a keV). Excitation energy not mentioned in 1993Li15. In the previous evaluation it was listed as 0.0+x (2008Ba31).
219.8 ^{&} 2	9/2 ⁻	E(level): from Adopted Levels (rounded to a tenth of a keV).
232.9 ^e 4	(7/2 ⁺)	
284.8 ^b 4	9/2 ⁺	E(level): not adopted. Depopulating 148.4γ from a different level in the adopted dataset.
298.9 [@] 5	9/2 ⁻	
301.2+z ^f 7		
337.5 ^a 4	11/2 ⁻	
460.3 ^c 5	11/2 ⁺	E(level): level energy of the 11/2 ⁺ g.s. band member at 420.13 keV in the adopted dataset.
465.5 ^d 5	9/2 ⁺	
507.6 ^{&} 4	13/2 ⁻	
514.1+z ^f 9		
521.6 [@] 7	13/2 ⁻	
568.0 ^e 6	(11/2 ⁺)	
657.2 ^b 5	13/2 ⁺	E(level): 616.96 in the adopted dataset.
693.1 ^a 5	15/2 ⁻	
744.6+z ^f 10		
848.3 ^d 6	13/2 ⁺	
858.3 [@] 9	17/2 ⁻	
876.5 ^c 6	15/2 ⁺	
926.3 ^{&} 5	17/2 ⁻	
999.4 ^e 7	(15/2 ⁺)	
1081.0+z ^f 11		
1110.0 ^b 6	17/2 ⁺	E(level): 1069.68 in the adopted dataset.
1151.6 ^a 6	19/2 ⁻	
1296.6 [@] 10	21/2 ⁻	
1304.2 ^d 7	17/2 ⁺	
1362.1 ^c 7	19/2 ⁺	E(level): 1321.20 in the adopted dataset.
1431.9 ^{&} 6	21/2 ⁻	

Continued on next page (footnotes at end of table)

$^{155}\text{Gd}(^{19}\text{F},5\text{n}\gamma), ^{122}\text{Sn}(^{51}\text{V},4\text{n}\gamma)$ **1993Li15,2003So08** (continued) ^{169}Ta Levels (continued)

E(level) [†]	J ^π #	Comments
1493.4 ^e 9	(19/2 ⁺)	
1622.1 ^b 7	21/2 ⁺	E(level): 1581.12 in the adopted dataset.
1684.3 ^a 7	23/2 ⁻	
1789.3 ^d 9	21/2 ⁺	
1820.5 [@] 11	25/2 ⁻	
1896.4 ^c 7	23/2 ⁺	
1996.3 ^{&} 7	25/2 ⁻	
2017.2 ^e 10	(23/2 ⁺)	
2171.4 ^b 8	25/2 ⁺	E(level): 2129.83 in the adopted dataset.
2205.3 10		
2263.5 ^a 7	27/2 ⁻	
2413.2 [@] 12	29/2 ⁻	
2447.1 ^c 8	27/2 ⁺	E(level): 2405.44 in the adopted dataset.
2530.5 ^e 11	(27/2 ⁺)	
2572.8 ^{&} 8	29/2 ⁻	
2666.8 11		
2676.8 ^b 8	29/2 ⁺	E(level): 2634.80 in the adopted dataset.
2797.2 ^a 8	31/2 ⁻	
2886.8 ^c 9	31/2 ⁺	E(level): 2845.01 in the adopted dataset.
2986.6 ^e 12	(31/2 ⁺)	
3005.5 ^{&} 8	33/2 ⁻	
3055.4 [@] 13	33/2 ⁻	
3095.7 ^b 9	33/2 ⁺	
3212.8 ^a 9	35/2 ⁻	
3236.8 [‡] 15		
3339.1 ^c 9	35/2 ⁺	E(level): 3296.89 in the adopted dataset.
3443.0 ^{&} 9	37/2 ⁻	
3462.0 ^e 13	(35/2 ⁺)	
3583.0 ^b 9	37/2 ⁺	E(level): 3541.17 in the adopted dataset.
3665.3 [@] 14	37/2 ⁻	
3700.8 ^a 9	39/2 ⁻	
3871.9 ^c 10	39/2 ⁺	E(level): 3829.81 in the adopted dataset.
3977.2 ^{&} 9	41/2 ⁻	
4020.0 ^e 17	(39/2 ⁺)	
4152.4 ^b 10	41/2 ⁺	E(level): 4110.13 in the adopted dataset.
4233.3 [@] 15	41/2 ⁻	
4284.4 ^a 10	43/2 ⁻	
4481.2 ^c 10	43/2 ⁺	E(level): 4438.84 in the adopted dataset.
4604.1 ^{&} 10	45/2 ⁻	
4793.6 ^b 10	45/2 ⁺	E(level): 4750.68 in the adopted dataset.
4863.7 [@] 16	45/2 ⁻	
4949.9 ^a 10	47/2 ⁻	
5153.6 ^c 11	47/2 ⁺	E(level): 5111.35 in the adopted dataset.
5309.9 ^{&} 10	49/2 ⁻	
5492.2 ^b 11	(49/2 ⁺)	E(level): 5450.0 in the adopted dataset.
5561.2 [@] 17	49/2 ⁻	
5682.2 ^a 11	(51/2 ⁻)	

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$^{155}\text{Gd}(^{19}\text{F},5\text{n}\gamma), ^{122}\text{Sn}(^{51}\text{V},4\text{n}\gamma)$ **1993Li15,2003So08** (continued) ^{169}Ta Levels (continued)

E(level) [†]	J ^π [#]	Comments
5877.1 ^c 11	(51/2 ⁺)	E(level): 5834.8 in the adopted dataset.
6078.1 [?] & 12	(53/2 ⁻)	
6236.9 ^b 11	(53/2 ⁺)	E(level): 6195.1 in the adopted dataset.
6303.2 [@] 19	(53/2 ⁻)	
6470.1 [?] a 12	(55/2 ⁻)	
6642.1 [?] c 12	(55/2 ⁺)	E(level): 6599.5 in the adopted dataset.
6905.1 [?] & 14	(57/2 ⁻)	
7020.4 [?] b 12	(57/2 ⁺)	E(level): 6978.2 in the adopted dataset.
7061.7 [@] 20	(57/2 ⁻)	E(level): not adopted, depopulating 758.5γ from a different level in the adopted dataset.
7312.1 [?] a 14	(59/2 ⁻)	
7801.7 [@] 22	(61/2 ⁻)	
8615.7 [?] @ 25	(65/2 ⁻)	E(level): not adopted, depopulating 814γ from a different level in the adopted dataset.
9480.7 [?] @ 27	(69/2 ⁻)	E(level): not adopted, depopulating 865γ from a different level in the adopted dataset.
10401.9 [?] @ 27	(73/2 ⁻)	E(level): not adopted, depopulating 921.2γ from a different level in the adopted dataset.

[†] From least-squares fit to E_γ, assuming equal uncertainty for all E_γ, except where otherwise noted.[‡] Level not adopted; deexciting γ not confirmed in subsequent detailed study using the $^{124}\text{Sn}(^{51}\text{V},6\text{n}\gamma)$ reaction.[#] From **1993Li15**, except as noted; based on γ multiplicities deduced from measured γ(θ), on observed band structure and on systematics of band structures in neighboring odd-A, odd-Z nuclides. The 9/2[514] and 5/2[402] configuration assignments are supported by measured B(M1)(ΔJ=1 transition)/B(E2)(ΔJ=2 transition) for intraband transitions deexciting individual band members. Band parameters for the 1/2[541] band are close to those for known 1/2[541] bands in this mass region. These J^π values are consistent with adopted ones (apart from use of parentheses) except for 1/2[541] band members with J>49/2 where the in-band cascade sequence in this reaction differs from the adopted one.[@] Band(A): 1/2[541], α=+1/2 band (**1993Li15**). Energies are given relative to the energy x of the level fed by the 107γ; from Adopted Levels, x=191.9 keV.& Band(B): 9/2[514], α=+1/2 band (**1993Li15**).^a Band(b): 9/2[514], α=-1/2 band (**1993Li15**).^b Band(C): 5/2[402], α=+1/2 band (**1993Li15**). Level energies are 40 keV higher than those in Adopted Levels because **1993Li15** assigned the 137 level as the J=7/2 member of this configuration instead of the 97 level.^c Band(c): 5/2[402], α=-1/2 band (**1993Li15**). See comment on signature partner band.^d Band(D): 1/2[411], α=+1/2 band (**2003So08**).^e Band(d): 1/2[411], α=-1/2 band (**2003So08**). Apparent K=1/2 decoupled band; 1/2[411] is only low-energy K=1/2 orbital available (1/2[541] is already assigned to a different band).^f Band(E): Band fragment. **1993Li15** make no configuration assignment for this band and subsequent (HI,xnγ) studies do not observe it; possibly it does not belong to ^{169}Ta . $\gamma(^{169}\text{Ta})$

E _γ [†]	I _γ [@]	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. ^d	Comments
107.0	27& 5	298.9	9/2 ⁻	191.9	5/2 ⁻		
117.8	37 ^a 5	337.5	11/2 ⁻	219.8	9/2 ⁻	D	A ₂ =-0.5 3; A ₄ =+0.1 4
136.3	35 7	136.2	7/2 ⁺	0.0	5/2 ⁺	(D)	A ₂ =-0.3 5; A ₄ =+0.1 7
147.9	83 ^c 11	147.9+z		0.0+z			
148.7	19 4	284.8	9/2 ⁺	136.2	7/2 ⁺	D+Q	A ₂ =-0.05 15; A ₄ =+0.18 20 A ₂ '=-0.40 9. E _γ : a comparable E _γ =148.4 2 from 244.8 keV level in the adopted dataset.

Continued on next page (footnotes at end of table)

$^{155}\text{Gd}(^{19}\text{F},5\text{n}\gamma), ^{122}\text{Sn}(^{51}\text{V},4\text{n}\gamma)$ **1993Li15,2003So08 (continued)** $\gamma(^{169}\text{Ta})$ (continued)

$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\textcircled{a}}$	$E_i(\text{level})$	J_i^{π}	E_f	J_f^{π}	Mult. ^d	Comments
152.2 [‡]		179.6	5/2 ⁺	27.5	(3/2 ⁺)		
153.3		301.2+z		147.9+z			
170.0	100 ^a 3	507.6	13/2 ⁻	337.5	11/2 ⁻	D+Q	$A_2=+0.07$ 3; $A_4=+0.09$ 4 $A_2'=-0.07$ 3.
175.3	34 3	460.3	11/2 ⁺	284.8	9/2 ⁺	D	$A_2=-0.1$ 4; $A_4=+0.1$ 5 $A_2'=-0.38$ 8.
185.3	58 ^a 3	693.1	15/2 ⁻	507.6	13/2 ⁻	D	$A_2=+0.09$ 9; $A_4=+0.06$ 12 $A_2'=-0.10$ 8.
196.7	32.0 25	657.2	13/2 ⁺	460.3	11/2 ⁺	D	$A_2=-0.06$ 25; $A_4=+0.2$ 3 $A_2'=-0.15$ 10.
205.3	23 ^b 3	232.9	(7/2 ⁺)	27.5	(3/2 ⁺)		E_{γ} : other: 205.8 (2003So08).
206.9	32 ^a 3	3212.8	35/2 ⁻	3005.5	33/2 ⁻	D	$A_2=+0.16$ 3; $A_4=+0.23$ 4 $A_2'=-0.14$ 5 for 206.9 γ +207.9 γ doublet.
207.9	33 ^a 5	3005.5	33/2 ⁻	2797.2	31/2 ⁻		$A_2=-0.18$ 8, $A_4=0.00$ 10 for doublet. $A_2'=-0.14$ 5 for 206.9 γ +207.9 γ .
208.7	33 5	3095.7	33/2 ⁺	2886.8	31/2 ⁺		$A_2=-0.18$ 8, $A_4=0.00$ 10 for doublet. $A_2'=-0.22$ 13 for multiplet.
209.8	55 5	2886.8	31/2 ⁺	2676.8	29/2 ⁺	(D)	$A_2=-0.05$ 13; $A_4=+0.01$ 17 $A_2'=-0.22$ 13 for multiplet.
212.9	95 ^c 5	514.1+z		301.2+z			
219.0	67.4 24	876.5	15/2 ⁺	657.2	13/2 ⁺	D	$A_2=+0.11$ 16; $A_4=+0.23$ 21 $A_2'=-0.07$ 9.
222.7	97.9 ^{&} 20	521.6	13/2 ⁻	298.9	9/2 ⁻	Q	$A_2=+0.24$ 6; $A_4=-0.03$ 9 $A_2'=+0.18$ 10 for doublet.
224.6	36 ^a 3	2797.2	31/2 ⁻	2572.8	29/2 ⁻	D	$A_2=0.00$ 8 \$ $A_4=+0.05$ 11 for doublet. $A_2'=-0.03$ 5.
225.4	62.3 ^a 20	1151.6	19/2 ⁻	926.3	17/2 ⁻	D	$A_2=0.00$ 8; $A_4=+0.09$ 11 $A_2'=-0.03$ 5.
229.8	28 3	2676.8	29/2 ⁺	2447.1	27/2 ⁺		$A_2=-0.08$ 10, $A_4=+0.04$ 14 for doublet.
230.0	27 ^a 3	3443.0	37/2 ⁻	3212.8	35/2 ⁻	D	$A_2=-0.08$ 10, $A_4=+0.04$ 14 for doublet. $A_2'=-0.06$ 6.
230.5	100 ^c 4	744.6+z		514.1+z			
232.5 [‡]		465.5	9/2 ⁺	232.9	(7/2 ⁺)		
233.4	27.5 20	1110.0	17/2 ⁺	876.5	15/2 ⁺		$A_2=+0.01$ 6, $A_4=+0.15$ 8 for doublet. $A_2'=+0.23$ 9.
233.5	69.4 ^a 20	926.3	17/2 ⁻	693.1	15/2 ⁻	D	$A_2=+0.01$ 6; $A_4=+0.15$ 8 $A_2'=+0.09$ 8.
243.4	34.4 21	3339.1	35/2 ⁺	3095.7	33/2 ⁺	D	$A_2=-0.19$ 20; $A_4=+0.1$ 3 $A_2'=-0.29$ 7 for 243.4 γ +244.0 doublet.
244.0	31 3	3583.0	37/2 ⁺	3339.1	35/2 ⁺		$A_2=+0.07$ 14; $A_4=+0.13$ 18 $A_2'=-0.29$ 7 for 243.4 γ +244.0 γ doublet.
252.0	14.6 24	1362.1	19/2 ⁺	1110.0	17/2 ⁺		$A_2=-0.03$ 6, $A_4=+0.04$ 8 for doublet. $A_2'=+0.08$ 12.
252.2	36.3 ^a 24	1684.3	23/2 ⁻	1431.9	21/2 ⁻	(D)	$A_2=-0.03$ 6, $A_4=+0.04$ 8 for doublet. $A_2'=-0.03$ 5.
258.1	25.5 ^a 18	3700.8	39/2 ⁻	3443.0	37/2 ⁻	D	$A_2=-0.11$ 11; $A_4=+0.12$ 15 $A_2'=-0.32$ 6.
260.0	42.0 18	1622.1	21/2 ⁺	1362.1	19/2 ⁺		$A_2=+0.12$ 10; $A_4=+0.01$ 14 $A_2'=+0.01$ 6.
267.1	47.3 ^a 19	2263.5	27/2 ⁻	1996.3	25/2 ⁻		$A_2=+0.12$ 19; $A_4=+0.10$ 26 $A_2'=+0.19$ 10.
274.3	30.0 20	1896.4	23/2 ⁺	1622.1	21/2 ⁺	D	$A_2=+0.16$ 17; $A_4=+0.01$ 24 $A_2'=-0.12$ 9 for multiplet.

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$^{155}\text{Gd}(^{19}\text{F},5n\gamma), ^{122}\text{Sn}(^{51}\text{V},4n\gamma)$ **1993Li15,2003So08 (continued)** $\gamma(^{169}\text{Ta})$ (continued)

E_γ [†]	I_γ [@]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^d	Comments
275.3	27.3 20	2171.4	25/2 ⁺	1896.4	23/2 ⁺		$A_2=-0.12$ 10, $A_4=0.00$ 13 for triplet. $A_2'=-0.12$ 9 for multiplet.
276.3	25.0 25	2447.1	27/2 ⁺	2171.4	25/2 ⁺		$A_2=-0.12$ 10, $A_4=0.00$ 13 for triplet. $A_2'=-0.12$ 9 for multiplet.
276.4	46.5 ^a 26	3977.2	41/2 ⁻	3700.8	39/2 ⁻	D	$A_2=-0.12$ 10, $A_4=0.00$ 13 for triplet. $A_2'=-0.14$ 9.
280.2 [‡]		848.3	13/2 ⁺	568.0	(11/2 ⁺)		
280.3	57 ^a 3	1431.9	21/2 ⁻	1151.6	19/2 ⁻	D	$A_2=-0.03$ 3, $A_4=+0.06$ 4 for doublet. $A_2'=-0.19$ 9.
280.4	21 3	4152.4	41/2 ⁺	3871.9	39/2 ⁺	(D)	$A_2=-0.03$ 5, $A_4=+0.06$ 6 for doublet. $A_2'=-0.07$ 10.
284.7	21.3 20	284.8	9/2 ⁺	0.0	5/2 ⁺		$A_2=+0.04$ 13; $A_4=-0.08$ 22 E_γ : γ omitted from Adopted Gammas. It is reported in 1993Li15 only and evaluator considers it likely that γ does not belong to ^{169}Ta .
286.1 [‡]		465.5	9/2 ⁺	179.6	5/2 ⁺		
287.7	29.5 ^a 18	507.6	13/2 ⁻	219.8	9/2 ⁻		$A_2=+0.26$ 5, $A_4=+0.01$ 7 for doublet.
288.9	29.5 18	3871.9	39/2 ⁺	3583.0	37/2 ⁺	D	$A_2=+0.07$ 5, $A_4=+0.01$ 7 for doublet. $A_2'=-0.21$ 12.
304.9 [‡]		1304.2	17/2 ⁺	999.4	(15/2 ⁺)		
306.5	42 ^a 3	4284.4	43/2 ⁻	3977.2	41/2 ⁻	D	$A_2=-0.21$ 15; $A_4=0.00$ 20 $A_2'=-0.15$ 10.
309.5	35.8 ^a 20	2572.8	29/2 ⁻	2263.5	27/2 ⁻	D	$A_2=+0.14$ 12; $A_4=+0.01$ 16 $A_2'=-0.13$ 7.
311.6	46.2 ^a 21	1996.3	25/2 ⁻	1684.3	23/2 ⁻	D	$A_2=+0.07$ 22, $A_4=0.0$ 3 for doublet. $A_2'=-0.13$ 7.
312.4	16 5	4793.6	45/2 ⁺	4481.2	43/2 ⁺		$A_2=+0.07$ 22, $A_4=0.0$ 4 for doublet.
319.3	43 ^a 5	4604.1	45/2 ⁻	4284.4	43/2 ⁻		$A_2=+0.30$ 16; $A_4=+0.02$ 22 $A_2'=-0.40$ 7 for doublet.
324.2	39.2 19	460.3	11/2 ⁺	136.2	7/2 ⁺	Q	$A_2=+0.48$ 23; $A_4=-0.04$ 23
328.8	16 3	4481.2	43/2 ⁺	4152.4	41/2 ⁺	D	$A_2=+0.6$ 3, $A_4=+0.1$ 3 for doublet. $A_2'=-0.23$ 9.
335.0	16 ^b 3	568.0	(11/2 ⁺)	232.9	(7/2 ⁺)		E_γ : other: 335.1 (2003So08).
336.4	84 ^c 3	1081.0+z		744.6+z			
336.7	100 ^{&} 6	858.3	17/2 ⁻	521.6	13/2 ⁻		$A_2=+0.22$ 13; $A_4=-0.12$ 19 $A_2'=+0.08$ 2 for doublet.
338.6	15.0 20	5492.2	(49/2 ⁺)	5153.6	47/2 ⁺		$A_2=+0.18$ 14; $A_4=+0.01$ 19
345.8	27 ^a 5	4949.9	47/2 ⁻	4604.1	45/2 ⁻	D	$A_2=0.00$ 8; $A_4=0.00$ 11 $A_2'=-0.40$ 14 for doublet.
356.0	39.4 ^a 17	693.1	15/2 ⁻	337.5	11/2 ⁻		$A_2=+0.33$ 10; $A_4=+0.20$ 9 Mult.: Level scheme implies E2, but A_4 is not consistent with a Q transition.
359.8	16.0 20	5153.6	47/2 ⁺	4793.6	45/2 ⁺		$A_2=+0.09$ 23, $A_4=0.0$ 3 for triplet.
360.0	19.0 ^a 23	5309.9	49/2 ⁻	4949.9	47/2 ⁻		$A_2=+0.09$ 23, $A_4=+0.01$ 13 for triplet.
360.0	15.0 20	6236.9	(53/2 ⁺)	5877.1	(51/2 ⁺)		$A_2=+0.09$ 23, $A_4=0.0$ 3 for triplet.
372.3	11 ^a 3	5682.2	(51/2 ⁻)	5309.9	49/2 ⁻		$A_2=+0.20$ 6, $A_4=+0.01$ 8 for doublet.
372.4	42.0 17	657.2	13/2 ⁺	284.8	9/2 ⁺		$A_2=+0.20$ 6, $A_4=-0.28$ 8 for doublet. $A_2'=-0.24$ 5 for doublet.
378.0 ^e	13.3 20	7020.4?	(57/2 ⁺)	6642.1?	(55/2 ⁺)		
382.8 [‡]		848.3	13/2 ⁺	465.5	9/2 ⁺		
385.0	17.0 20	5877.1	(51/2 ⁺)	5492.2	(49/2 ⁺)		$A_2=+0.33$ 11, $A_4=+0.03$ 15 for doublet.
392.0 ^e	6 ^a 3	6470.1?	(55/2 ⁻)	6078.1?	(53/2 ⁻)		

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$^{155}\text{Gd}(^{19}\text{F},5\text{n}\gamma), ^{122}\text{Sn}(^{51}\text{V},4\text{n}\gamma)$ **1993Li15,2003So08** (continued) $\gamma(^{169}\text{Ta})$ (continued)

E_γ †	I_γ @	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^d	Comments
396 ^e	26.4 ^a 18	6078.1?	(53/2 ⁻)	5682.2	(51/2 ⁻)		$A_2=+0.33$ 11, $A_4=+0.03$ 15 for multiplet.
405.2 ^e	15.4 17	6642.1?	(55/2 ⁺)	6236.9	(53/2 ⁺)		
407 ^e		7312.1?	(59/2 ⁻)	6905.1?	(57/2 ⁻)		
415.8	42 ^a 4	3212.8	35/2 ⁻	2797.2	31/2 ⁻		$A_2=+0.34$ 8, $A_4=-0.10$ 11 for doublet. $A_2'=+0.15$ 7.
416.0 [‡]		2205.3		1789.3	21/2 ⁺		
416.4	58 4	876.5	15/2 ⁺	460.3	11/2 ⁺		$A_2=+0.34$ 8, $A_4=-0.10$ 11 for doublet.
418.5	62 ^a 3	926.3	17/2 ⁻	507.6	13/2 ⁻		$A_2=+0.60$ 5, $A_4=+0.13$ 7 for doublet. $A_2'=+0.13$ 7.
418.8	50 3	3095.7	33/2 ⁺	2676.8	29/2 ⁺		$A_2=+0.60$ 5; $A_4=+0.13$ 7
431.4	19 ^b 3	999.4	(15/2 ⁺)	568.0	(11/2 ⁺)		E_γ : other: 431.2 (2003So08).
432.9	54 ^a 3	3005.5	33/2 ⁻	2572.8	29/2 ⁻	Q	$A_2=+0.26$ 13; $A_4=-0.15$ 17 $A_2'=+0.51$ 10.
435 ^e	6 ^a 3	6905.1?	(57/2 ⁻)	6470.1?	(55/2 ⁻)		
437.7	35.0 ^a 22	3443.0	37/2 ⁻	3005.5	33/2 ⁻		$A_2=+0.31$ 7, $A_4=-0.15$ 9 for triplet. $A_2'=+0.03$ 8 for doublet.
438.3	95.1 ^{&} 22	1296.6	21/2 ⁻	858.3	17/2 ⁻		$A_2=+0.31$ 7, $A_4=-0.14$ 9 for triplet. $A_2'=+0.16$ 4 for doublet.
439.9	49.9 22	2886.8	31/2 ⁺	2447.1	27/2 ⁺	(Q)	$A_2=+0.32$ 7, $A_4=-0.15$ 8 for triplet. $A_2'=+0.24$ 8.
452.6	30 4	3339.1	35/2 ⁺	2886.8	31/2 ⁺	(Q)	$A_2=+0.48$ 10, $A_4=-0.10$ 13 for triplet. $A_2'=+0.27$ 6.
452.9	61 4	1110.0	17/2 ⁺	657.2	13/2 ⁺	Q	$A_2=+0.48$ 10, $A_4=-0.10$ 13 for doublet. $A_2'=+0.27$ 6.
455.9 [‡]		1304.2	17/2 ⁺	848.3	13/2 ⁺		
456.1 [‡]		2986.6	(31/2 ⁺)	2530.5	(27/2 ⁺)		
458.3	97.0 ^a 19	1151.6	19/2 ⁻	693.1	15/2 ⁻	Q	$A_2=+0.41$ 10; $A_4=-0.17$ 14 $A_2'=+0.20$ 12.
461.5 [‡]		2666.8		2205.3			
475.4 [‡]		3462.0	(35/2 ⁺)	2986.6	(31/2 ⁺)		
485.1 [‡]		1789.3	21/2 ⁺	1304.2	17/2 ⁺		
485.7	84.1 25	1362.1	19/2 ⁺	876.5	15/2 ⁺	(Q)	$A_2=+0.1$ 3; $A_4=+0.01$ 5 $A_2'=+0.20$ 9.
487.0	25 3	3583.0	37/2 ⁺	3095.7	33/2 ⁺	(Q)	$A_2=+0.6$ 5, $A_4=0.0$ 6 for doublet. $A_2'=+0.26$ 8.
487.9	20.1 ^a 23	3700.8	39/2 ⁻	3212.8	35/2 ⁻	Q	$A_2=+0.6$ 5, $A_4=+0.05$ 6 for doublet. $A_2'=+0.41$ 18.
494.0 [#]	11 ^b 4	1493.4	(19/2 ⁺)	999.4	(15/2 ⁺)		
505.0	55 3	2676.8	29/2 ⁺	2171.4	25/2 ⁺		$A_2=+0.2$ 3, $A_4=0.0$ 5 for doublet. $A_2'=-0.01$ 10 for doublet.
505.8	99 ^a 4	1431.9	21/2 ⁻	926.3	17/2 ⁻		$A_2=+0.2$ 3 \$ $A_4=+0.12$ 7 for doublet. $A_2'=+0.16$ 4 for doublet.
512.1	82 4	1622.1	21/2 ⁺	1110.0	17/2 ⁺		$A_2=-0.2$ 6; $A_4=-0.7$ 8 $A_2'=-0.01$ 9 for doublet.
513.3 [‡]	12 ^b 4	2530.5	(27/2 ⁺)	2017.2	(23/2 ⁺)		Order of 513.3 γ and 523.8 γ taken from 2003So08; 1993Li15 give the reverse order for these transitions.
523.8 [#]	12 ^b 4	2017.2	(23/2 ⁺)	1493.4	(19/2 ⁺)		E_γ : other: 523.6 (2003So08). See comment on 513.3 γ .
523.9	94 ^{&} 4	1820.5	25/2 ⁻	1296.6	21/2 ⁻	Q	$A_2=+0.36$ 3; $A_4=-0.19$ 4 $A_2'=+0.26$ 6.

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$^{155}\text{Gd}(^{19}\text{F},5\text{n}\gamma), ^{122}\text{Sn}(^{51}\text{V},4\text{n}\gamma)$ **1993Li15,2003So08 (continued)** $\gamma(^{169}\text{Ta})$ (continued)

E_γ [†]	I_γ [@]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^d	Comments
532.5	77 ^a 3	1684.3	23/2 ⁻	1151.6	19/2 ⁻	Q	$A_2=+0.23$ 5; $A_4=-0.05$ 7 $A_2'=+0.20$ 12.
533.0	22 3	3871.9	39/2 ⁺	3339.1	35/2 ⁺	(Q)	$A_2=+0.23$ 5, $A_4=-0.05$ 7 for triplet. $A_2'=+0.28$ 7.
533.4	55 ^a 3	2797.2	31/2 ⁻	2263.5	27/2 ⁻	(Q)	$A_2=+0.23$ 5, $A_4=-0.05$ 7 for multiplet. $A_2'=+0.20$ 4.
534.0	26 ^a 3	3977.2	41/2 ⁻	3443.0	37/2 ⁻	(Q)	$A_2=+0.23$ 5, $A_4=-0.37$ 7 for multiplet. $A_2'=+0.20$ 4.
534.3	62 3	1896.4	23/2 ⁺	1362.1	19/2 ⁺		E_γ : from figs. 1 (gated spectra) and 2 (level scheme) of 1993Li15 ; $E_\gamma=543.3$ in table 1 (measured transition properties) is presumed to be a typographical error. $A_2=+0.23$ 5, $A_4=-0.05$ 7 for multiplet. $A_2'=+0.28$ 7 for doublet.
549.2	65 3	2171.4	25/2 ⁺	1622.1	21/2 ⁺		$A_2=+0.38$ 6, $A_4=-0.12$ 8 for doublet. $A_2'=+0.16$ 10.
550.6	60 3	2447.1	27/2 ⁺	1896.4	23/2 ⁺		$A_2=+0.38$ 6, $A_4=-0.13$ 8 for doublet. $A_2'=+0.16$ 10.
558 [‡]		4020.0	(39/2 ⁺)	3462.0	(35/2 ⁺)		
564.7	67 ^a 3	1996.3	25/2 ⁻	1431.9	21/2 ⁻	(Q)	$A_2=+0.19$ 16; $A_4=-0.15$ 21 $A_2'=+0.15$ 10 for doublet.
568.0	55 ^{&} 3	4233.3	41/2 ⁻	3665.3	37/2 ⁻	(Q)	$A_2=+0.15$ 15, $A_4=-0.13$ 26 for doublet. $A_2'=+0.17$ 8.
569.3	26 3	4152.4	41/2 ⁺	3583.0	37/2 ⁺	(Q)	$A_2=+0.15$ 15, $A_4=-0.13$ 20 for doublet. $A_2'=+0.12$ 9.
570 ^{‡e}		3236.8?		2666.8			
576.5	57.6 ^a 23	2572.8	29/2 ⁻	1996.3	25/2 ⁻	(Q)	$A_2=+0.10$ 9; $A_4=0.00$ 12 $A_2'=+0.13$ 9.
579.3	68 ^a 5	2263.5	27/2 ⁻	1684.3	23/2 ⁻		$A_2=+0.38$ 21, $A_4=-0.06$ 25 for doublet. $A_2'=+0.15$ 5.
583.7	24 ^a 3	4284.4	43/2 ⁻	3700.8	39/2 ⁻	Q	$A_2=+0.29$ 15; $A_4=-0.21$ 20 $A_2'=+0.15$ 5.
592.7	92 ^{&} 3	2413.2	29/2 ⁻	1820.5	25/2 ⁻	Q	$A_2=+0.28$ 12; $A_4=-0.10$ 17 $A_2'=+0.29$ 6.
609.4	24 3	4481.2	43/2 ⁺	3871.9	39/2 ⁺		$A_2=+0.12$ 7, $A_4=-0.18$ 4 for doublet.
609.9	64 ^{&} 3	3665.3	37/2 ⁻	3055.4	33/2 ⁻	Q	$A_2=+0.12$ 3, $A_4=-0.19$ 5 for doublet. $A_2'=+0.23$ 9.
627.6	28 ^a 5	4604.1	45/2 ⁻	3977.2	41/2 ⁻	Q	$A_2=+0.24$ 15; $A_4=-0.27$ 21 $A_2'=+0.06$ 14.
630.4	36 ^{&} 3	4863.7	45/2 ⁻	4233.3	41/2 ⁻	Q	$A_2=+0.45$ 18; $A_4=+0.04$ 24 $A_2'=+0.36$ 12.
641.1	24 3	4793.6	45/2 ⁺	4152.4	41/2 ⁺		$A_2=+0.17$ 13, $A_4=-0.03$ 18 for doublet.
642.2	67 ^{&} 3	3055.4	33/2 ⁻	2413.2	29/2 ⁻	Q	$A_2=+0.19$ 13, $A_4=-0.03$ 18 for doublet. $A_2'=+0.25$ 8.
665.3	26 ^a 3	4949.9	47/2 ⁻	4284.4	43/2 ⁻		$A_2=+0.1$ 3; $A_4=0.0$ 4
672.4	23 4	5153.6	47/2 ⁺	4481.2	43/2 ⁺	Q	$A_2=+0.36$ 16; $A_4=-0.07$ 21
697.5	27 ^{&} 4	5561.2	49/2 ⁻	4863.7	45/2 ⁻		$A_2=+0.08$ 6, $A_4=-0.17$ 8 for doublet.
698.8	25 3	5492.2	(49/2 ⁺)	4793.6	45/2 ⁺		$A_2=+0.06$ 6, $A_4=-0.16$ 8 for doublet.
705.9	26 ^a 3	5309.9	49/2 ⁻	4604.1	45/2 ⁻	(Q)	$A_2=+0.06$ 16; $A_4=-0.17$ 21
723.4	21 3	5877.1	(51/2 ⁺)	5153.6	47/2 ⁺	Q	$A_2=+0.34$ 8; $A_4=+0.07$ 11
732.3	15 ^a 4	5682.2	(51/2 ⁻)	4949.9	47/2 ⁻		
740	13 ^{&} 4	7801.7	(61/2 ⁻)	7061.7	(57/2 ⁻)		Unconfirmed in ($^{51}\text{V},6\text{n}\gamma$) study by 2006Ha46 ; not

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$^{155}\text{Gd}(^{19}\text{F},5\text{n}\gamma), ^{122}\text{Sn}(^{51}\text{V},4\text{n}\gamma)$ **1993Li15,2003So08 (continued)** $\gamma(^{169}\text{Ta})$ (continued)

$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\textcircled{a}}$	$E_i(\text{level})$	J_i^{π}	E_f	J_f^{π}	Comments
						included in Adopted Gammas. $A_2=+0.08$ 6 for doublet.
742	17 ^{&} 4	6303.2	(53/2 ⁻)	5561.2	49/2 ⁻	Unconfirmed in ($^{51}\text{V},6\text{n}\gamma$) study by 2006Ha46; not included in Adopted Gammas. $A_2=+0.08$ 6, $A_4=-0.17$ 8 for doublet.
744.7	21 3	6236.9	(53/2 ⁺)	5492.2	(49/2 ⁺)	
758.5	9 ^{&} 3	7061.7	(57/2 ⁻)	6303.2	(53/2 ⁻)	Placed from J=53/2 band member in Adopted Levels, Gammas.
764.7 ^e	7 3	6642.1?	(55/2 ⁺)	5877.1	(51/2 ⁺)	
768 ^e	19 ^a 4	6078.1?	(53/2 ⁻)	5309.9	49/2 ⁻	
783.9 ^e	7 3	7020.4?	(57/2 ⁺)	6236.9	(53/2 ⁺)	
788 ^e	7 ^a 3	6470.1?	(55/2 ⁻)	5682.2	(51/2 ⁻)	
814 ^e	<6 ^{&}	8615.7?	(65/2 ⁻)	7801.7	(61/2 ⁻)	Placed from J=57/2 band member in Adopted Levels, Gammas.
827 ^e	8 ^a 4	6905.1?	(57/2 ⁻)	6078.1?	(53/2 ⁻)	
842 ^e	7 ^a 3	7312.1?	(59/2 ⁻)	6470.1?	(55/2 ⁻)	
865 ^e	<5 ^{&}	9480.7?	(69/2 ⁻)	8615.7?	(65/2 ⁻)	Placed from J=61/2 band member in Adopted Levels, Gammas.
921.2 ^e	<5 ^{&}	10401.9?	(73/2 ⁻)	9480.7?	(69/2 ⁻)	E_{γ} : placed from J=65/2 band member in Adopted Levels, Gammas (a 1030 γ deexcites the 73/2 ⁻ 1/2[541] band member there).

[†] From 1993Li15; uncertainties unstated by authors. 1988Yu02 and 1989Yu03 give E_{γ} for only the lower half of the 1/2[541] band; their data agree with those from 1993Li15 to better than 0.6 keV.

[‡] From 2003So08; uncertainty unstated by authors.

[#] In table 1 (observed transition properties) of 1993Li15, the intraband 494.0 γ and 523.8 γ are placed deexciting 27/2⁺ and 19/2⁺ band members, respectively; in fig. 2 (level scheme), the reverse is the case. The evaluator adopts the latter because it leads to the more plausible sequence of E_{γ} values for the band's $\Delta J=2$ γ cascade.

[@] 1993Li15 report I_{γ} relative to that for the strongest γ within each band. I_{γ} data tabulated here without comment are for the 5/2[402] g.s. band and are normalized so $I(485.7\gamma)=84.1$ 25. I_{γ} data for transitions within other bands are footnoted to indicate their relevant intensity normalizations.

[&] Relative to $I(336.7\gamma)=100$ 6.

^a Relative to $I(170.0\gamma)=100$ 3.

^b Relative to $I(205.3\gamma)=23$ 3.

^c Relative to $I(230.5\gamma)=100$ 4.

^d Assigned by evaluator based on $\gamma(\theta)$. Values of A_2 and A_4 deduced by authors from ($^{19}\text{F},5\text{n}\gamma$) data are given in comments along with values of A_2 (denoted A_2') deduced by 1993Li15 from ($^{51}\text{V},4\text{n}\gamma$) assuming $A_4=0.0$.

^e Placement of transition in the level scheme is uncertain.

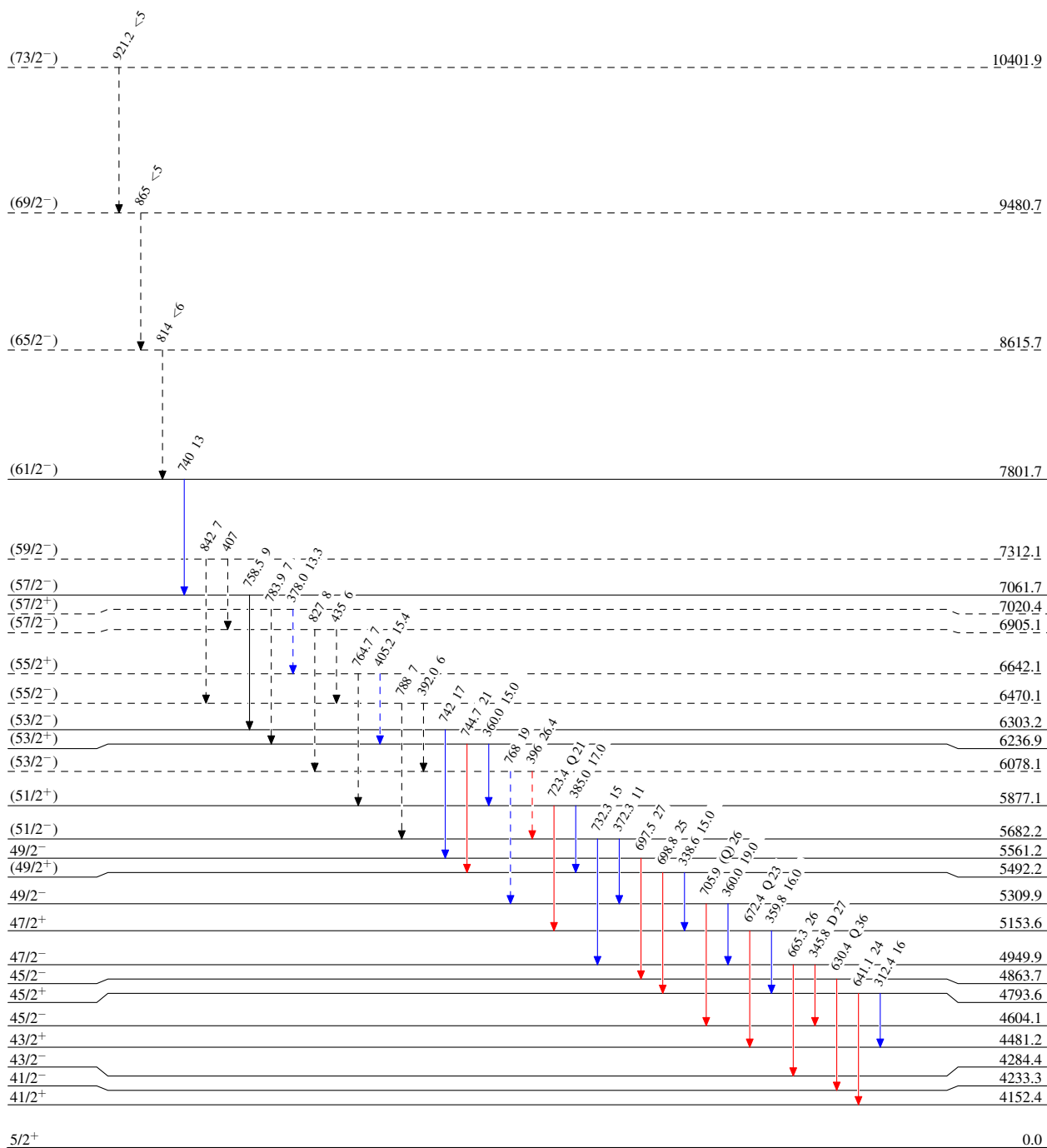
$^{155}\text{Gd}(^{19}\text{F},5\text{n}\gamma), ^{122}\text{Sn}(^{51}\text{V},4\text{n}\gamma)$ 1993Li15,2003So08

Legend

Level Scheme

Intensities: Relative I_γ

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$
- - - - -→ γ Decay (Uncertain)



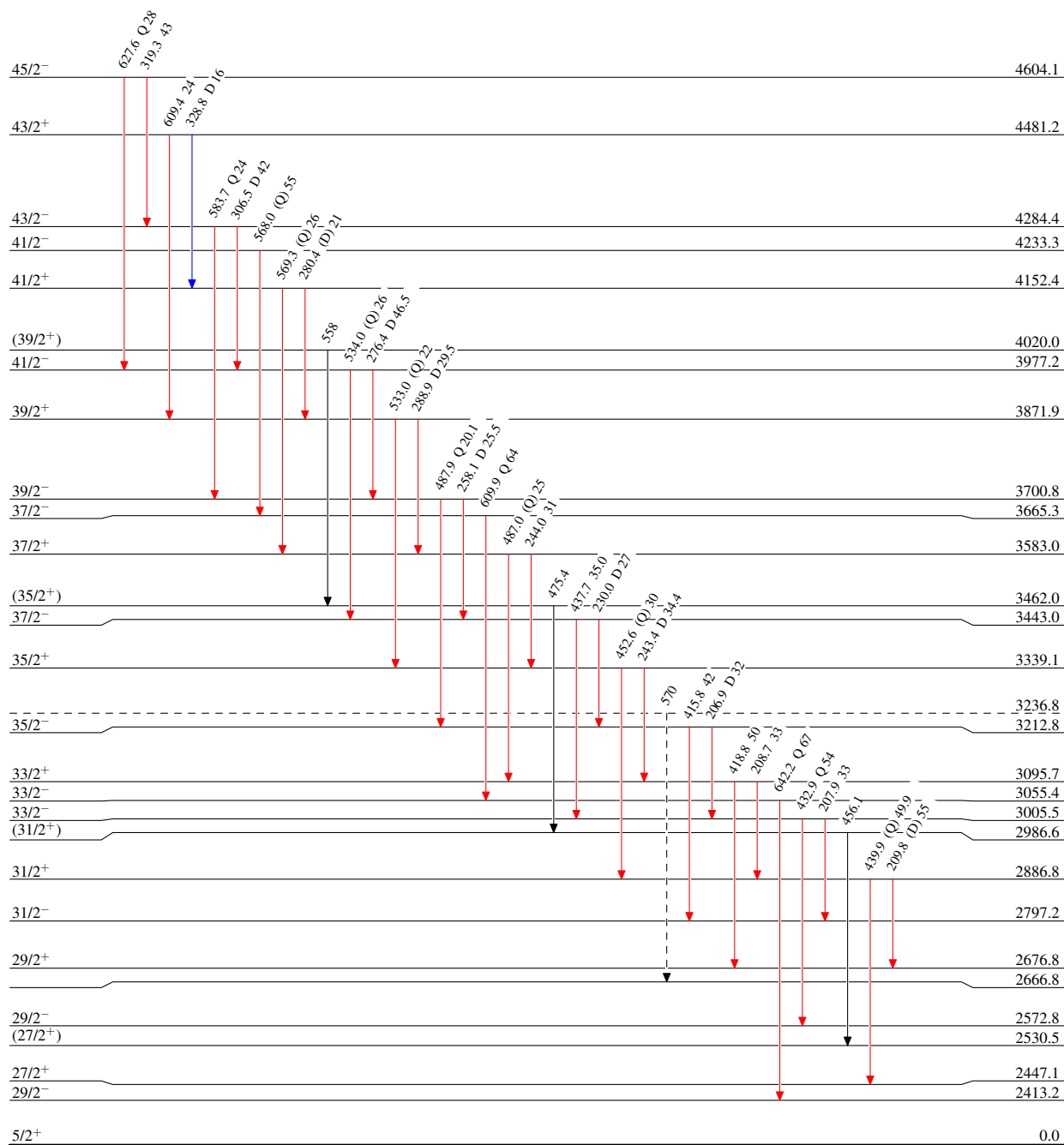
$^{155}\text{Gd}(^{19}\text{F},5n\gamma), ^{122}\text{Sn}(^{51}\text{V},4n\gamma)$ 1993Li15,2003So08

Legend

Level Scheme (continued)

Intensities: Relative I_γ

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\cdots\cdots\cdots\longrightarrow$ γ Decay (Uncertain)



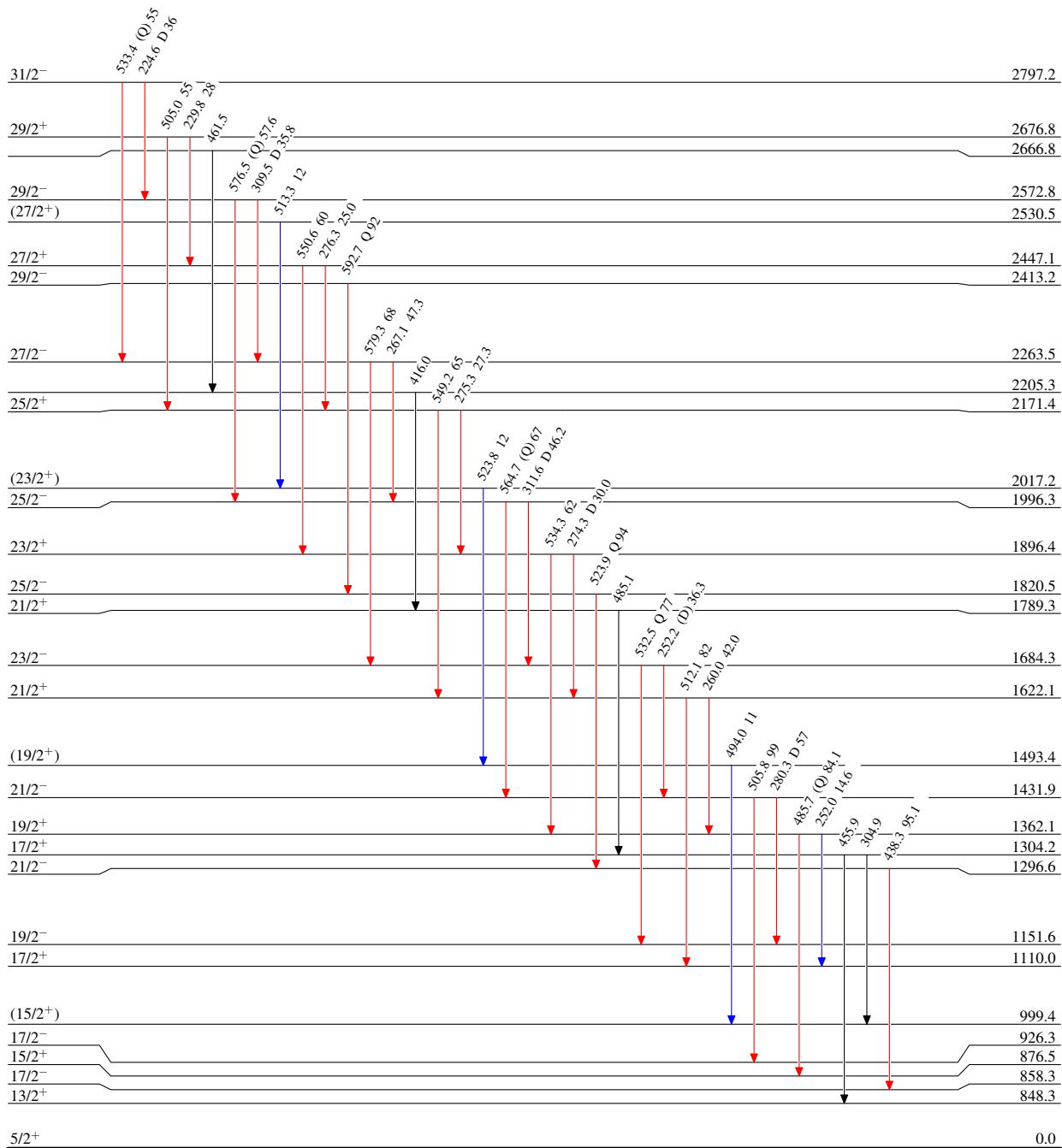
$^{155}\text{Gd}(^{19}\text{F},5\text{n}\gamma), ^{122}\text{Sn}(^{51}\text{V},4\text{n}\gamma)$ 1993Li15,2003So08

Level Scheme (continued)

Intensities: Relative I_γ

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$



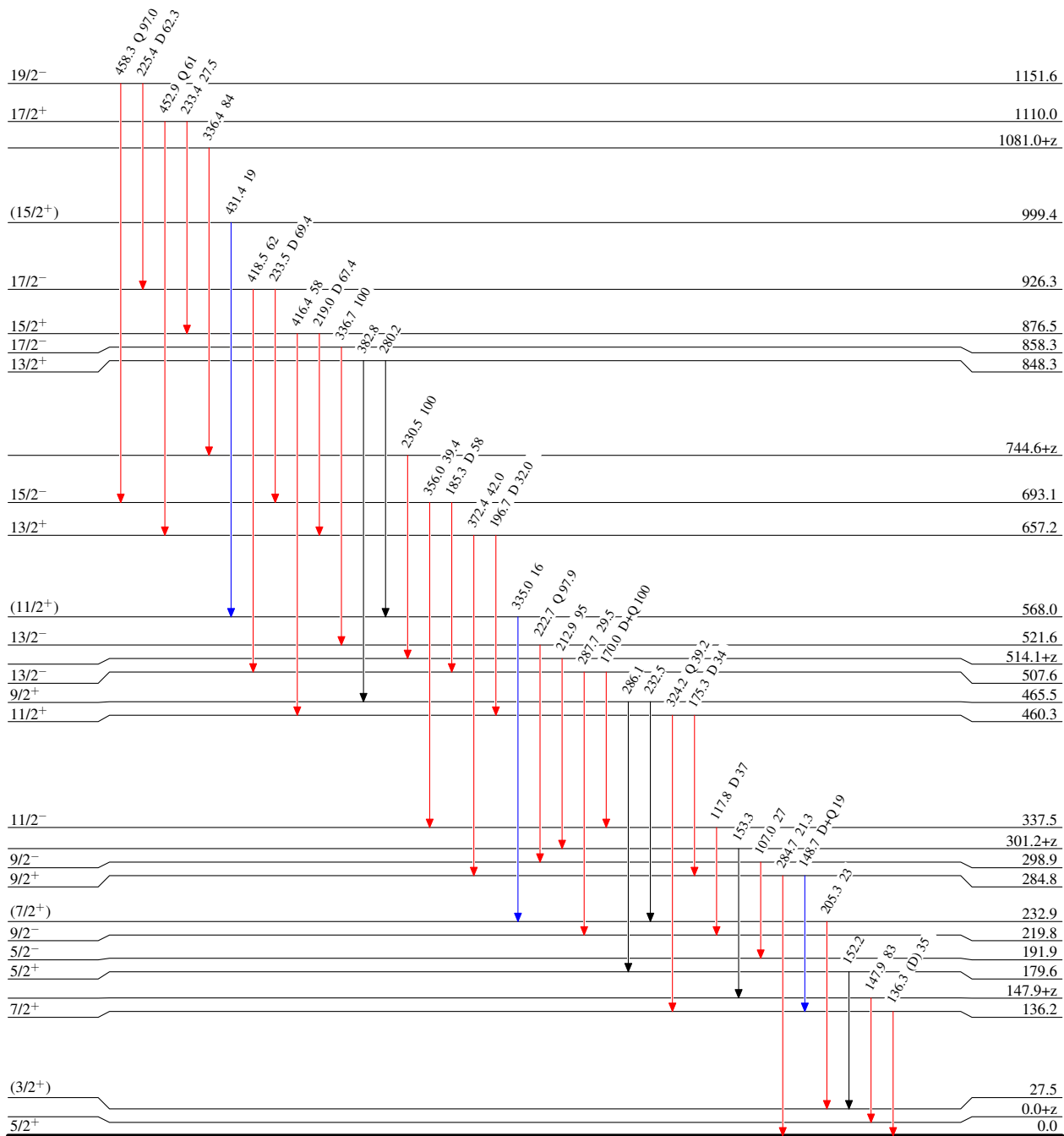
$^{155}\text{Gd}(^{19}\text{F},5\text{n}\gamma), ^{122}\text{Sn}(^{51}\text{V},4\text{n}\gamma) \quad 1993\text{Li15}, 2003\text{So08}$

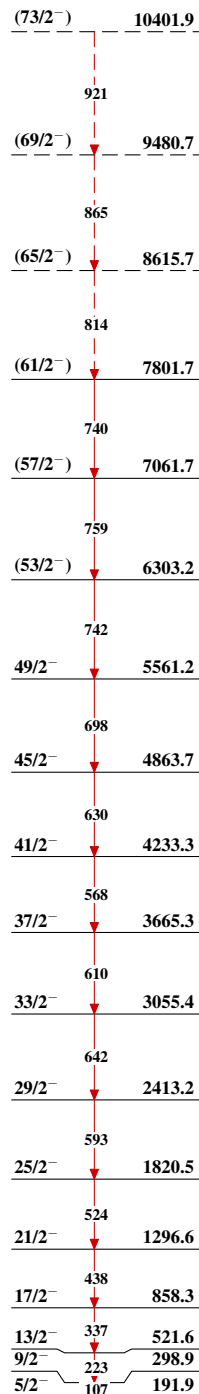
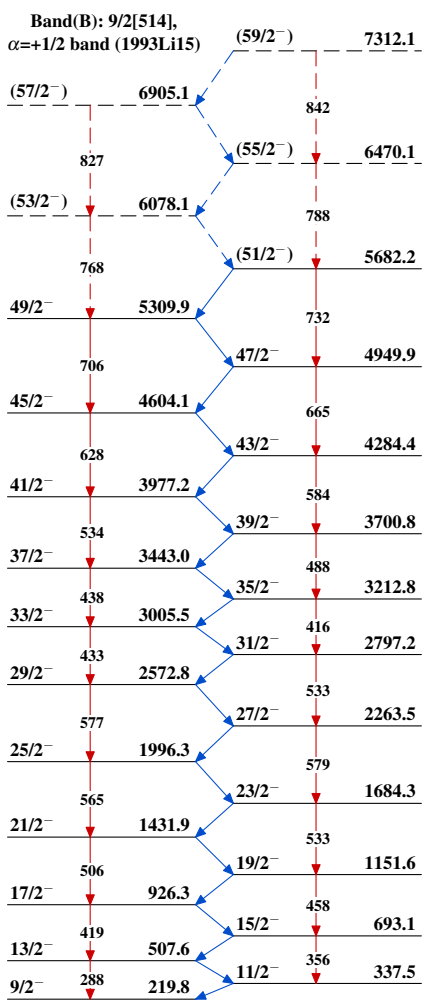
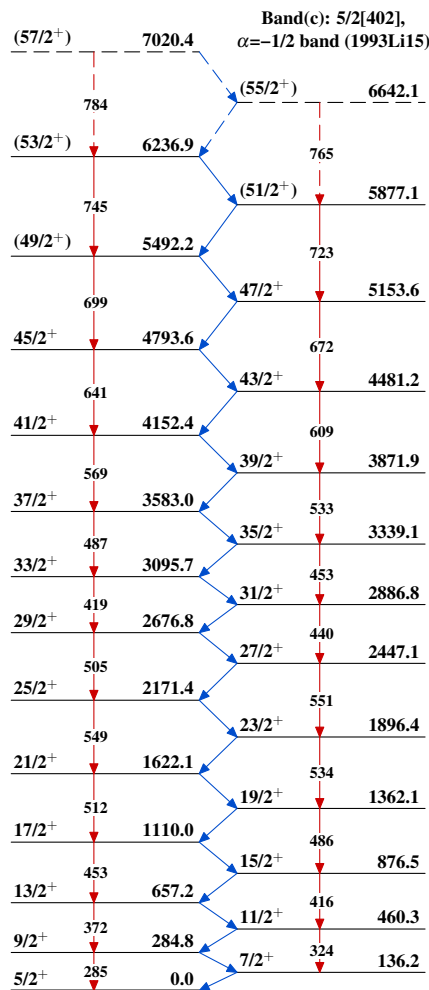
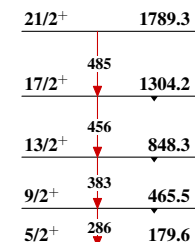
Level Scheme (continued)

Intensities: Relative I_γ

Legend

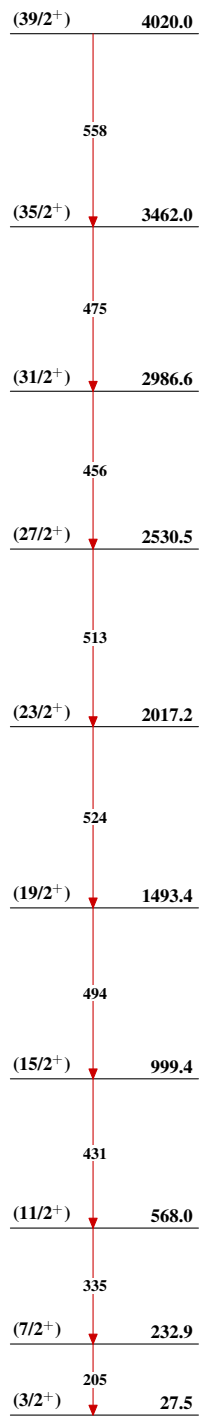
- $I_\gamma < 2\% \times I_\gamma^{\text{max}}$
- $I_\gamma < 10\% \times I_\gamma^{\text{max}}$
- $I_\gamma > 10\% \times I_\gamma^{\text{max}}$



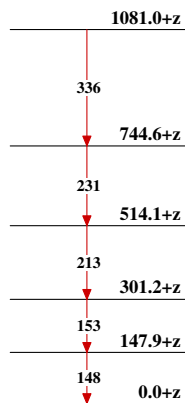
$^{155}\text{Gd}(^{19}\text{F},5\text{n}\gamma), ^{122}\text{Sn}(^{51}\text{V},4\text{n}\gamma)$ 1993Li15,2003So08Band(A): 1/2[541],
 $\alpha=+1/2$ band (1993Li15)Band(b): 9/2[514],
 $\alpha=-1/2$ band (1993Li15)Band(C): 5/2[402],
 $\alpha=+1/2$ band (1993Li15)Band(D): 1/2[411],
 $\alpha=+1/2$ band (2003So08)

$^{155}\text{Gd}(^{19}\text{F},5\text{n}\gamma), ^{122}\text{Sn}(^{51}\text{V},4\text{n}\gamma)$ 1993Li15,2003So08 (continued)

Band(d): $1/2[411]$,
 $\alpha=-1/2$ band (2003So08)



Band(E): Band fragment



$^{159}\text{Tb}(^{16}\text{O},6n\gamma)$ **2005Ku40,1998Zh17,1998Zh03**

2005Ku40: E=104 MeV; pulsed beam; one HPGe and two NaI detectors; measured $T_{1/2}$, Q (using time differential perturbed angular distribution method, $\theta=0^\circ$ and 90°).

1998Zh17,1998Zh03: E=105 MeV; prompt (± 36 ns), delayed (12 to 600 ns) and preprompt (-600 to -12 ns) spectra obtained in conjunction with the authors' study of ^{170}Ta (reported, along with additional experimental detail, in **1999Zh27**); 4 HPGe detectors with BGO Compton shields, $\theta=\pm 90^\circ$, 30° and 145° ; measured E_γ , $\gamma\gamma$ coin, $\gamma(\text{Ta K x ray})$ coin, $\gamma\gamma(t)$; deduced $T_{1/2}$ from delayed $\gamma\gamma$ coin.

The level scheme is the partial scheme proposed by **1998Zh17**. It omits several known $\Delta J=2$ transitions (in the $5/2[402]$ and $9/2[514]$ bands) which must be present in this reaction also.

 ^{169}Ta Levels

E(level) [†]	J^π [‡]	$T_{1/2}$ [#]	Comments
0.0 ^b	$5/2^+$		
0.0+x			E(level): 'x' in 1998Zh03 . if $x=11.4$ 3 then $J^\pi=(1/2^+)$ as of the Adopted Levels, however, 169.5 γ from $5/2^-$ (Fig. 3 (1998Zh17)).
16.0+x			E(level): '16+x' in 1998Zh03 . if $x=11.4$ 3 then $J^\pi=(3/2^+)$ as of the 27.5 keV adopted level. Adopted $J^\pi=(3/2^+)$.
96.5 ^d	$7/2^+$		1998Zh17 assign the 97 and 136 levels, respectively, to the $7/2[404]$ and $5/2[402]$ bands. In Adopted Levels, the reverse is the case, supported by coincidence information from a subsequent extensive study of the ($^{51}\text{V},6n\gamma$) reaction (2006Ha46).
136.3 ^c	$7/2^+$		Band assignment not adopted; see comment on 97 level.
169.5+x [@]	$5/2$	17 ns 4	Q=2.23 13 (2005Ku40) E(level): for the same J^π and band assignment, level energy would be 191.9 in the Adopted Levels. However, the depopulating gammas match those from 180.1 keV in the Adopted Levels. Q: from time differential perturbed angular distribution (TDPAD). J^π : TDPAD pattern depends on level spin and indicates $J=5/2$ for this level (2005Ku40). This result is at variance with $J^\pi=1/2^-$ in ($^{51}\text{V},6n\gamma$) (2006Ha46) based on extensive interconnected band structures. Note that in Adopted Levels, Gammas the 169 γ feeds a $(1/2^+)$ level so $J^\pi=5/2^-$ would imply M2 multipolarity for the 169 γ and this would violate RUL. The $5/2^-$ $1/2[541]$ level is associated with a different level in Adopted Levels, so the present band assignment for this level is not adopted. $T_{1/2}$: 17 ns 4 from $\gamma\gamma$ delayed $\gamma\gamma$ coin (1998Zh17 , 1998Zh03) using $1/2[541]$ intraband γ 's as 'start' and $(154\gamma+170\gamma)$ as 'stop'. Other: 44 ns 5 from fit to time spectrum gated by $(154\gamma+170\gamma)$ (2005Ku40). Reason for discrepancy unknown.
220.0 ^{&}	$9/2^-$	28 ns 5	Q=2.28 13 (2005Ku40) Q: from time differential perturbed angular distribution (TDPAD). J^π : TDPAD pattern depends on level spin and indicates $J=9/2$ for this level. $T_{1/2}$: 28 ns 5 from $\gamma\gamma$ delayed $\gamma\gamma$ coin (1998Zh17 , 1998Zh03) using $9/2[514]$ intraband γ 's as 'start' and 124γ as 'stop'. Other: 54 ns 6 from fit to time spectrum gated by 124γ (2005Ku40). Reason for discrepancy unknown.
276.6+x [@]	$9/2^-$		In Adopted Levels, E=299.5.
285.0 ^b	$9/2^+$		In Adopted Levels, E=244.8.
337.8 ^a	$11/2^-$		
460.3 ^c	$11/2^+$		E(level): level energy of the $11/2^+$ g.s. band member at 420.13 keV in the adopted dataset.
499.3+x [@]	$13/2^-$		In Adopted Levels, E=522.3.
508 ^{&}	$13/2^-$		
693 ^a	$15/2^-$		
836.0+x [@]	$17/2^-$		In Adopted Levels, E=858.7.

[†] From least-squares fit to E_γ , assuming equal uncertainty for all E_γ .

[‡] From **1998Zh17**, based on earlier decay and (HI,xn γ) studies, except as noted. Major discrepancies with adopted values are noted. Additionally, all adopted values are given in parentheses.

[#] From $\gamma\gamma(t)$ (centroid method) (**1998Zh17**, **1998Zh03**).

$^{159}\text{Tb}(^{16}\text{O},6n\gamma)$ [2005Ku40,1998Zh17,1998Zh03](#) (continued) ^{169}Ta Levels (continued)

@ Band(A): $1/2[541]$, $\alpha=+1/2$ band. In Adopted Levels, the $J=5/2$ band member lies ≈ 12 keV above the 17 ns level deexcited by the 153.53γ and 169.5γ .

& Band(B): $9/2[514]$, $\alpha=+1/2$ band.

^a Band(b): $9/2[514]$, $\alpha=-1/2$ band.

^b Band(C): $5/2[402]$, $\alpha=+1/2$ band. See comment on signature partner band.

^c Band(c): $5/2[402]$, $\alpha=-1/2$ band. for $J>5/2$, level energies are 40 keV higher than those in Adopted Levels because [1998Zh17](#) assign the 137 level as the $J=7/2$ member of this configuration instead of the 97 level.

^d Band(D): $7/2[404]$, $\alpha=-1/2$ band. Band assignment in Adopted Levels differs; see comment on $5/2[402]$ bands.

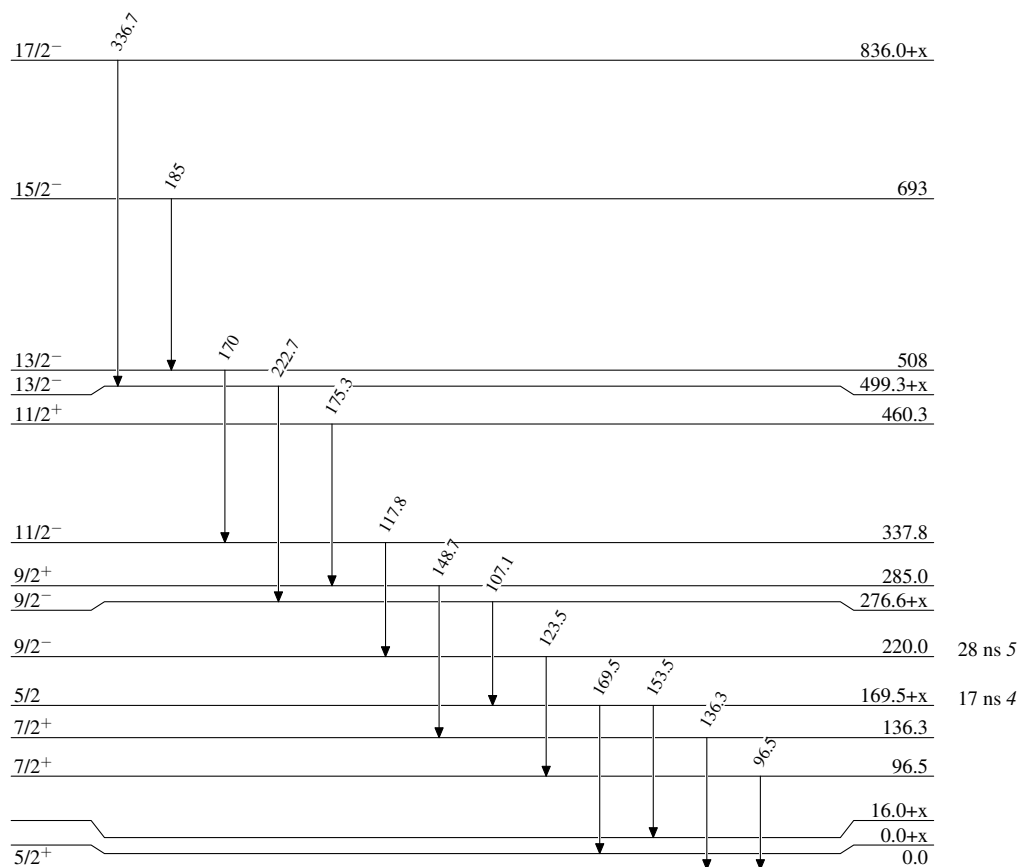
 $\gamma(^{169}\text{Ta})$

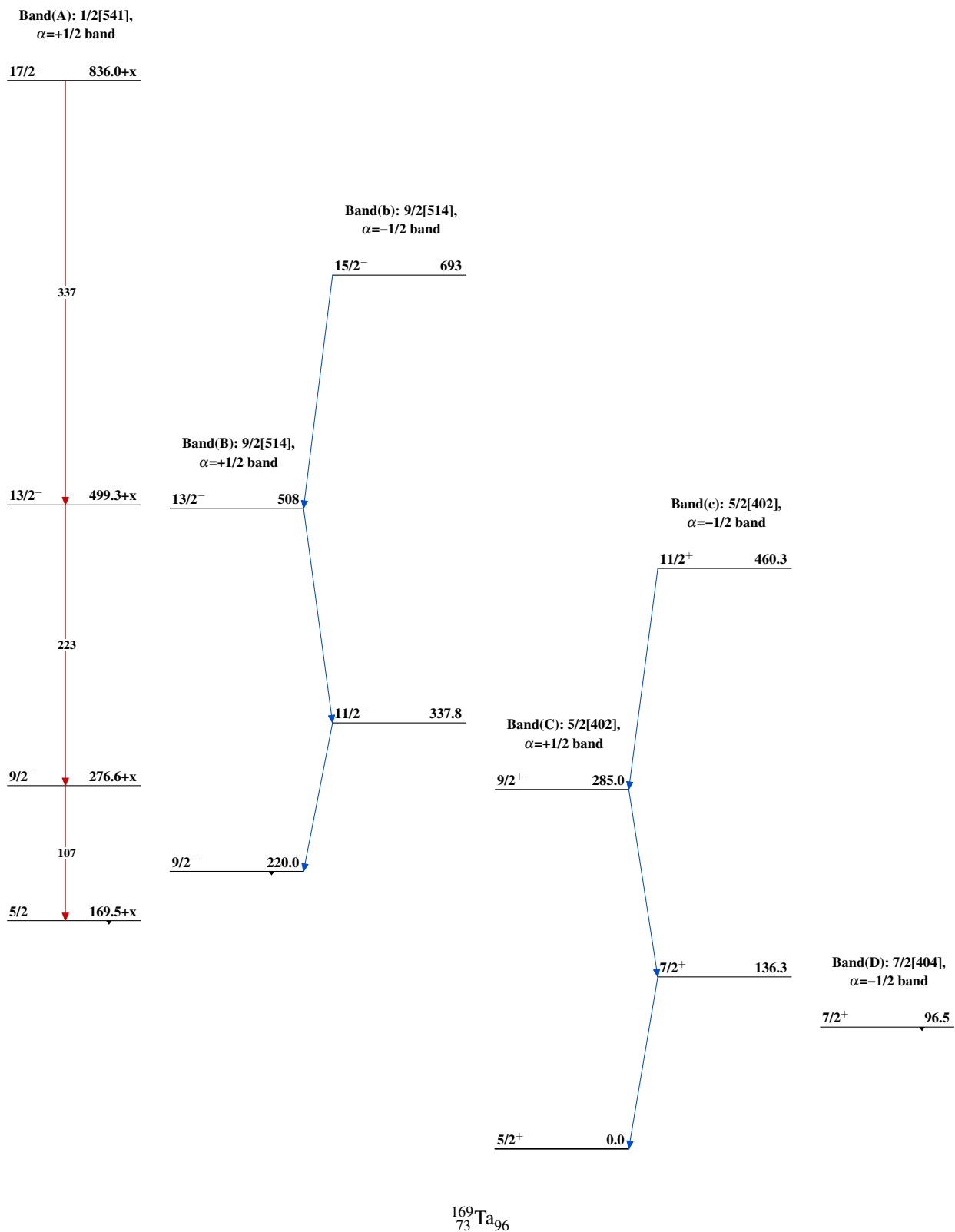
E_γ [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
96.5	96.5	$7/2^+$	0.0	$5/2^+$	
107.1	$276.6+x$	$9/2^-$	$169.5+x$	$5/2$	
117.8	337.8	$11/2^-$	220.0	$9/2^-$	
123.5	220.0	$9/2^-$	96.5	$7/2^+$	
136.3	136.3	$7/2^+$	0.0	$5/2^+$	
148.7	285.0	$9/2^+$	136.3	$7/2^+$	E_γ : a comparable $E_\gamma=148.4$ 2 from the 244.8 keV level in the adopted dataset.
153.5	$169.5+x$	$5/2$	$16.0+x$		
169.5	$169.5+x$	$5/2$	$0.0+x$		
170	508	$13/2^-$	337.8	$11/2^-$	
175.3	460.3	$11/2^+$	285.0	$9/2^+$	
185	693	$15/2^-$	508	$13/2^-$	
222.7	$499.3+x$	$13/2^-$	$276.6+x$	$9/2^-$	
336.7	$836.0+x$	$17/2^-$	$499.3+x$	$13/2^-$	

[†] From [1998Zh17](#); authors do not state uncertainty in E_γ .

$^{159}\text{Tb}(^{16}\text{O},6n\gamma)$ 2005Ku40,1998Zh17,1998Zh03

Level Scheme

 $^{169}_{73}\text{Ta}_{96}$

$^{159}\text{Tb}(^{16}\text{O},6n\gamma)$ 2005Ku40,1998Zh17,1998Zh03

Adopted Levels, Gammas

$Q(\beta^-) = -6509$ 19; $S(n) = 8096$ 20; $S(p) = 3.81 \times 10^3$ 3; $Q(\alpha) = 4.29 \times 10^3$ 3 [2021Wa16](#)

Identification: cross bombardments, excitation functions, and x-ray coincidence data for ^{36}Ar , ^{40}Ar bombardments of Cs, Ba, La, and Pr ([1987ScZL](#)).

 ^{169}W LevelsCross Reference (XREF) Flags

A ^{169}Re ε decay (8.1 s)
B ^{173}Os α decay
C $^{154}\text{Gd}(^{20}\text{Ne}, 5n\gamma)$

E(level) [†]	J $\pi^{\ddagger}$	T _{1/2}	XREF	Comments
0.0 [#]	(5/2 ⁻)	75 s 6	B	$\% \varepsilon + \% \beta^+ = 100$ $\% \varepsilon + \% \beta^+$: only ε decay has been observed. $\% \alpha \approx 0.01$ can be estimated from extrapolation of $\log T_{1/2}(\alpha)$ versus $\log Q(\alpha)$ for ^{159}W , ^{161}W , ^{163}W . J π : systematics for N=95 isotones strongly favor a 5/2 ⁻ 5/2[523] g.s. for ^{169}W , as for ^{163}Er , ^{165}Yb , ^{167}Hf , ^{171}Os . However, the expected allowed unhindered ε decay from this state to a π 7/2[523] level in ^{169}Ta has not been identified as yet. Other low-lying orbitals are expected to be 5/2[642] and 3/2[651] (1985Re06). Hindrance factor from 5/2 ⁻ is 0.36 in ^{173}Os α decay, if the α decay branching of ^{173}Os is 0.4% 2. Also, the expected allowed unhindered ε decay from this state to a π 7/2[523] level in ^{169}Ta has not been identified yet. T _{1/2} : weighted average of 55 s 10 (1987Es08 , 1989Br19), 76 s 6 from $170\gamma(t)$ (1990Me12), and 80 s 6 (1992HeZV). Unweighted average of these data is 70 s 8.
0.0+x [#]	(9/2 ⁻)		A C	
0.0+y [@]	(13/2 ⁺)		C	J π : bandhead for strongly decoupled band, similar to i _{13/2} $\pi=+$ bands in other N=95 nuclei (^{163}Er , ^{165}Yb , ^{167}Hf).
145.3+x 2	(11/2 ⁻)		A C	
208.6+y [@] 3	(17/2 ⁺)		C	
327.1+x [#] 2	(13/2 ⁻)		C	
576.0+y [@] 4	(21/2 ⁺)		C	
734.3+x [#] 4	(17/2 ⁻)		C	
1063.6+y [@] 5	(25/2 ⁺)		C	
1176.0+x [#] 5	(21/2 ⁻)		C	
1422.6+y ^{&} 6	(23/2 ⁻)		C	J π : bandhead for $\pi=(-)$ side band; 23/2 ⁻ for lowest-energy level observed is based on level systematics for N=95 isotones.
1615.1+x [#] 6	(25/2 ⁻)		C	
1639.0+y [@] 6	(29/2 ⁺)		C	
1759.1+y ^{&} 6	(27/2 ⁻)		C	
2019.2+x [#] 7	(29/2 ⁻)		C	
2160.9+y ^{&} 7	(31/2 ⁻)		C	
2269.4+y [@] 7	(33/2 ⁺)		C	
2434.5+x [#] 7	(33/2 ⁻)		C	
2597.8+y ^{&} 8	(35/2 ⁻)		C	
2893.4+y [@] 7	(37/2 ⁺)		C	
2899.8+x [#] 8	(37/2 ⁻)		C	
3099.7+y ^{&} 8	(39/2 ⁻)		C	
3452.7+x [#] 8	(41/2 ⁻)		C	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

¹⁶⁹W Levels (continued)

E(level) [†]	J ^π [‡]	XREF	E(level) [†]	J ^π [‡]	XREF	E(level) [†]	J ^π [‡]	XREF
3475.2+y [@] 8	(41/2 ⁺)	C	4790.5+x [#] 11	(49/2 ⁻)	C	5784.0+y ^{&} 13	(55/2 ⁻)	C
3678.3+y ^{&} 9	(43/2 ⁻)	C	4849.4+y [@] 9	(49/2 ⁺)	C	6354.9+x [#] 14	(57/2 ⁻)	C
4088.9+x [#] 9	(45/2 ⁻)	C	5027.8+y ^{&} 11	(51/2 ⁻)	C	6568.4+y [@] 10	(57/2 ⁺)	C
4116.1+y [@] 9	(45/2 ⁺)	C	5546.2+x [#] 12	(53/2 ⁻)	C	6594.9+y ^{&} 14	(59/2 ⁻)	C
4324.7+y ^{&} 9	(47/2 ⁻)	C	5671.3+y [@] 10	(53/2 ⁺)	C	7224+x [#] 14	(61/2 ⁻)	C

[†] From least-squares fit to E_γ. 1985Re06 estimate the energy offset “y” to be <100 keV.

[‡] From coincidence data, rotational structure, and γ-ray multipolarities in ¹⁵⁴Gd(²⁰Ne,5nγ), except where noted.

Band(A): 5/2[523] band.

@ Band(B): i_{13/2} π=+ band.

& Band(C): π=(-) side band.

γ(¹⁶⁹W)

E _i (level)	J ^π _i	E _γ [†]	I _γ [‡]	E _f	J ^π _f	Mult. [#]	α [@]	Comments
145.3+x	(11/2 ⁻)	145.3 2	100	0.0+x	(9/2 ⁻)	(M1+E2)	1.29 35	E _γ : from ¹⁶⁹ Re ε decay. See ¹⁵⁴ Gd(²⁰ Ne,5nγ) for comment regarding order of 145.3γ and 181.7γ.
208.6+y	(17/2 ⁺)	208.6 3	100	0.0+y	(13/2 ⁺)	(E2)	0.268 4	See ¹⁵⁴ Gd(²⁰ Ne,5nγ) for comment regarding order of 145.3γ and 181.7γ.
327.1+x	(13/2 ⁻)	181.7 3	65 27	145.3+x	(11/2 ⁻)	(M1+E2)	0.65 22	
		327.1 3	100 40	0.0+x	(9/2 ⁻)	(E2)	0.0659 9	
576.0+y	(21/2 ⁺)	367.4 3	100	208.6+y	(17/2 ⁺)	(E2)	0.0473 7	
734.3+x	(17/2 ⁻)	407.2 3	100	327.1+x	(13/2 ⁻)	(E2)	0.0357 5	
1063.6+y	(25/2 ⁺)	487.6 3	100	576.0+y	(21/2 ⁺)	(E2)	0.02235 31	
1176.0+x	(21/2 ⁻)	441.7 3	100	734.3+x	(17/2 ⁻)	(E2)	0.0288 4	
1422.6+y	(23/2 ⁻)	846.6 6	100	576.0+y	(21/2 ⁺)			
1615.1+x	(25/2 ⁻)	439.1 3	100	1176.0+x	(21/2 ⁻)	(E2)	0.0292 4	
1639.0+y	(29/2 ⁺)	575.4 3	100	1063.6+y	(25/2 ⁺)	(E2)	0.01493 21	
1759.1+y	(27/2 ⁻)	336.5 3	100 21	1422.6+y	(23/2 ⁻)	(E2)	0.0607 9	
		695.5 6	<74	1063.6+y	(25/2 ⁺)			
2019.2+x	(29/2 ⁻)	404.1 3	100	1615.1+x	(25/2 ⁻)	(E2)	0.0364 5	
2160.9+y	(31/2 ⁻)	401.8 3	100	1759.1+y	(27/2 ⁻)	(E2)	0.0370 5	
2269.4+y	(33/2 ⁺)	630.4 3	100	1639.0+y	(29/2 ⁺)	(E2)	0.01207 17	
2434.5+x	(33/2 ⁻)	415.3 3	100	2019.2+x	(29/2 ⁻)	(E2)	0.0339 5	
2597.8+y	(35/2 ⁻)	436.9 3	100	2160.9+y	(31/2 ⁻)	(E2)	0.0296 4	
2893.4+y	(37/2 ⁺)	624.0 3	100	2269.4+y	(33/2 ⁺)	(E2)	0.01236 17	
2899.8+x	(37/2 ⁻)	465.3 3	100	2434.5+x	(33/2 ⁻)	(E2)	0.02517 35	
3099.7+y	(39/2 ⁻)	501.9 3	100	2597.8+y	(35/2 ⁻)	(E2)	0.02079 29	
3452.7+x	(41/2 ⁻)	552.9 3	100	2899.8+x	(37/2 ⁻)	(E2)	0.01642 23	
3475.2+y	(41/2 ⁺)	581.8 3	100	2893.4+y	(37/2 ⁺)	(E2)	0.01454 20	
3678.3+y	(43/2 ⁻)	578.6 3	100	3099.7+y	(39/2 ⁻)	(E2)	0.01473 21	
4088.9+x	(45/2 ⁻)	636.2 3	100	3452.7+x	(41/2 ⁻)	(E2)	0.01182 17	
4116.1+y	(45/2 ⁺)	640.9 3	100	3475.2+y	(41/2 ⁺)	(E2)	0.01162 16	
4324.7+y	(47/2 ⁻)	646.4 3	100	3678.3+y	(43/2 ⁻)	(E2)	0.01140 16	
4790.5+x	(49/2 ⁻)	701.6 6	100	4088.9+x	(45/2 ⁻)	[E2]	0.00949 13	
4849.4+y	(49/2 ⁺)	733.3 3	100	4116.1+y	(45/2 ⁺)	(E2)	0.00861 12	
5027.8+y	(51/2 ⁻)	703.1 6	100	4324.7+y	(47/2 ⁻)	[E2]	0.00944 13	
5546.2+x	(53/2 ⁻)	755.7 6	100	4790.5+x	(49/2 ⁻)	[E2]	0.00807 11	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{169}\text{W})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [#]	$\alpha^\text{@}$
5671.3+y	(53/2 ⁺)	821.9 3	100	4849.4+y	(49/2 ⁺)	(E2)	0.00674 9
5784.0+y	(55/2 ⁻)	756.2 6	100	5027.8+y	(51/2 ⁻)	[E2]	0.00806 11
6354.9+x	(57/2 ⁻)	808.7 6	100	5546.2+x	(53/2 ⁻)	[E2]	0.00698 10
6568.4+y	(57/2 ⁺)	897.1 3	100	5671.3+y	(53/2 ⁺)	(E2)	0.00562 8
6594.9+y	(59/2 ⁻)	810.9 6	100	5784.0+y	(55/2 ⁻)		
7224+x?	(61/2 ⁻)	869 ^{&}	100	6354.9+x	(57/2 ⁻)		

[†] From $^{154}\text{Gd}(^{20}\text{Ne}, 5n\gamma)$, except as noted.

[‡] Relative photon branching from each level; intensities are from $^{154}\text{Gd}(^{20}\text{Ne}, 5n\gamma)$.

[#] From $\gamma(\theta)$ in $^{154}\text{Gd}(^{20}\text{Ne}, 5n\gamma)$, except as noted, assigning $\Delta\pi=(\text{no})$ for intraband transitions.

[@] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with "Frozen Orbitals" approximation based on γ -ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

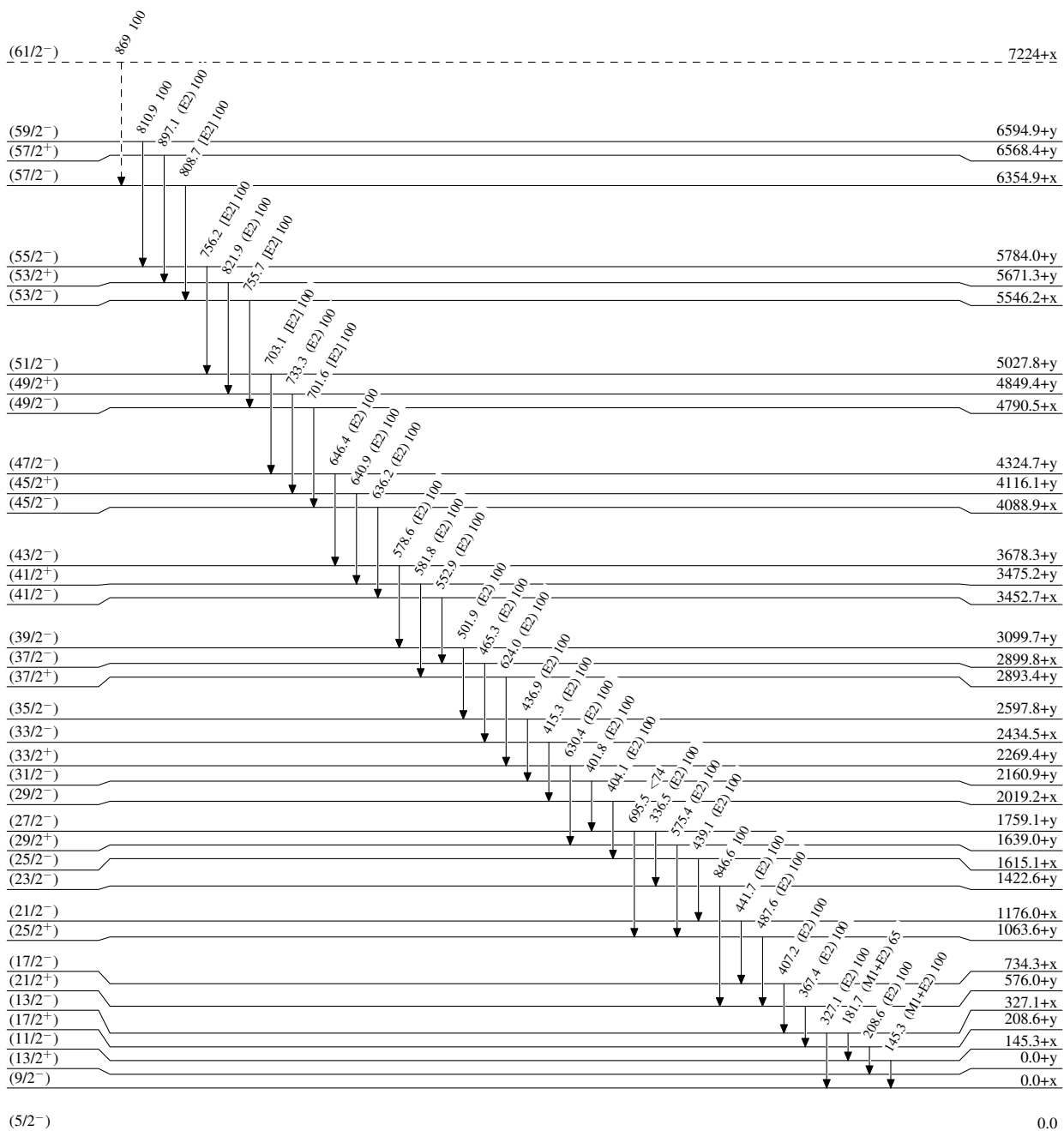
[&] Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

Legend

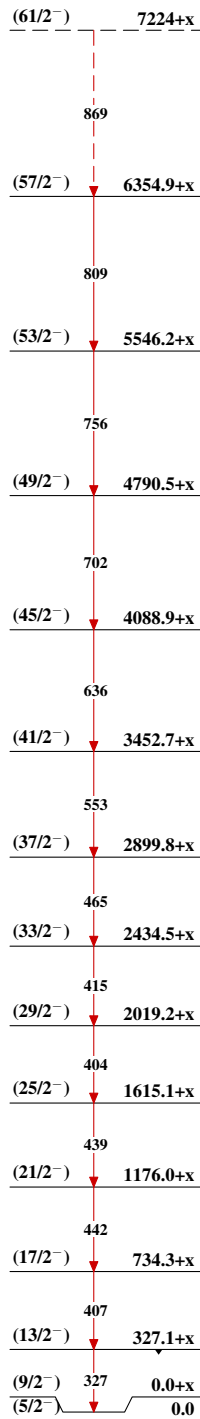
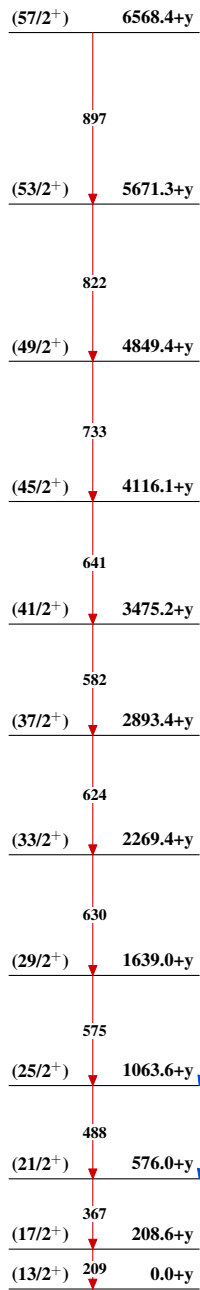
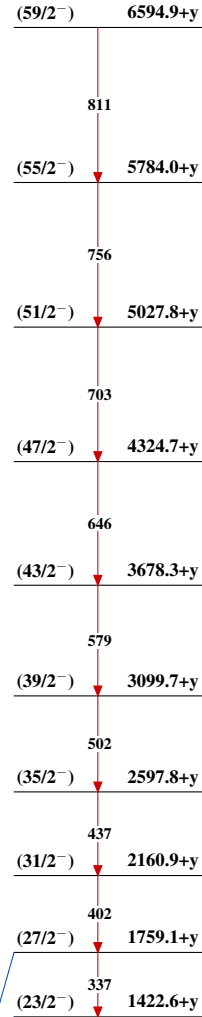
Level Scheme

Intensities: Relative photon branching from each level

 - - - - - $\blacktriangleright$ γ Decay (Uncertain)


Adopted Levels, Gammas

Band(A): 5/2[523] band

Band(B): $i_{13/2}$ $\pi=+$ bandBand(C): $\pi=(-)$ side band

^{169}Re $\varepsilon+\beta^+$ decay (8.1 s) [1992Me10](#)

Parent: ^{169}Re : $E=0.0$; $J^\pi=(9/2^-)$; $T_{1/2}=8.1$ s 5; $Q(\varepsilon)=6509$ 19; $\% \varepsilon + \% \beta^+$ decay ≈ 100

^{169}Re - $J^\pi, T_{1/2}$: from ^{169}Re Adopted Levels.

^{169}Re - $Q(\varepsilon)$: from [2021Wa16](#).

[1992Me10](#): sources produced by $^{141}\text{Pr}+^{32}\text{S}$, $E(^{32}\text{S})\approx 178$ MeV; measured E_γ , I_γ , $\gamma\gamma$ coin, $\gamma(t)$, γ and α excitation functions.

Insufficient information was obtained by [1992Me10](#) to enable them to construct a decay scheme, primarily because the 101 γ is a doublet. See [1992Me10](#) for detailed $\gamma\gamma$ coin information.

 ^{169}W Levels

<u>E(level)</u>	<u>$J^\pi^\dagger$</u>
0.0+x	(9/2 $^-$)
145.3+x 3	(11/2 $^-$)

† From Adopted Levels.

 $\gamma(^{169}\text{W})$

I_γ normalization: decay scheme is incomplete and so it is not normalized.

With the exception of the 124 γ and 361 γ , all lines observed by [1992Me10](#) are coincident with W x rays, and all but the 124 γ are coincident with a 101 γ .

<u>E_γ</u>	<u>$I_\gamma^\dagger$</u>	<u>$E_i(\text{level})$</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.</u>	<u>$\alpha^\ddagger$</u>	<u>Comments</u>
$^{x26.5}$	33 2							
$^{x101.2}$ 2	100							Doublet; γ is self-coincident. Assigned to ^{169}Re ε decay based on measured 101 γ excitation function (1992Me10).
$^{x123.7}$ 4	≈ 10							
145.3 2	17 3	145.3+x	(11/2 $^-$)	0.0+x	(9/2 $^-$)	(M1+E2)	1.29 35	Mult.: from Adopted Gammas. Placed in accord with adopted placement of a 145 γ from the ($^{20}\text{Ne}, 5n\gamma$) study in 1985Re06 .
$^{x210.9}$ 2	20 3							
$^{x254.1}$ 4	14 1							
$^{x360.5}$ 4	5 1							
$^{x392.6}$ 2	14 2							
$^{x492.9}$ 2	11 2							
$^{x1054.1}$ 4	15 2							

† Photon intensity relative to $I_\gamma=100$ for the 101-keV doublet.

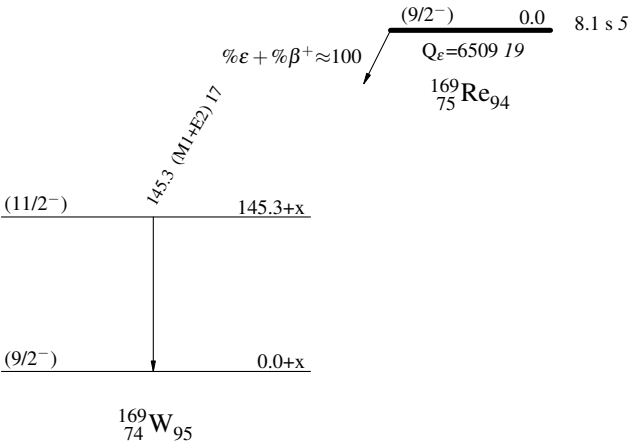
‡ Total theoretical internal conversion coefficients, calculated using the BrIcc code ([2008Ki07](#)) with "Frozen Orbitals" approximation based on γ -ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

^{x} γ ray not placed in level scheme.

^{169}Re $\epsilon+\beta^+$ decay (8.1 s) **1992Me10**

Decay Scheme

Intensities: Relative I_γ



^{173}Os α decay [1995Hi02](#), [1971Bo06](#)

Parent: ^{173}Os : $E=0.0$; $J^\pi=5/2^-$; $T_{1/2}=22.4$ s 9; $Q(\alpha)=5055$ 6; $\% \alpha$ decay=0.4 2

^{173}Os - $J^\pi, T_{1/2}$: from ^{173}Os Adopted Levels in the ENSDF database (update).

^{173}Os - $Q(\alpha)$: from [2021Wa16](#).

^{173}Os - $\% \alpha$ decay: $\% \alpha=0.4$ 2 ([1995Hi02](#)) from ^{173}Os Adopted Levels in the ENSDF database (update). Other: 0.021 +13-5 ([1971Bo06](#)).

[1995Hi02](#): sources from $^{140}\text{Ce}(^{36}\text{Ar}, 3n)$, $E=178, 185$ MeV; measured $E\alpha$, $I\alpha$, $E\gamma$, $\alpha(t)$, $\gamma(t)$, $\% \alpha(^{173}\text{Os})$.

[1971Bo06](#): Sources from $^{164}\text{Er}(^{16}\text{O}, 7n)$ ($E(^{16}\text{O})=110-160$ MeV, helium-jet transport); erbium oxide targets enriched to 62.7% in ^{164}Er ; measured $E\alpha$, $I\alpha$ (silicon detectors), excitation functions.

Parent $T_{1/2}=22.4$ s 9 ([1995Hi02](#)); other: 16 s 5 ([1971Bo06](#)).

 ^{169}W Levels

<u>E(level)</u>	<u>$J^\pi^\dagger$</u>	<u>$T_{1/2}^\dagger$</u>
0.0	(5/2 ⁻)	75 s 6

[†] From Adopted Levels.

 α radiations

<u>$E\alpha$</u>	<u>E(level)</u>	<u>$I\alpha^\ddagger$</u>	<u>HF[†]</u>	<u>Comments</u>
4939 6	0.0	100	0.36 19	$E\alpha$: weighted average of 4940 10 (1971Bo06) and 4938 7 (1995Hi02). $E\alpha=4939$ 6 implies $Q(\alpha)=5056$ 6, assuming a g.s. to g.s. transition, cf. 5055 6 from 2021Wa16 .

[†] The nuclear radius parameter $r_0(^{169}\text{W})=1.562$ 24 is deduced from interpolation (or unweighted average) of radius parameters of the adjacent even-even nuclides: $^{168}\text{W}=1.583$ 13 and $^{170}\text{W}=1.540$ 34 in [2020Si16](#).

[‡] For absolute intensity per 100 decays, multiply by 0.004 2.

$^{154}\text{Gd}(^{20}\text{Ne}, 5n\gamma)$ 1985Re06

Slightly edited, no significant changes compared to that in the previous evaluation (2008Ba31) by C.M. Baglin.

$E(^{20}\text{Ne})=105\text{--}125$ MeV; metallic Gd targets enriched to 97% in ^{154}Gd , evaporation-residue separation; measured $E\gamma$, $I\gamma$ (Ge,

Ge(Li), NaI detectors, high-spin filter, bismuth germanate anti-Compton shield), $\gamma\gamma$ coin, γ -ray angular distributions (5 angles from 0° to 90°). Used pairing-self-consistent cranking model to interpret level structure.

See 1985Re06 for tentative assignment of an additional weak band to ^{169}W .

 ^{169}W Levels

E(level) [†]	J^π [‡]	Comments
0.0+x [#]	(9/2 ⁻)	E(level): unknown in 1985Re06.
0.0+y [@]	13/2 ⁺	E(level): 1985Re06 estimate “y” to be <100 keV.
145.3+x ³	(11/2 ⁻)	
208.6+y ^{@ 3}	17/2 ⁺	
327.1+x ^{# 3}	(13/2 ⁻)	
576.0+y ^{@ 4}	21/2 ⁺	
734.3+x ^{# 4}	(17/2 ⁻)	
1063.6+y ^{@ 5}	25/2 ⁺	
1176.0+x ^{# 5}	(21/2 ⁻)	
1422.6+y ^{& 6}	(23/2 ⁻)	
1615.1+x ^{# 6}	(25/2 ⁻)	
1639.0+y ^{@ 6}	29/2 ⁺	
1759.1+y ^{& 6}	(27/2 ⁻)	
2019.2+x ^{# 7}	(29/2 ⁻)	
2160.9+y ^{& 7}	(31/2 ⁻)	
2269.4+y ^{@ 7}	33/2 ⁺	
2434.5+x ^{# 7}	(33/2 ⁻)	
2597.8+y ^{& 8}	(35/2 ⁻)	
2893.4+y ^{@ 7}	37/2 ⁺	
2899.8+x ^{# 8}	(37/2 ⁻)	
3099.7+y ^{& 8}	(39/2 ⁻)	
3452.7+x ^{# 8}	(41/2 ⁻)	
3475.2+y ^{@ 8}	41/2 ⁺	
3678.3+y ^{& 9}	(43/2 ⁻)	
4088.9+x ^{# 9}	(45/2 ⁻)	
4116.1+y ^{@ 9}	45/2 ⁺	
4324.7+y ^{& 9}	(47/2 ⁻)	
4790.5+x ^{# 11}	(49/2 ⁻)	
4849.4+y ^{@ 9}	49/2 ⁺	
5027.8+y ^{& 11}	(51/2 ⁻)	
5546.2+x ^{# 12}	(53/2 ⁻)	
5671.3+y ^{@ 10}	53/2 ⁺	
5784.0+y ^{& 13}	(55/2 ⁻)	
6354.9+x ^{# 14}	(57/2 ⁻)	
6568.4+y ^{@ 10}	57/2 ⁺	
6594.9+y ^{& 14}	(59/2 ⁻)	
7224+x ^{#?}	(61/2 ⁻)	

Continued on next page (footnotes at end of table)

¹⁵⁴Gd(²⁰Ne,5nγ) **1985Re06** (continued)

¹⁶⁹W Levels (continued)

† From least-squares fit to E_γ.

‡ Authors' values, based on coincidence data, rotational-band structure, and γ-ray multipolarities. In Adopted Levels, Gammas, all assignments are given in parentheses.

Band(A): 5/2[523] band.

@ Band(B): i_{13/2} π=+ band.

& Band(C): π=(-) side band.

<u>γ(¹⁶⁹W)</u>							Comments
E _γ	I _γ [‡]	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. [@]	
145.3 3	4.6 19	145.3+x	(11/2 ⁻)	0.0+x	(9/2 ⁻)	D(+Q)	A ₂ =-0.14 9 E _γ : in Table 2 (measured ¹⁶⁹ W transition properties) and Figure 5 (¹⁶⁹ W level drawing) in 1985Re06 show interchanged order for 145.3γ and 181.7γ; evaluator assumes Figure 5 to be correct.
181.7 3	3.4 14	327.1+x	(13/2 ⁻)	145.3+x	(11/2 ⁻)	D(+Q)	A ₂ =-0.15 10 See comment with 145.3γ.
208.6 3	119 24	208.6+y	17/2 ⁺	0.0+y	13/2 ⁺	Q	A ₂ =+0.23 2; A ₄ =-0.05 3
327.1 † 3	5.2 21	327.1+x	(13/2 ⁻)	0.0+x	(9/2 ⁻)	(Q)	A ₂ =+0.21 9
336.5 3	19 # 4	1759.1+y	(27/2 ⁻)	1422.6+y	(23/2 ⁻)	Q	A ₂ =+0.22 8; A ₄ =-0.08 5
367.4 † 3	100 20	576.0+y	21/2 ⁺	208.6+y	17/2 ⁺	Q	A ₂ =+0.31 3; A ₄ =-0.10 5
401.8 3	26 5	2160.9+y	(31/2 ⁻)	1759.1+y	(27/2 ⁻)	Q	A ₂ =+0.29 4; A ₄ =-0.08 5
404.1 3	15 3	2019.2+x	(29/2 ⁻)	1615.1+x	(25/2 ⁻)	Q	A ₂ =+0.27 6; A ₄ =-0.09 7
407.2 3	13 5	734.3+x	(17/2 ⁻)	327.1+x	(13/2 ⁻)	Q	A ₂ =+0.36 6; A ₄ =-0.01 7
415.3 3	18 4	2434.5+x	(33/2 ⁻)	2019.2+x	(29/2 ⁻)	Q	A ₂ =+0.25 6; A ₄ =-0.009 7
436.9 3	24 5	2597.8+y	(35/2 ⁻)	2160.9+y	(31/2 ⁻)	Q	A ₂ =+0.25 6; A ₄ =-0.03 7
439.1 3	15 # 3	1615.1+x	(25/2 ⁻)	1176.0+x	(21/2 ⁻)	(Q)	A ₂ =+0.30 5
441.7 3	14 # 6	1176.0+x	(21/2 ⁻)	734.3+x	(17/2 ⁻)	(Q)	A ₂ =+0.13 6
465.3 3	25 5	2899.8+x	(37/2 ⁻)	2434.5+x	(33/2 ⁻)	Q	A ₂ =+0.36 3; A ₄ =-0.07 4
487.6 3	91 18	1063.6+y	25/2 ⁺	576.0+y	21/2 ⁺	Q	A ₂ =+0.31 3; A ₄ =-0.10 4
501.9 3	20 4	3099.7+y	(39/2 ⁻)	2597.8+y	(35/2 ⁻)	Q	A ₂ =+0.32 3; A ₄ =-0.05 4
552.9 3	24 5	3452.7+x	(41/2 ⁻)	2899.8+x	(37/2 ⁻)	Q	A ₂ =+0.35 5; A ₄ =-0.09 6
575.4 † 3	75 15	1639.0+y	29/2 ⁺	1063.6+y	25/2 ⁺	Q	A ₂ =+0.35 5; A ₄ =-0.13 6
578.6 † 3	17 3	3678.3+y	(43/2 ⁻)	3099.7+y	(39/2 ⁻)	Q	A ₂ =+0.30 6; A ₄ =-0.13 7
581.8 3	38 8	3475.2+y	41/2 ⁺	2893.4+y	37/2 ⁺	Q	A ₂ =+0.36 6; A ₄ =-0.11 7
624.0 3	44 9	2893.4+y	37/2 ⁺	2269.4+y	33/2 ⁺	Q	A ₂ =+0.36 6; A ₄ =-0.12 7
630.4 † 3	53 11	2269.4+y	33/2 ⁺	1639.0+y	29/2 ⁺	Q	A ₂ =+0.36 5; A ₄ =-0.11 6
636.2 3	14 6	4088.9+x	(45/2 ⁻)	3452.7+x	(41/2 ⁻)	Q	A ₂ =+0.36 5; A ₄ =-0.10 6
640.9 3	26 5	4116.1+y	45/2 ⁺	3475.2+y	41/2 ⁺	Q	A ₂ =+0.30 7; A ₄ =-0.04 8
646.4 † 3	15 3	4324.7+y	(47/2 ⁻)	3678.3+y	(43/2 ⁻)	Q	A ₂ =+0.30 7; A ₄ =-0.13 8
695.5 6	10 # 4	1759.1+y	(27/2 ⁻)	1063.6+y	25/2 ⁺		Contaminated by transition in ¹⁷⁰ W.
701.6 6	12 # 5	4790.5+x	(49/2 ⁻)	4088.9+x	(45/2 ⁻)		A ₂ =+0.27 5, A ₄ =-0.09 7 for doublet.
703.1 6	14 # 6	5027.8+y	(51/2 ⁻)	4324.7+y	(47/2 ⁻)		A ₂ =+0.27 5, A ₄ =-0.09 7 for doublet.
733.3 3	13 5	4849.4+y	49/2 ⁺	4116.1+y	45/2 ⁺	Q	A ₂ =+0.26 5; A ₄ =-0.13 6
755.7 6	7 # 3	5546.2+x	(53/2 ⁻)	4790.5+x	(49/2 ⁻)		A ₂ =+0.36 6, A ₄ =-0.12 for doublet.
756.2 6	10 # 4	5784.0+y	(55/2 ⁻)	5027.8+y	(51/2 ⁻)		A ₂ =+0.36 6, A ₄ =-0.12 for doublet.
808.7 6	4.3 # 17	6354.9+x	(57/2 ⁻)	5546.2+x	(53/2 ⁻)		A ₂ =+0.27 8 for doublet.
810.9 † 6	6.7 # 27	6594.9+y	(59/2 ⁻)	5784.0+y	(55/2 ⁻)		A ₂ =+0.27 8 for doublet.
821.9 3	7 3	5671.3+y	53/2 ⁺	4849.4+y	49/2 ⁺	(Q)	A ₂ =+0.35 8
846.6 6	17 # 3	1422.6+y	(23/2 ⁻)	576.0+y	21/2 ⁺		Contaminated by transition in ⁵⁶ Fe.

Continued on next page (footnotes at end of table)

$^{154}\text{Gd}(^{20}\text{Ne}, 5n\gamma)$ **1985Re06 (continued)** $\gamma(^{169}\text{W})$ (continued)

E_γ	$I_\gamma^\ddagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [@]	Comments
869 ^{&}	≈ 2	7224+x?	(61/2 ⁻)	6354.9+x	(57/2 ⁻)		
897.1 3	6.5 26	6568.4+y	57/2 ⁺	5671.3+y	53/2 ⁺	(Q)	$A_2 = +0.13$ 9

[†] Table 2 (measured ^{169}W transition properties) and Figure 5 (^{169}W level drawing) in **1985Re06** show slightly different energy values; evaluator assumes Table 2 to be correct.

[‡] Arbitrary units for $E(^{20}\text{Ne})=125$ MeV; $\Delta I_\gamma=20\%$ for strong lines (estimated by evaluator to be those with $I_\gamma \geq 15$), and 40% for weak lines and doublets.

[#] Obtained from coincidence projection spectra.

[@] Inferred from γ -ray angular distributions, listed in the comments.

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

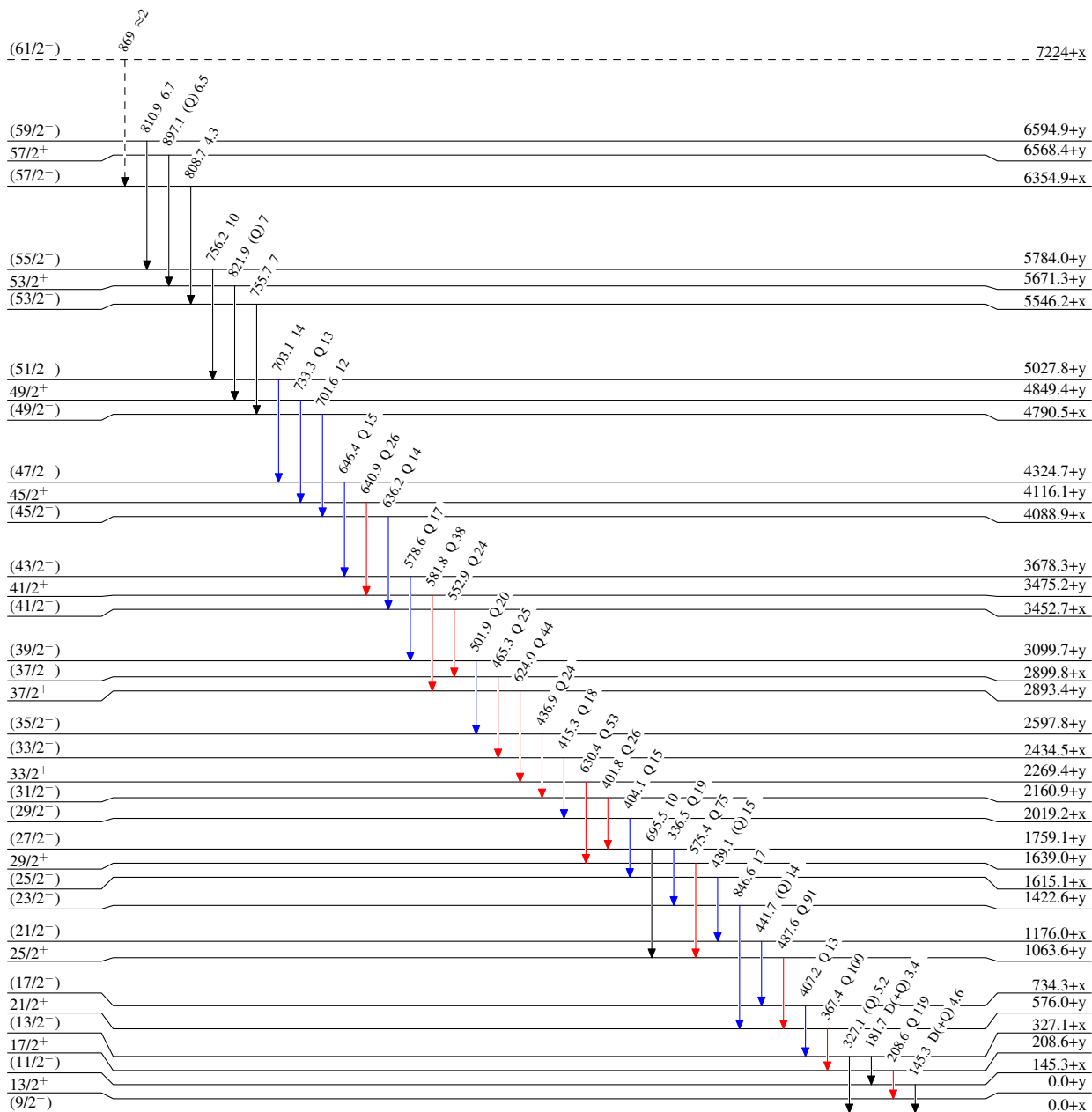
$^{154}\text{Gd}(^{20}\text{Ne}, 5n\gamma)$ 1985Re06

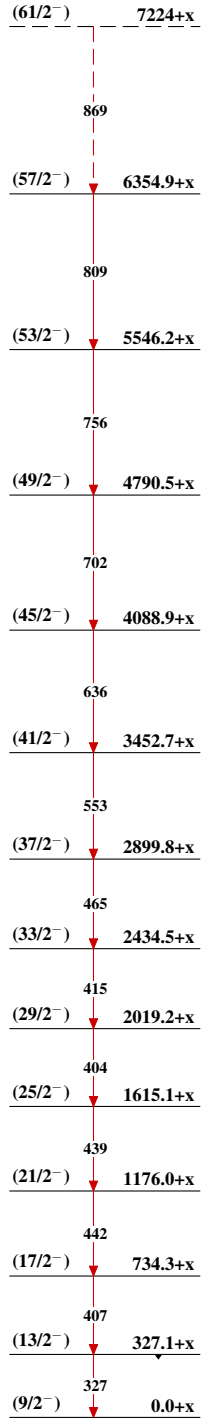
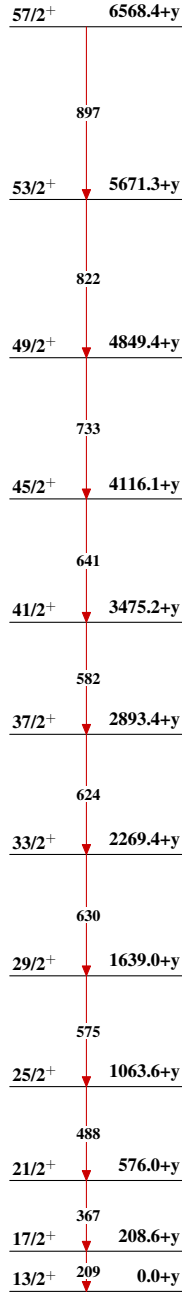
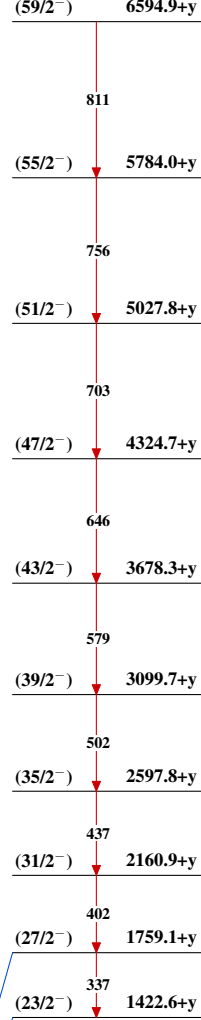
Legend

Level Scheme

 Intensities: relative I_γ for $E(^{20}\text{Ne})=125$ MeV

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$
- - - γ Decay (Uncertain)



$^{154}\text{Gd}(^{20}\text{Ne}, 5n\gamma)$ 1985Re06Band(A): $5/2[523]$ bandBand(B): $i_{13/2} \pi=+$ bandBand(C): $\pi=(-)$ side band $^{169}_{74}\text{W}_{95}$

Adopted Levels, Gammas

$Q(\beta^-) = -7686$ 28; $S(n) = 10690$ 30; $S(p) = 805$ 16; $Q(\alpha) = 5014$ 13 2021Wa16

$S(2n) = 19720$ 40 (syst), $S(2p) = 4640$ 30, $Q(\varepsilon p) = 2700$ 30 (2021Wa16).

Identification: ^{169}Re is known as the α -decay parent of ^{165}Ta and the α -decay daughter of ^{173}Ir . See comment below for assignment of ^{169}Re (15.1 s) to an isomer.

Theory (partial list):

2011Pr17: calculation of band structure and deformation using deformed Hartree-Fock and angular momentum projection theory.

Notation for quasiparticle orbits:

ν $i_{13/2}$: A, B, C, D.

ν $h_{9/2}$: E, F.

π $h_{11/2}$: E_p , F_p .

 ^{169}Re LevelsCross Reference (XREF) Flags

- A ^{173}Ir α decay (9.3 s)
 B ^{173}Ir α decay (2.16 s)
 C $^{118}\text{Sn}(^{55}\text{Mn}, 4n\gamma)$
 D $^{144}\text{Sm}(^{28}\text{Si}, p2n\gamma)$

E(level) [†]	J^π [‡]	$T_{1/2}$	XREF	Comments
0.0 [@]	(9/2 ⁻)	8.1 s 5	BCD	$\% \varepsilon + \% \beta^+ \approx 100$; $\% \alpha < 0.01$ $\% \alpha$: ≈ 0.01 to 0.001 (1992Me10). Both α and $\varepsilon + \beta^+$ decays were observed by 1992Me10. J^π : possible 9/2[514] bandhead, analogous to ^{171}Re ; M1+E2 intraband 136 γ from (11/2 ⁻) 136 level. $T_{1/2}$: weighted average of 6.6 s 9 from 4700 α (t) (1992Me10) and 8.3 s 3 from 101 γ (t) (1992Me10).
118.93 ^d 33	(5/2 ⁺)		C	J^π : see comment on 5/2[402], $\alpha = +1/2$ band.
136.38 ^{&} 13	(11/2 ⁻)		BCD	J^π : HF=1.7 4 in α decay from (11/2 ⁻) ^{173}Ir . However, α decay parent state is suggested to be the 11/2[505] bandhead by 1992Sc16 (not the 11/2 ⁻ 9/2[514] state assigned here).
187 17	(1/2 ⁺ , 3/2 ⁺)	15.1 s 15	A	$\% \alpha \approx 0.2$; $\% \varepsilon + \% \beta^+ = ?$; $\% \text{IT} = ?$ E(level): from ^{173}Ir α decay (9.3 s). Level energy held fixed in least-squares adjustment; x=175 13 (2021Ko07). Identification: three-particle channels for ^{27}Al and ^{28}Si bombardment of ^{144}Sm show activity in second reaction only (1984Sc06); observation of same activity with Re compound nucleus (1978Ca11) confirms formation from $^{144}\text{Sm}(^{28}\text{Si}, p2n)$. Assignment to isomer based on systematics (1984Sc06). $\% \alpha$: estimated from extrapolation of $\log T_{1/2}(\alpha)$ versus $\log Q(\alpha)$. Only α decay observed, but other decay modes apparently dominate. $E\alpha = 5066$ keV 3 (1982De11), 5061 keV 10 (1992Me10), 5083 keV (2004GoZZ), and 5050 keV 10 (1984Sc06). J^π : fed in α decay (HF=1.2 6) from a possible 3/2[402] or 5/2[402] bandhead state (1992Sc16); parent state assigned (1/2 ⁺ , 3/2 ⁺) in 2001Ko44 and 2021Ha32 based on favored α decay from (1/2 ⁺ , 3/2 ⁺) ^{177}Au g.s. $T_{1/2}$: weighted average of 12.9 s 11 from 5050 α (t) in 1984Sc06 and 16.3 s 8 from 5061 α (t) in 1992Me10 (the unweighted average is 14.6 s 17).
215.88 32	(3/2)		CD	J^π : stretched D 320 γ from (5/2 ⁻) 535.98 level.
271.46 ^e 31	(7/2 ⁺)		CD	
278.78 24	(7/2)		C	J^π : D 355.0 γ , consistent with stretched D, from (9/2 ⁻) 633.78. (11/2) excluded from excitation energy consideration, i.e. J^π increases with excitation energy.
382.70 [@] 14	(13/2 ⁻)		CD	J^π : intraband D+Q 246.3 γ to (11/2 ⁻) and Q, $\Delta J = 2$ 382.8 γ to (9/2 ⁻) g.s..

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Re Levels (continued)

E(level) [†]	J ^π [‡]	XREF	Comments
447.81 30	(9/2 ⁺ , 7/2 ⁺)	C	J ^π : 328.9γ to (5/2 ⁺); 450.1γ from (13/2 ⁺ , 11/2 ⁺).
535.98 [#] 24	(5/2 ⁻)	CD	J ^π : bandhead assignment in 2002Zh42. For arguments see the band footnote.
622.53 ^{&} 16	(15/2 ⁻)	CD	J ^π : intraband D+Q, ΔJ=1 240.0γ to (13/2 ⁻); stretched Q intraband 486.1γ to (11/2 ⁻). 136.
633.78 [#] 14	(9/2 ⁻)	CD	J ^π : (D), ΔJ=(1) 497.4γ to (11/2 ⁻); intraband 98γ to (5/2 ⁻) 536. Only the 98-keV branch was reported in (²⁸ Si,p2nγ).
637.64 29	(11/2 ⁺ , 9/2 ⁺)	C	J ^π : 366.2γ to (7/2 ⁺); 484.1γ from (15/2 ⁺ , 13/2 ⁺).
886.85 [#] 15	(13/2 ⁻)	CD	J ^π : stretched Q 886.8γ to (9/2 ⁻) g.s..
897.99 27	(13/2 ⁺ , 11/2 ⁺)	C	J ^π : 260.4γ to (11/2 ⁺ , 9/2 ⁺), 450.1γ to (9/2 ⁺ , 7/2 ⁺).
940.05 [@] 17	(17/2 ⁻)	CD	J ^π : intraband stretched D 317.6γ to (15/2 ⁻) and stretched Q 557.4γ to (13/2 ⁻).
1121.71 27	(15/2 ⁺ , 13/2 ⁺)	C	J ^π : 223.7γ to (13/2 ⁺); 484.1γ to (11/2 ⁺ , 9/2 ⁺); 310.2γ from (17/2 ⁺).
1218.61 ^{&} 18	(19/2 ⁻)	CD	J ^π : intraband D+Q 278.6γ to (17/2 ⁻) and stretched Q 596.0γ to (15/2 ⁻).
1275.68 [#] 20	(17/2 ⁻)	CD	J ^π : intraband stretched Q 388.8γ to (13/2 ⁻).
1343.01 ^b 18	(15/2 ⁺)	CD	J ^π : stretched Q or D, ΔJ=0 720.5γ to (15/2 ⁻); 403.0γ to (17/2 ⁻), 960.2γ to (13/2 ⁻).
1431.90 ^a 21	(17/2 ⁺)	CD	J ^π : 310.2γ to (15/2 ⁺), 533.9γ to (13/2 ⁺), intraband 88.0γ to (15/2 ⁺).
1510.08 21		C	J ^π : 887.6γ to (15/2 ⁻); 1127.3γ to (13/2 ⁻).
1584.00 [@] 20	(21/2 ⁻)	CD	J ^π : intraband D+Q 365.4γ to (19/2 ⁻) and stretched Q 644.0γ to (17/2 ⁻).
1623.44 ^b 18	(17/2 ⁺)	CD	J ^π : stretched D 280.5γ to (15/2 ⁺); intraband stretched D 404.9γ to (19/2 ⁻). Differs from (19/2) proposed in (²⁸ Si,p2nγ).
1663.53 ^c 20	(17/2 ⁺)	C	J ^π : 387.8γ to (17/2 ⁻); 1041.0γ to (15/2 ⁻).
1764.87 [#] 25	(21/2 ⁻)	CD	J ^π : intraband stretched Q 489.2γ to (17/2 ⁻).
1799.34 ^a 19	(19/2 ⁺)	CD	J ^π : intraband stretched D 175.9γ to (17/2 ⁺); 215.3γ to (21/2 ⁻); D 859.3γ to (17/2 ⁻). Differs from (21/2 ⁺) proposed in (²⁸ Si,p2nγ).
1815.40 26		D	J ^π : 192.0γ to (17/2 ⁺) 1623; possible 107γ from (21/2 ⁺) 1922.18.
1882.38 ^{&} 22	(23/2 ⁻)	CD	J ^π : intraband stretched D 298.3γ to (21/2 ⁻); intraband stretched Q 663.7γ to (19/2 ⁻).
1922.18 ^b 27	(21/2 ⁺)	D	J ^π : intraband D 122.8γ to (19/2 ⁺); differs from 23/2 proposed in (²⁸ Si,p2nγ).
1991.63 20	(21/2 ⁺ , 19/2 ⁺)	C	J ^π : 368.2γ to (17/2 ⁺); 773.0γ to (19/2 ⁻); 191.9γ from (23/2 ⁺) (19/2 ⁻).
2038.46 ^c 26	(21/2 ⁺)	C	J ^π : stretched Q intraband 374.9γ to (17/2 ⁺).
2122.87 ^f 24	(21/2 ⁺)	C	J ^π : 323.6γ to (19/2 ⁺), 690.9γ to (17/2 ⁺), band member.
2183.53 ^g 24	(23/2 ⁺)	C	J ^π : 191.9γ to (21/2 ⁺), 384.2γ to (19/2 ⁺), band member.
2257.94 [@] 23	(25/2 ⁻)	CD	J ^π : intraband stretched D 375.5γ to (23/2 ⁻); intraband stretched Q 674.1γ to (21/2 ⁻).
2306.53 ^f 31	(25/2 ⁺)	CD	J ^π : intraband stretched D 123.0γ to (23/2 ⁺).
2321.15 [#] 28	(25/2 ⁻)	CD	J ^π : intraband stretched Q 556.3γ to (21/2 ⁻).
2462.16 ^g 35	(27/2 ⁺)	CD	XREF: D(2078.2) J ^π : intraband stretched D 155.6γ to (25/2 ⁺).
2486.95 ^{&} 24	(27/2 ⁻)	CD	
2498.06 ^c 30	(25/2 ⁺)	C	
2509.50 30	(25/2 ⁺)	C	J ^π : 410.0γ to (21/2 ⁺); 516.0γ from (29/2 ⁺).
2602.95 [@] 25	(29/2 ⁻)	CD	
2657.71 ^f 35	(29/2 ⁺)	CD	XREF: D(2274.0)
2743.87 ^{&} 28	(31/2 ⁻)	CD	
2896.48 ^g 4	(31/2 ⁺)	CD	XREF: D(2512.9)
2903.66 [#] 29	(29/2 ⁻)	CD	
2921.23 29		C	
2924.05 [@] 28	(33/2 ⁻)	CD	
3025.53 ^c 32	(29/2 ⁺)	C	
3083.94 ^h 28	(27/2 ⁺)	C	
3141.49 ^{&} 29	(35/2 ⁻)	CD	

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Adopted Levels, Gammas (continued) ^{169}Re Levels (continued)

E(level) [†]	J ^π [‡]	XREF	Comments
3169.8 ^f 4	(33/2 ⁺)	CD	XREF: D(2786.4)
3344.46 ^h 27	(31/2 ⁺)	C	
3396.58 [@] 29	(37/2 ⁻)	CD	XREF: D(3081.4)
3458.6 [#] 4	(33/2 ⁻)	CD	
3464.7 ^g 4	(35/2 ⁺)	CD	
3608.2 ^c 4	(33/2 ⁺)	C	
3686.99 ^{&} 31	(39/2 ⁻)	CD	
3720.27 ^h 30	35/2 ⁺	C	XREF: D(3408.8)
3792.2 ^f 4	(37/2 ⁺)	CD	
			E(level): differs in ($^{28}\text{Si,p2n}\gamma$) because order of 623 γ and 642 γ cascade was reversed in that study.
3942.8 [#] 4	(37/2 ⁻)	CD	XREF: D(3723.1)
3947.16 ⁱ 33	(37/2 ⁺)	C	
4006.00 [@] 32	(41/2 ⁻)	CD	
4106.6 ^g 4	(39/2 ⁺)	CD	
4164.5 ^k 4	(37/2 ⁻)	C	
4219.97 ^h 31	(39/2 ⁺)	C	J ^π : stretched Q 705.9 γ to (33/2 ⁻).
4238.1 ^c 4	(37/2 ⁺)	C	
4297.8 ^j 6	(39/2 ⁺)	C	XREF: D(4050.4)
4356.35 ^{&} 33	(43/2 ⁻)	CD	
4434.1 ^f 4	(41/2 ⁺)	CD	
4452.3 [#] 5	(41/2 ⁻)	CD	
4533.62 ⁱ 34	(41/2 ⁺)	C	
4727.49 [@] 34	(45/2 ⁻)	CD	C
4728.2 ^g 4	(43/2 ⁺)	C	
4746.1 ^k 4	(41/2 ⁻)	C	C
4798.8 ^j 4	(43/2 ⁺)	C	
4837.1 ^h 4	(43/2 ⁺)	C	C
4867.2 ^c 5	(41/2 ⁺)	C	
5015.7 ^f 4	(45/2 ⁺)	C	C
5048.8 [#] 5	(45/2 ⁻)	C	
5080.0 ⁱ 4	(45/2 ⁺)	C	C
5125.5 ^{&} 4	(47/2 ⁻)	C	
5298.7 ^g 5	(47/2 ⁺)	C	C
5377.7 ^k 5	(45/2 ⁻)	C	
5389.4 ^j 4	(47/2 ⁺)	C	C
5426.4 ^c 5	(45/2 ⁺)	C	
5537.9 [@] 4	(49/2 ⁻)	C	C
5546.0 ^h 4	(47/2 ⁺)	C	
5595.1 ^f 5	(49/2 ⁺)	C	C
5727.0 [#] 5	(49/2 ⁻)	C	
5732.7 ⁱ 4	(49/2 ⁺)	C	C
5912.1 ^g 5	(51/2 ⁺)	C	
5973.5 ^{&} 4	(51/2 ⁻)	C	C
6056.6 ^c 6	(49/2 ⁺)	C	

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Adopted Levels, Gammas (continued) ^{169}Re Levels (continued)

E(level) [†]	J ^π [‡]	XREF	E(level) [†]	J ^π [‡]	XREF	E(level) [†]	J ^π [‡]	XREF
6061.5 ^k 5	(49/2 ⁻)	C	7313.2 [@] 4	(57/2 ⁻)	C	8554.4 ^h 6	(63/2 ⁺)	C
6105.6 ^j 4	(51/2 ⁺)	C	7398.6 ⁱ 4	(57/2 ⁺)	C	8626.6 ^{&} 7	(63/2 ⁻)	C
6249.0 ^f 5	(53/2 ⁺)	C	7416.4 ^g 5	(59/2 ⁺)	C	8778.6 ^f 5	(65/2 ⁺)	C
6315.6 ^h 5	(51/2 ⁺)	C	7494.4 ^c 8	(57/2 ⁺)	C	8861.6 ^l 7		C
6414.2 [@] 4	(53/2 ⁻)	C	7635.4 ^k 6	(57/2 ⁻)	C	8918.8 [#] 7	(65/2 ⁻)	C
6466.7 [#] 6	(53/2 ⁻)	C	7756.2 ^{&} 4	(59/2 ⁻)	C	9137.7 ^c 11	(65/2 ⁺)	C
6516.8 ⁱ 4	(53/2 ⁺)	C	7785.6 ^h 6	(59/2 ⁺)	C	9295.7 ^g 7	(67/2 ⁺)	C
6615.6 ^g 5	(55/2 ⁺)	C	7838.3 ^j 7	(59/2 ⁺)	C	9396.1 ^h 6	(67/2 ⁺)	C
6743.1 ^c 6	(53/2 ⁺)	C	7843.7 ^f 5	(61/2 ⁺)	C	9741.6 ^l 9		C
6812.5 ^k 5	(53/2 ⁻)	C	8024.1 ^l 7		C	9812.8 [#] 7	(69/2 ⁻)	C
6869.7 ^{&} 4	(55/2 ⁻)	C	8062.3 [#] 6	(61/2 ⁻)	C	10307.2 ^h 8	(71/2 ⁺)	C
6945.3 ^j 4	(55/2 ⁺)	C	8185.9 [@] 4	(61/2 ⁻)	C	10756.0 [#] 9	(73/2 ⁻)	C
6998.9 ^f 5	(57/2 ⁺)	C	8298.6 ^c 9	(61/2 ⁺)	C	11286.2 ^h 9	(75/2 ⁺)	C
7064.2 ^h 5	(55/2 ⁺)	C	8311.6 ^g 5	(63/2 ⁺)	C	11765.0 [#] 10	(77/2 ⁻)	C
7248.3 [#] 6	(57/2 ⁻)	C	8316.6 ⁱ 7	(61/2 ⁺)	C			

[†] From least-squares fit to E_γ , assigning 0.5 keV uncertainty to E_γ data for which authors did not state an uncertainty.

[‡] From $^{118}\text{Sn}(^{55}\text{Mn},4n\gamma)$, based on transition multiplicities, deduced band structure, alignment, band crossing frequencies and comparison with neighboring odd-A Re isotopes, unless noted otherwise.

[#] Band(A): 1/2[541] band (2002Zh42). Decoupled sequence with initial alignment of $3\hbar$; delayed AB crossing at $\hbar\omega=0.27$ MeV; second crossing at $\hbar\omega=0.43$ MeV occurs at lower frequency than expected for Cd alignment and alignment gain may result instead from mixing with another band. Level-spacings consistent with trends in known 1/2[541] bands in heavier odd-A Re isotopes.

[@] Band(B): 9/2[514], $\alpha=+1/2$ band (2002Zh42). Initial alignment $\approx 1.5\hbar$; lower than cranked shell model prediction of $2.6\hbar$, possibly indicating mixing with $K=11/2$ orbital. First band crossing at $\hbar\omega=0.23$ MeV matches prediction for AB alignment. Observed B(M1)/B(E2) ratios and alignments consistent with calculated values for π 9/2[514] band. Second crossing near 0.44 MeV associated with CD alignment.

[&] Band(b): 9/2[514], $\alpha=-1/2$ band (2002Zh42). See comment on signature partner band.

^a Band(C): $\alpha=+1/2$, 3 quasiparticle band (2002Zh42). Configuration: $(\pi$ 9/2[514]) $\otimes(\nu$ $i_{13/2})(\nu$ $f_{7/2}$ or $h_{9/2})$ (2002Zh42). Strongly feeds g.s. band via D transitions, possibly suggesting opposite parity (2013Ha02).

^b Band(c): $\alpha=-1/2$, 3 quasiparticle band (2002Zh42). Configuration: $(\pi$ 9/2[514]) $\otimes(\nu$ $i_{13/2})(\nu$ $f_{7/2}$ or $h_{9/2})$. See comment on signature partner band.

^c Band(D): π 1/2[660] band. Decoupled band; initial alignment of $6\hbar$ is somewhat low for a 3-quasiparticle structure but consistent with π 1/2[660]; band crossing observed near $\hbar\omega=0.30$ MeV (possibly delayed AB alignment).

^d Band(E): π 5/2[402] band, $\alpha=+1/2$. Strongly-coupled structure with almost zero initial alignment, suggests π 5/2[402] or π 7/2[402] and observed B(M1)/B(E2) ratios clearly favor the former.

^e Band(e): π 5/2[402] band, $\alpha=-1/2$. See comment on signature partner band.

^f Band(F): π $h_{11/2}$ ν AE band, $\alpha=+1/2$. Strongly-coupled structure. Energy and initial alignment $\approx 10\hbar$ suggests a 3-quasiparticle structure. Band crossing at $\hbar\omega=0.30$ MeV is near predicted BC crossing (AB is blocked) and is consistent with its observation in the $\pi h_{11/2}\nu i_{13/2}$ band in ^{170}Re at 0.29 MeV. Observed B(M1)/B(E2) ratios consistent with those predicted for assigned configuration, where E is $\pi=-$ orbital closest to the Fermi surface, and with absence of CD alignment at high frequency. J^π assignments are based on data from $(^{55}\text{Mn},4n\gamma)$; J values proposed by authors in $(^{28}\text{Si},p2n\gamma)$ are one unit lower than adopted here.

^g Band(f): π $h_{11/2}$ ν AE band, $\alpha=-1/2$. See comment on signature partner band.

^h Band(G): π $h_{9/2}$ ν AE band, $\alpha=-1/2$. Decoupled sequence. Lowest level feeds J=25/2 and 27/2 states. Initial alignment 2-3 $\hbar$ larger than that of $\pi h_{11/2}$ ν AE band; crossing at 0.37 MeV, between expectations for BC and CD alignments. Larger

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Adopted Levels, Gammas (continued)

 ^{169}Re Levels (continued)

deformation driven by $\pi h_{9/2}$ may delay BC crossing.

- ⁱ Band(H): $\pi h_{11/2} \nu$ AF band, $\alpha=+1/2$. Strongly-coupled band feeding g.s. band. Observed B(M1)/B(E2) ratios agree with those predicted for the suggested configuration.
- ^j Band(h): $\pi h_{11/2} \nu$ AF band, $\alpha=-1/2$. See comment on signature partner band.
- ^k Band(I): Band fragment (1). Decoupled sequence feeding 1/2[541] band via stretched Q transitions, suggesting $\pi=-$. Excitation energy suggests 3⁻ or 5-quasiparticle configuration. Initial alignment $\approx 13\hbar$. Decoupled character suggests involvement of π 1/2[411], π 1/2[541] or π 1/2[660]; J rules out assignment as 1/2[541] signature partner, and 1/2[660] has already been assigned elsewhere, so authors tentatively assign the π 1/2[411] ? AEBC configuration.
- ^l Band(J): Band fragment (2). Feeds into 1/2[541] band.

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Re})$									Comments
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. @	δ	$\alpha^\&$	
136.38	(11/2 ⁻)	136.3 2	100	0.0	(9/2 ⁻)	M1+E2	0.66 8	1.86 5	E_γ : weighted average of 136.2 2 from ^{173}Ir α decay (2.16 s), 136.4 2 from ($^{55}\text{Mn}, 4n\gamma$), and 136.4 2 from ($^{28}\text{Si}, p2n\gamma$). Mult., δ : from ^{173}Ir α decay (2.16 s).
271.46	(7/2 ⁺)	152.5 2	100	118.93	(5/2 ⁺)				
382.70	(13/2 ⁻)	246.3 2	100	136.38	(11/2 ⁻)	(M1+E2)		0.28 12	
		382.8 2	13 2	0.0	(9/2 ⁻)	(E2)		0.0439 6	I_γ : from ($^{28}\text{Si}, p2n\gamma$). Other: ≈ 24 from ($^{55}\text{Mn}, 4n\gamma$).
447.81	(9/2 ⁺ , 7/2 ⁺)	176.3 2	100 10	271.46	(7/2 ⁺)				
		328.9 2	17.6 22	118.93	(5/2 ⁺)				
535.98	(5/2 ⁻)	320.1 2	100	215.88	(3/2)	D			
622.53	(15/2 ⁻)	240.0 2	100	382.70	(13/2 ⁻)	(M1+E2)		0.31 13	E_γ : weighted average of 239.8 2 from ($^{55}\text{Mn}, 4n\gamma$) and 240.1 2 from ($^{28}\text{Si}, p2n\gamma$).
		486.1 [‡] 2	67 5	136.38	(11/2 ⁻)	(E2)		0.02346 33	I_γ : other I_γ : 86 from ($^{28}\text{Si}, p2n\gamma$).
633.78	(9/2 ⁻)	97.8 2	51 7	535.98	(5/2 ⁻)				Mult.: consistent with D based on angular distribution ratio in ($^{55}\text{Mn}, 4n\gamma$) but level scheme requires $\Delta J=2$.
		355.0 2	24 3	278.78	(7/2)	D			
		497.4 2	100 14	136.38	(11/2 ⁻)	(D)			
		633.8 2	29 3	0.0	(9/2 ⁻)				
637.64	(11/2 ⁺ , 9/2 ⁺)	189.9 2	100 11	447.81	(9/2 ⁺ , 7/2 ⁺)				
		366.2 2	42 4	271.46	(7/2 ⁺)				
886.85	(13/2 ⁻)	253.1 2	100 6	633.78	(9/2 ⁻)	(E2)		0.1484 21	Mult.: from ($^{28}\text{Si}, p2n\gamma$).
		886.8 2	9.4 12	0.0	(9/2 ⁻)	Q			
897.99	(13/2 ⁺ , 11/2 ⁺)	260.4 2	100 9	637.64	(11/2 ⁺ , 9/2 ⁺)				
		450.1 2	62 6	447.81	(9/2 ⁺ , 7/2 ⁺)				
940.05	(17/2 ⁻)	317.6 2	100 6	622.53	(15/2 ⁻)	(M1)		0.2041 29	
		557.4 2	60 6	382.70	(13/2 ⁻)	(E2)		0.01680 24	E_γ : weighted average of 557.3 2 from ($^{55}\text{Mn}, 4n\gamma$) and 557.5 2 from ($^{28}\text{Si}, p2n\gamma$).
1121.71	(15/2 ⁺ , 13/2 ⁺)	223.7 2	100 8	897.99	(13/2 ⁺ , 11/2 ⁺)				
		484.1 2	61 5	637.64	(11/2 ⁺ , 9/2 ⁺)				
1218.61	(19/2 ⁻)	278.6 2	65 4	940.05	(17/2 ⁻)	(M1+E2)		0.20 9	E_γ : weighted average of 278.4 2 from ($^{55}\text{Mn}, 4n\gamma$) and 278.7 2 from ($^{28}\text{Si}, p2n\gamma$).
									Other I_γ : 58 from ($^{28}\text{Si}, p2n\gamma$).
		596.0 2	100 7	622.53	(15/2 ⁻)	(E2)		0.01435 20	
1275.68	(17/2 ⁻)	388.8 [‡] 2	100 [#]	886.85	(13/2 ⁻)	(E2)		0.0420 6	Mult.: Q from ($^{28}\text{Si}, p2n\gamma$).
1343.01	(15/2 ⁺)	403.0 5		940.05	(17/2 ⁻)				E_γ : from ($^{28}\text{Si}, p2n\gamma$); absent in ($^{55}\text{Mn}, 4n\gamma$).
		720.5 2	100 7	622.53	(15/2 ⁻)				Mult.: interpreted by 2013Ha02 as $\Delta J=0$, $\Delta\pi=\text{yes}$ transition.
		960.2 2	39 4	382.70	(13/2 ⁻)				

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Re})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [@]	$\alpha\&$	Comments
1431.90	(17/2 ⁺)	88.0 5		1343.01	(15/2 ⁺)			E_γ : from ($^{28}\text{Si}, p2n\gamma$); γ absent in ($^{55}\text{Mn}, 4n\gamma$).
		310.2 2	100 10	1121.71	(15/2 ⁺ , 13/2 ⁺)			Absent in ($^{28}\text{Si}, p2n\gamma$).
		533.9 2	86 8	897.99	(13/2 ⁺ , 11/2 ⁺)			Absent in ($^{28}\text{Si}, p2n\gamma$).
1510.08		887.6 2	100 33	622.53	(15/2 ⁻)			
		1127.3 5	<100	382.70	(13/2 ⁻)			
1584.00	(21/2 ⁻)	365.4 2	91 7	1218.61	(19/2 ⁻)	(M1+E2)	0.09 5	
		644.0 2	100 9	940.05	(17/2 ⁻)	(E2)	0.01202 17	E_γ : weighted average of 643.9 2 from ($^{55}\text{Mn}, 4n\gamma$) and 644.1 2 from ($^{28}\text{Si}, p2n\gamma$).
1623.44	(17/2 ⁺)	113.4 2	4.2 8	1510.08				From ($^{55}\text{Mn}, 4n\gamma$) only.
		191.4 2	50 8	1431.90	(17/2 ⁺)			Other $E_\gamma(I_\gamma)$: 192.3 2 (233 70) from ($^{28}\text{Si}, p2n\gamma$).
		280.5 2	92 8	1343.01	(15/2 ⁺)	(M1)	0.286 4	Other I_γ : 126 37 from ($^{28}\text{Si}, p2n\gamma$).
								Mult.: D from ($^{55}\text{Mn}, 4n\gamma$); however, DCO and anisotropy in ($^{28}\text{Si}, p2n\gamma$) are consistent with Q also.
		404.9 2	100 8	1218.61	(19/2 ⁻)	(E1)	0.01175 17	Other I_γ : 100 30 from ($^{28}\text{Si}, p2n\gamma$).
		683.4 2	53 5	940.05	(17/2 ⁻)			Mult.: D from ($^{55}\text{Mn}, 4n\gamma$); $\Delta\pi$ =yes from level scheme.
		1000.9 2	48 3	622.53	(15/2 ⁻)	(E1)	1.86×10 ⁻³ 3	From ($^{55}\text{Mn}, 4n\gamma$) only.
								Mult.: D from ($^{55}\text{Mn}, 4n\gamma$); $\Delta\pi$ =yes from level scheme.
1663.53	(17/2 ⁺)	387.8 2	25 6	1275.68	(17/2 ⁻)			
		1041.0 2	100 13	622.53	(15/2 ⁻)			
1764.87	(21/2 ⁻)	489.2 2	100	1275.68	(17/2 ⁻)	(E2)	0.02309 32	
1799.34	(19/2 ⁺)	175.9 2	100 12	1623.44	(17/2 ⁺)	(M1)	1.038 15	
		215.3 2	4.0 8	1584.00	(21/2 ⁻)			
		367.5 2	6.4 12	1431.90	(17/2 ⁺)			Other E_γ (I_γ): 368.3 (56 17) in ($^{28}\text{Si}, p2n\gamma$).
		859.3 2	14.8 12	940.05	(17/2 ⁻)	D		Mult.: level scheme requires $\Delta\pi$ =yes.
1815.40	(23/2 ⁻)	192.0 [‡] 2	100	1623.44	(17/2 ⁺)			
298.3 2		51 3	1584.00	(21/2 ⁻)	(M1)	0.2418 34		
663.7 2		100 7	1218.61	(19/2 ⁻)	(E2)	0.01123 16	E_γ : weighted average of 663.8 2 from ($^{55}\text{Mn}, 4n\gamma$) and 663.5 2 from ($^{28}\text{Si}, p2n\gamma$).	
1922.18	(21/2 ⁺)	107.0 5		1815.40				E_γ : placement from ($^{28}\text{Si}, p2n\gamma$), weak γ , not confirmed in ($^{55}\text{Mn}, 4n\gamma$).
1991.63	(21/2 ⁺ , 19/2 ⁺)	122.8 2	100	1799.34	(19/2 ⁺)	(M1)	2.87 4	$E_\gamma, I_\gamma, \text{Mult.}$: from ($^{28}\text{Si}, p2n\gamma$).
		192.3 2	100 21	1799.34	(19/2 ⁺)			
		368.2 2	21 3	1623.44	(17/2 ⁺)			
		773.0 2	2.9 7	1218.61	(19/2 ⁻)			
2038.46	(21/2 ⁺)	374.9 2	100	1663.53	(17/2 ⁺)	(E2)	0.0465 7	

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Re})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. @	$\alpha\&$	Comments
2122.87	(21/2 ⁺)	323.6 2	76 10	1799.34	(19/2 ⁺)			
		690.9 2	100 14	1431.90	(17/2 ⁺)			
2183.53	(23/2 ⁺)	(61)		2122.87	(21/2 ⁺)			
		191.9 2	100 13	1991.63	(21/2 ⁺ , 19/2 ⁺)			
		384.2 2	21 3	1799.34	(19/2 ⁺)			
2257.94	(25/2 ⁻)	375.5 2	90 7	1882.38	(23/2 ⁻)	(M1)	0.1303 18	E_γ : weighted average of 375.4 2 from ($^{55}\text{Mn}, 4n\gamma$) and 375.6 2 from ($^{28}\text{Si}, p2n\gamma$). Mult.: D in ($^{28}\text{Si}, p2n\gamma$) and (D+Q) in ($^{55}\text{Mn}, 4n\gamma$).
		674.1 [‡] 2	100 7	1584.00	(21/2 ⁻)	(E2)	0.01084 15	
2306.53	(25/2 ⁺)	123.0 2	100	2183.53	(23/2 ⁺)	(M1)	2.86 4	
2321.15	(25/2 ⁻)	556.3 2	100	1764.87	(21/2 ⁻)	(E2)	0.01688 24	Other E_γ : 554.8 from ($^{28}\text{Si}, p2n\gamma$).
2462.16	(27/2 ⁺)	155.6 2	100	2306.53	(25/2 ⁺)	(M1)	1.466 21	
2486.95	(27/2 ⁻)	229.1 2	72 4	2257.94	(25/2 ⁻)	(M1)	0.498 7	
		604.5 2	100 7	1882.38	(23/2 ⁻)	(E2)	0.01389 19	
2498.06	(25/2 ⁺)	459.6 2	100	2038.46	(21/2 ⁺)	(E2)	0.0270 4	
2509.50	(25/2 ⁺)	471.0 2	100	2038.46	(21/2 ⁺)			
2602.95	(29/2 ⁻)	116.0 2	100 5	2486.95	(27/2 ⁻)	(M1)	3.38 5	
		345.0 2	14 4	2257.94	(25/2 ⁻)			Other I_γ : ≤ 33 from ($^{28}\text{Si}, p2n\gamma$).
2657.71	(29/2 ⁺)	195.5 2	100 11	2462.16	(27/2 ⁺)	(M1+E2)	0.56 21	Mult.: D in ($^{28}\text{Si}, p2n\gamma$) and (D+Q) in ($^{55}\text{Mn}, 4n\gamma$).
		351.2 2	18.9 16	2306.53	(25/2 ⁺)	(E2)	0.0557 8	Mult.: Q intraband γ from ($^{28}\text{Si}, p2n\gamma$).
2743.87	(31/2 ⁻)	140.9 2	100	2602.95	(29/2 ⁻)	(M1)	1.942 28	
		257.0 [‡] 5	$\leq 11^\#$	2486.95	(27/2 ⁻)			γ absent in ($^{55}\text{Mn}, 4n\gamma$).
2896.4	(31/2 ⁺)	238.7 2	100 14	2657.71	(29/2 ⁺)	(M1)	0.445 6	Mult.: from ($^{28}\text{Si}, p2n\gamma$).
		434.3 2	21.9 24	2462.16	(27/2 ⁺)	(E2)	0.0313 4	Mult.: from ($^{28}\text{Si}, p2n\gamma$).
2903.66	(29/2 ⁻)	582.5 2	100	2321.15	(25/2 ⁻)	(E2)	0.01514 21	
2921.23		663.3 2	100	2257.94	(25/2 ⁻)			
2924.05	(33/2 ⁻)	180.2 2	100 6	2743.87	(31/2 ⁻)	(M1)	0.970 14	
		321.1 2	11.4 26	2602.95	(29/2 ⁻)	(E2)	0.0721 10	E_γ : weighted average of 321.0 2 from ($^{55}\text{Mn}, 4n\gamma$) and 321.3 3 from ($^{28}\text{Si}, p2n\gamma$).
3025.53	(29/2 ⁺)	516.0 2	73 9	2509.50	(25/2 ⁺)			
		527.5 2	100 9	2498.06	(25/2 ⁺)	(E2)	0.01918 27	
3083.94	(27/2 ⁺)	574.4 5		2509.50	(25/2 ⁺)			
		585.7 5		2498.06	(25/2 ⁺)			
		597.0 5		2486.95	(27/2 ⁻)			
		762.9 5		2321.15	(25/2 ⁻)			
3141.49	(35/2 ⁻)	217.5 2	100 5	2924.05	(33/2 ⁻)	(M1)	0.575 8	E_γ : weighted average of 217.4 2 from ($^{55}\text{Mn}, 4n\gamma$) and 217.6 2 from ($^{28}\text{Si}, p2n\gamma$).
		397.6 2	16.2 15	2743.87	(31/2 ⁻)	(E2)	0.0396 6	E_γ : weighted average of 397.5 2 from ($^{55}\text{Mn}, 4n\gamma$) and 397.7 2 from ($^{28}\text{Si}, p2n\gamma$).

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Re})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. @	$\alpha^\&$	Comments
								I_γ : 33 10 from ($^{28}\text{Si}, p2n\gamma$). Mult.: Q from ($^{28}\text{Si}, p2n\gamma$); $\Delta\pi$ from level scheme.
3169.8	(33/2 ⁺)	273.3 2	100 5	2896.4	(31/2 ⁺)	(M1)	0.307 4	
		512.0 2	25.3 21	2657.71	(29/2 ⁺)	(E2)	0.02063 29	
3344.46	(31/2 ⁺)	260.5 2	100 13	3083.94	(27/2 ⁺)			
		423.3 5	<20	2921.23				
		440.8 2	20 7	2903.66	(29/2 ⁻)			
3396.58	(37/2 ⁻)	255.2 2	100 5	3141.49	(35/2 ⁻)	(M1+E2)	0.26 11	
		472.5 2	23.7 26	2924.05	(33/2 ⁻)	(E2)	0.02520 35	
3458.6	(33/2 ⁻)	554.9 2	100	2903.66	(29/2 ⁻)	(E2)	0.01698 24	Other I_γ : 556.8 from ($^{28}\text{Si}, p2n\gamma$). Mult.: Q intraband γ from ($^{28}\text{Si}, p2n\gamma$).
3464.7	(35/2 ⁺)	294.8 2	100 12	3169.8	(33/2 ⁺)	(M1)	0.2497 35	
		568.3 2	49 5	2896.4	(31/2 ⁺)	(E2)	0.01604 22	Other I_γ : 37 6 from ($^{28}\text{Si}, p2n\gamma$).
3608.2	(33/2 ⁺)	582.7 2	100	3025.53	(29/2 ⁺)	(E2)	0.01513 21	
3686.99	(39/2 ⁻)	290.5 2	100 8	3396.58	(37/2 ⁻)	(M1)	0.260 4	E_γ : weighted average of 290.4 2 from ($^{55}\text{Mn}, 4n\gamma$) and 290.6 2 from ($^{28}\text{Si}, p2n\gamma$).
		545.5 2	29.2 17	3141.49	(35/2 ⁻)	(E2)	0.01769 25	E_γ : weighted average of 545.4 2 from ($^{55}\text{Mn}, 4n\gamma$) and 545.8 3 from ($^{28}\text{Si}, p2n\gamma$).
3720.27	35/2 ⁺	375.8 2	100	3344.46	(31/2 ⁺)			
3792.2	(37/2 ⁺)	327.6 2	100 15	3464.7	(35/2 ⁺)			
		622.5 2	61 5	3169.8	(33/2 ⁺)	(E2)	0.01298 18	Other I(623 γ):I(328 γ)=35 11:100 30 from ($^{28}\text{Si}, p2n\gamma$).
3942.8	(37/2 ⁻)	484.2 2	100	3458.6	(33/2 ⁻)	(E2)	0.02369 33	
3947.16	(37/2 ⁺)	805.6 2	100	3141.49	(35/2 ⁻)			
4006.00	(41/2 ⁻)	319.0 2	100 4	3686.99	(39/2 ⁻)	(M1)	0.2017 28	E_γ : weighted average of 319.1 2 from ($^{55}\text{Mn}, 4n\gamma$) and 318.8 2 from ($^{28}\text{Si}, p2n\gamma$).
		609.4 2	56 4	3396.58	(37/2 ⁻)	(E2)	0.01363 19	E_γ : weighted average of 609.5 2 from ($^{55}\text{Mn}, 4n\gamma$) and 609.2 3 from ($^{28}\text{Si}, p2n\gamma$).
								Other I_γ : 35 10 from ($^{28}\text{Si}, p2n\gamma$).
4106.6	(39/2 ⁺)	314.4 2	100 9	3792.2	(37/2 ⁺)	(M1)	0.2098 30	Mult.: from ($^{28}\text{Si}, p2n\gamma$).
		641.8 2	67 5	3464.7	(35/2 ⁺)			Other I_γ : 60 from ($^{28}\text{Si}, p2n\gamma$).
4164.5	(37/2 ⁻)	705.9 2	100	3458.6	(33/2 ⁻)	(E2)	0.00979 14	Mult.: stretched Q from ($^{55}\text{Mn}, 4n\gamma$); $\Delta\pi$ from level scheme.
4219.97	(39/2 ⁺)	499.7 2	100 11	3720.27	35/2 ⁺			
		823.4 2	21 5	3396.58	(37/2 ⁻)			
4238.1	(37/2 ⁺)	629.9 2	100	3608.2	(33/2 ⁺)			
4356.35	(43/2 ⁻)	350.4 2	100 6	4006.00	(41/2 ⁻)	(M1)	0.1567 22	E_γ : weighted average of 350.3 2 from ($^{55}\text{Mn}, 4n\gamma$) and 350.5 3 from ($^{28}\text{Si}, p2n\gamma$).
		669.4 2	44 3	3686.99	(39/2 ⁻)	(E2)	0.01102 15	
4434.1	(41/2 ⁺)	327.5 2	100 11	4106.6	(39/2 ⁺)			
		641.9 2	74 9	3792.2	(37/2 ⁺)			Other I(642 γ):I(328 γ)=100 30:17 5 from ($^{28}\text{Si}, p2n\gamma$).

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Re})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. @	$\alpha\&$	Comments
4452.3	(41/2 ⁻)	509.5 2	100	3942.8	(37/2 ⁻)	(E2)	0.02087 29	Other E_γ : 509.0 in ($^{28}\text{Si}, p2n\gamma$).
4533.62	(41/2 ⁺)	586.4 2	19 3	3947.16	(37/2 ⁺)			
		846.7 2	100 11	3686.99	(39/2 ⁻)			
4727.49	(45/2 ⁻)	371.2 2	100 10	4356.35	(43/2 ⁻)	(M1+E2)	0.09 4	
		721.4 2	92 6	4006.00	(41/2 ⁻)			Other E_γ : 722.0 from ($^{28}\text{Si}, p2n\gamma$).
4728.2	(43/2 ⁺)	294.2 2	100 13	4434.1	(41/2 ⁺)			
		621.7 2	75 6	4106.6	(39/2 ⁺)			
4746.1	(41/2 ⁻)	581.6 2	100 13	4164.5	(37/2 ⁻)			
		803.3 2	38 13	3942.8	(37/2 ⁻)	(E2)	0.00742 10	Mult.: Q from ($^{55}\text{Mn}, 4n\gamma$); $\Delta\pi$ from level scheme.
4798.8	(43/2 ⁺)	265.2 2	100 11	4533.62	(41/2 ⁺)			
		501.0 5	<8.1	4297.8	(39/2 ⁺)			
4837.1	(43/2 ⁺)	617.1 2	100	4219.97	(39/2 ⁺)			
4867.2	(41/2 ⁺)	629.1 2	100	4238.1	(37/2 ⁺)			
5015.7	(45/2 ⁺)	287.5 2	100 11	4728.2	(43/2 ⁺)	(M1)	0.267 4	E_γ : presumed to be the 287.0 γ known in ($^{28}\text{Si}, p2n\gamma$), but unplaced in that study.
		581.6 2	83 11	4434.1	(41/2 ⁺)			
5048.8	(45/2 ⁻)	596.5 2	100	4452.3	(41/2 ⁻)	(E2)	0.01432 20	
5080.0	(45/2 ⁺)	281.2 2	100 8	4798.8	(43/2 ⁺)			
		546.4 2	17.5 25	4533.62	(41/2 ⁺)			
5125.5	(47/2 ⁻)	398.0 2	100 8	4727.49	(45/2 ⁻)			
		769.2 2	83 5	4356.35	(43/2 ⁻)			
5298.7	(47/2 ⁺)	282.9 2	100 13	5015.7	(45/2 ⁺)	(M1)	0.279 4	
		570.5 2	93 8	4728.2	(43/2 ⁺)	(E2)	0.01590 22	
5377.7	(45/2 ⁻)	631.6 2	100	4746.1	(41/2 ⁻)			
5389.4	(47/2 ⁺)	309.4 2	100 7	5080.0	(45/2 ⁺)			
		590.6 2	38 3	4798.8	(43/2 ⁺)			
5426.4	(45/2 ⁺)	559.2 2	100	4867.2	(41/2 ⁺)	(E2)	0.01667 23	
5537.9	(49/2 ⁻)	412.3 2	90 10	5125.5	(47/2 ⁻)	(M1+E2)	0.069 33	
		810.4 2	100 7	4727.49	(45/2 ⁻)			
5546.0	(47/2 ⁺)	708.9 2	100	4837.1	(43/2 ⁺)			
5595.1	(49/2 ⁺)	296.4 2	100 9	5298.7	(47/2 ⁺)			
		579.3 2	58 7	5015.7	(45/2 ⁺)			
5727.0	(49/2 ⁻)	678.2 2	100	5048.8	(45/2 ⁻)	(E2)	0.01070 15	
5732.7	(49/2 ⁺)	343.2 2	100 5	5389.4	(47/2 ⁺)			
		652.7 2	65 5	5080.0	(45/2 ⁺)			
5912.1	(51/2 ⁺)	317.0 2	100 12	5595.1	(49/2 ⁺)			
		613.4 2	64 8	5298.7	(47/2 ⁺)			
5973.5	(51/2 ⁻)	435.7 2	86 14	5537.9	(49/2 ⁻)			
		847.9 2	100 14	5125.5	(47/2 ⁻)			
6056.6	(49/2 ⁺)	630.2 2	100	5426.4	(45/2 ⁺)			
6061.5	(49/2 ⁻)	683.8 2	100	5377.7	(45/2 ⁻)			

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Re})$ (continued)							
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. @	$\alpha\&$
6105.6	(51/2 ⁺)	372.9 2	100 7	5732.7	(49/2 ⁺)		
		716.2 2	73 7	5389.4	(47/2 ⁺)		
6249.0	(53/2 ⁺)	337.0 2	100 9	5912.1	(51/2 ⁺)		
		653.9 2	56 4	5595.1	(49/2 ⁺)		
6315.6	(51/2 ⁺)	769.6 2	100	5546.0	(47/2 ⁺)		
6414.2	(53/2 ⁻)	440.7 2	88 13	5973.5	(51/2 ⁻)		
		876.3 2	100 13	5537.9	(49/2 ⁻)		
6466.7	(53/2 ⁻)	739.7 2	100	5727.0	(49/2 ⁻)		
6516.8	(53/2 ⁺)	411.1 2	100 10	6105.6	(51/2 ⁺)		
		784.1 2	100 10	5732.7	(49/2 ⁺)		
6615.6	(55/2 ⁺)	366.6 2	100 8	6249.0	(53/2 ⁺)		
		703.5 2	54 5	5912.1	(51/2 ⁺)		
6743.1	(53/2 ⁺)	686.5 2	100	6056.6	(49/2 ⁺)		
6812.5	(53/2 ⁻)	751.0 2	100	6061.5	(49/2 ⁻)		
6869.7	(55/2 ⁻)	455.4 2	57 5	6414.2	(53/2 ⁻)		
		896.4 2	100 10	5973.5	(51/2 ⁻)		
6945.3	(55/2 ⁺)	428.6 2	100 13	6516.8	(53/2 ⁺)		
		839.7 2	100 13	6105.6	(51/2 ⁺)		
6998.9	(57/2 ⁺)	383.4 2	100 7	6615.6	(55/2 ⁺)		
		749.9 2	64 4	6249.0	(53/2 ⁺)		
7064.2	(55/2 ⁺)	748.6 2	100	6315.6	(51/2 ⁺)		
7248.3	(57/2 ⁻)	781.6 2	100	6466.7	(53/2 ⁻)	(E2)	0.00786 11
7313.2	(57/2 ⁻)	443.4 2	63 13	6869.7	(55/2 ⁻)		
		898.9 2	100 13	6414.2	(53/2 ⁻)		
7398.6	(57/2 ⁺)	453.4 2	100 20	6945.3	(55/2 ⁺)		
		881.8 2	100 20	6516.8	(53/2 ⁺)		
7416.4	(59/2 ⁺)	417.5 2	100 6	6998.9	(57/2 ⁺)		
		800.8 2	76 6	6615.6	(55/2 ⁺)		
7494.4	(57/2 ⁺)	751.3 5	100	6743.1	(53/2 ⁺)		
7635.4	(57/2 ⁻)	822.9 2	100	6812.5	(53/2 ⁻)		
7756.2	(59/2 ⁻)	443.0 2	36 7	7313.2	(57/2 ⁻)		
		886.5 2	100 7	6869.7	(55/2 ⁻)		
7785.6	(59/2 ⁺)	721.4 2	100	7064.2	(55/2 ⁺)		
7838.3?	(59/2 ⁺)	893.0 ^a 5	100	6945.3	(55/2 ⁺)		
7843.7	(61/2 ⁺)	427.3 2	100 8	7416.4	(59/2 ⁺)		
		844.8 2	77 8	6998.9	(57/2 ⁺)		
8024.1		775.9 5	100	7248.3	(57/2 ⁻)		
8062.3	(61/2 ⁻)	814.0 2	100	7248.3	(57/2 ⁻)	(E2)	0.00721 10
8185.9	(61/2 ⁻)	429.7 2	75 13	7756.2	(59/2 ⁻)		
		872.8 2	100 13	7313.2	(57/2 ⁻)		
8298.6	(61/2 ⁺)	804.2 5	100	7494.4	(57/2 ⁺)		
8311.6	(63/2 ⁺)	467.9 2	60 20	7843.7	(61/2 ⁺)		

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Re})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π
8311.6	(63/2 ⁺)	895.2 2	100 10	7416.4	(59/2 ⁺)	9137.7?	(65/2 ⁺)	839.0 ^a 5	100	8298.6	(61/2 ⁺)
8316.6?	(61/2 ⁺)	918.0 ^a 5	100	7398.6	(57/2 ⁺)	9295.7	(67/2 ⁺)	984.1 5	100	8311.6	(63/2 ⁺)
8554.4	(63/2 ⁺)	768.8 2	100	7785.6	(59/2 ⁺)	9396.1	(67/2 ⁺)	841.7 2	100	8554.4	(63/2 ⁺)
8626.6	(63/2 ⁻)	870.4	100	7756.2	(59/2 ⁻)	9741.6		880.0 5	100	8861.6	
8778.6	(65/2 ⁺)	467.0 2	71 29	8311.6	(63/2 ⁺)	9812.8	(69/2 ⁻)	894.0 2	100	8918.8	(65/2 ⁻)
		934.9 2	100 14	7843.7	(61/2 ⁺)	10307.2	(71/2 ⁺)	911.1 5	100	9396.1	(67/2 ⁺)
8861.6		799.3 5		8062.3	(61/2 ⁻)	10756.0	(73/2 ⁻)	943.2 5	100	9812.8	(69/2 ⁻)
		837.5 5		8024.1		11286.2	(75/2 ⁺)	979.0 5	100	10307.2	(71/2 ⁺)
8918.8	(65/2 ⁻)	856.5 2	100	8062.3	(61/2 ⁻)	11765.0	(77/2 ⁻)	1009.0 5	100	10756.0	(73/2 ⁻)

[†] From ¹¹⁸Sn(⁵⁵Mn,4n γ), except as noted.

[‡] From ¹⁴⁴Sm(²⁸Si,p2n γ).

From ¹⁴⁴Sm(²⁸Si,p2n γ), assigning $\Delta I_\gamma=30\%$ in cases where authors did not state branching ratio (authors report $\Delta I_\gamma=5\%$ to 30%).

@ From ¹⁴⁴Sm(²⁸Si,p2n γ), except as noted; ΔJ based on measured DCO ratios and γ anisotropy, $\Delta\pi=(\text{no})$ assigned by evaluator for intraband transitions.

& Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with “Frozen Orbitals” approximation based on γ -ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

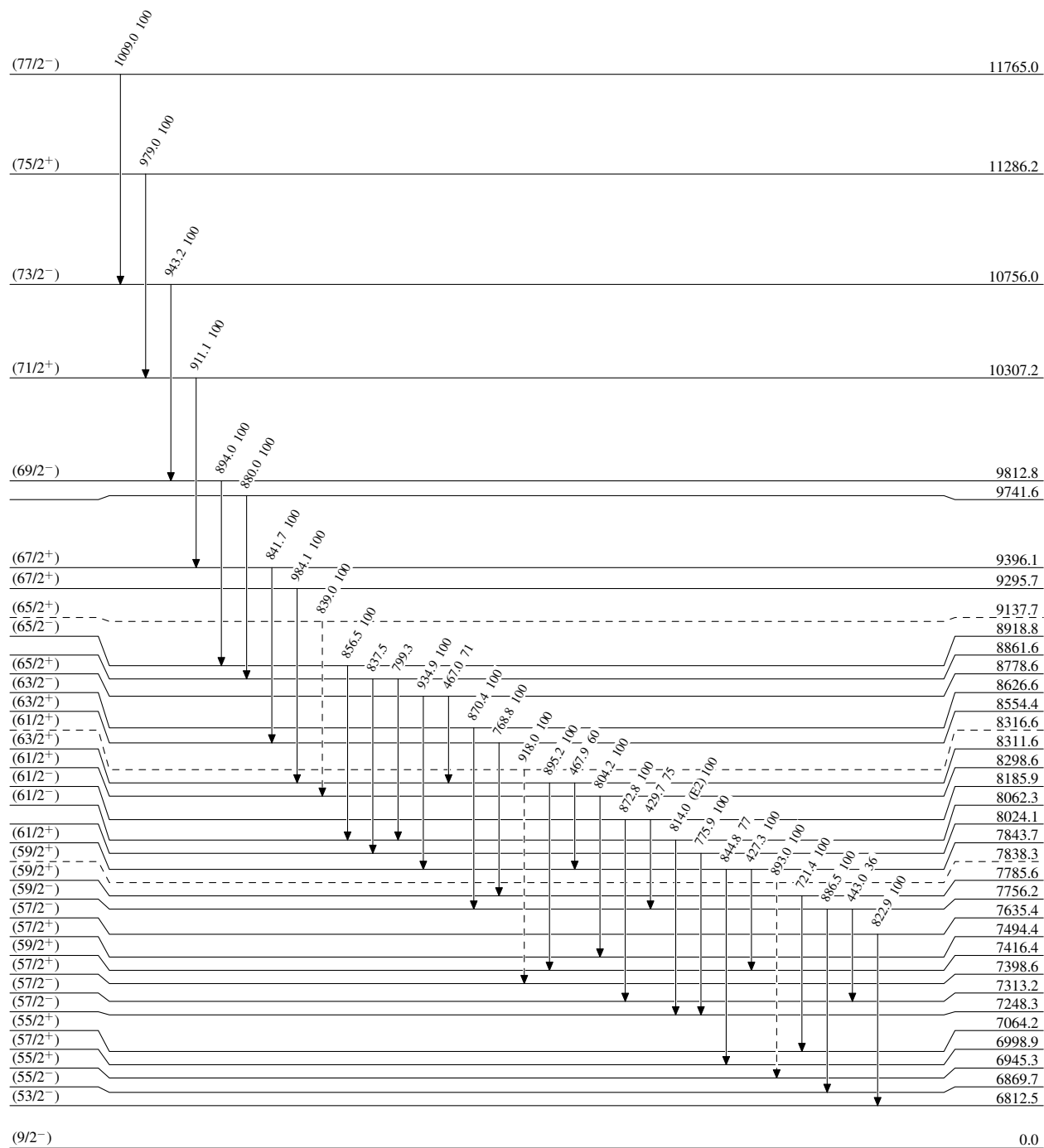
^a Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

Legend

Level Scheme

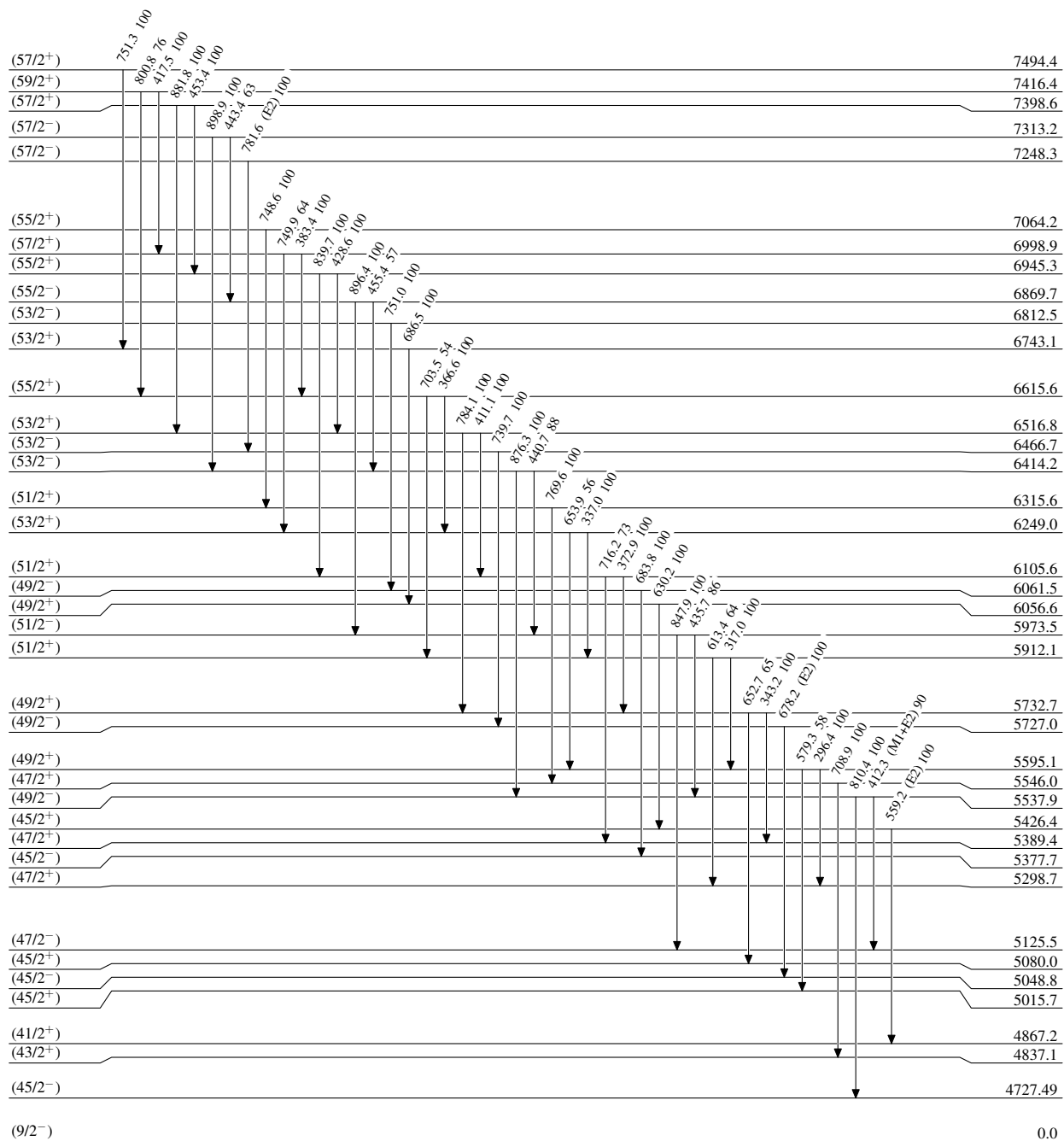
Intensities: Relative photon branching from each level

 - - - - - $\rightarrow$ γ Decay (Uncertain)


Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

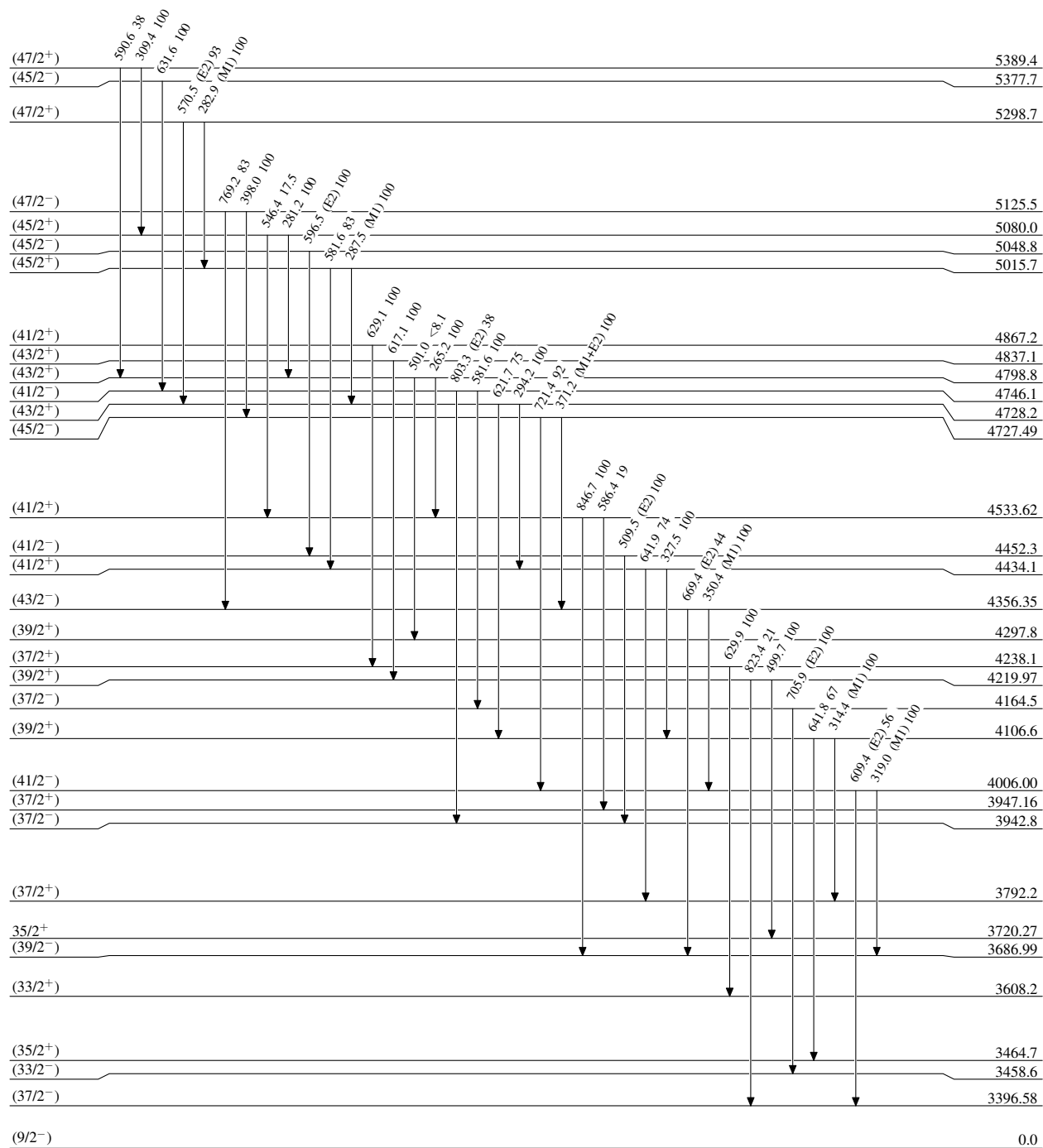


8.1 s 5

Adopted Levels, Gammas

Level Scheme (continued)

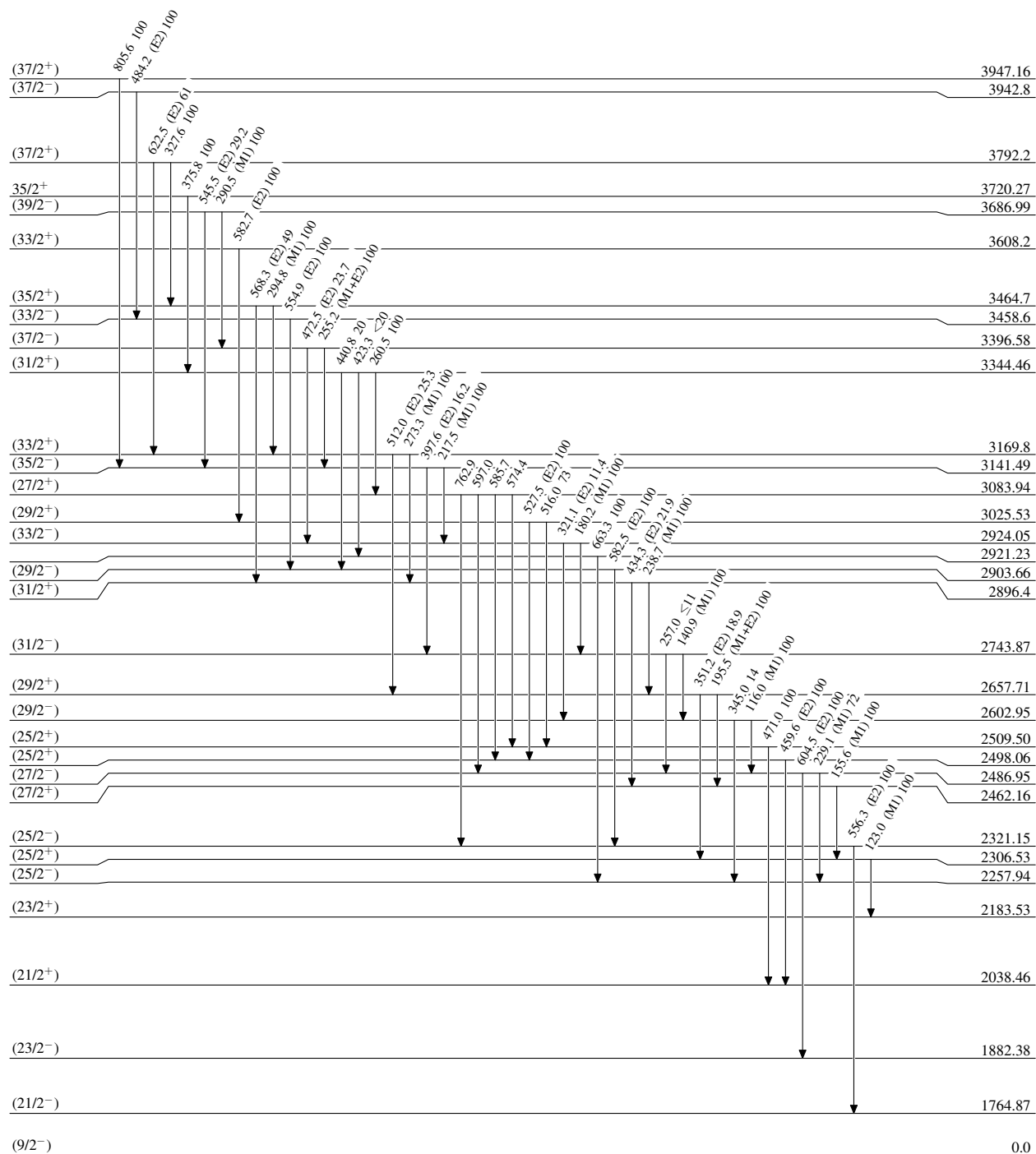
Intensities: Relative photon branching from each level



Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

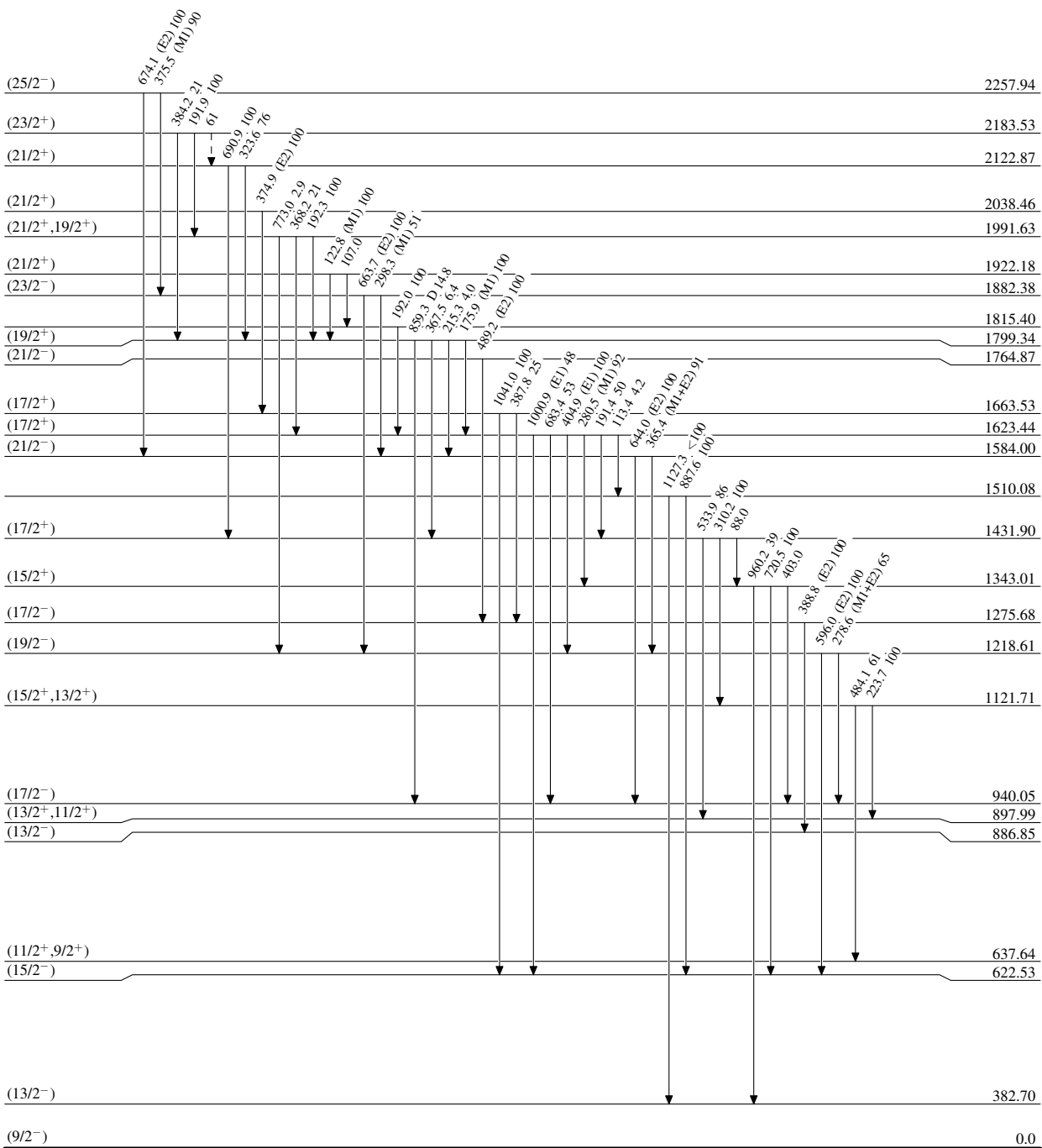


Adopted Levels, Gammas

Legend

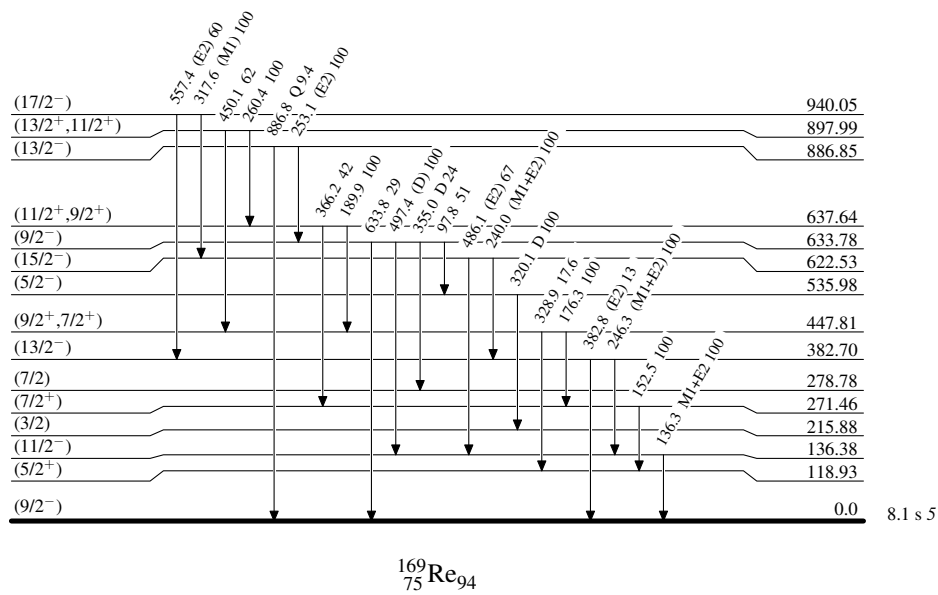
Level Scheme (continued)

Intensities: Relative photon branching from each level

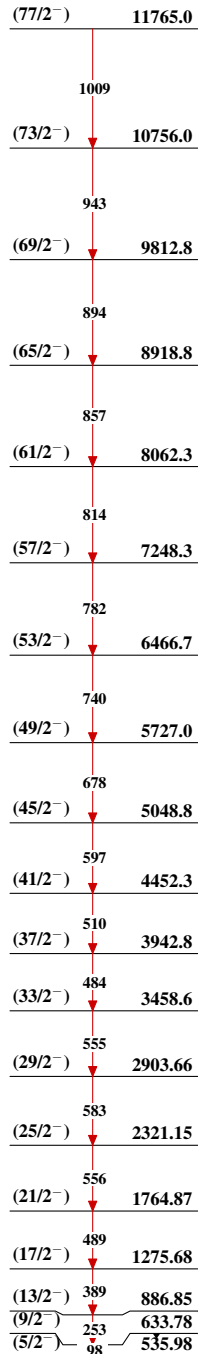
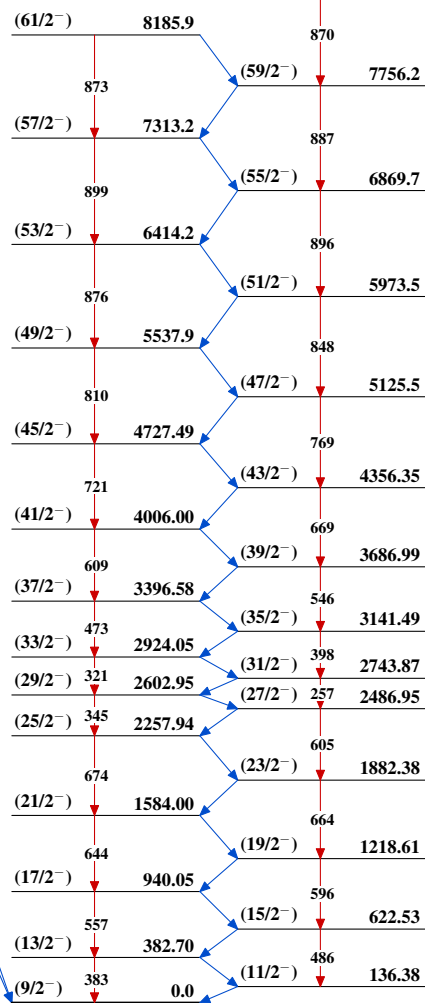
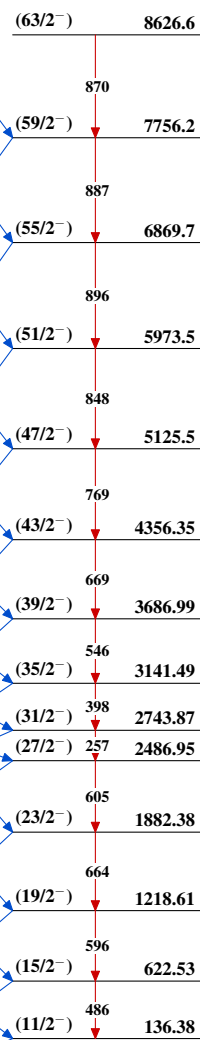
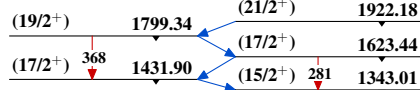
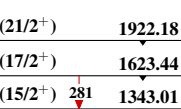
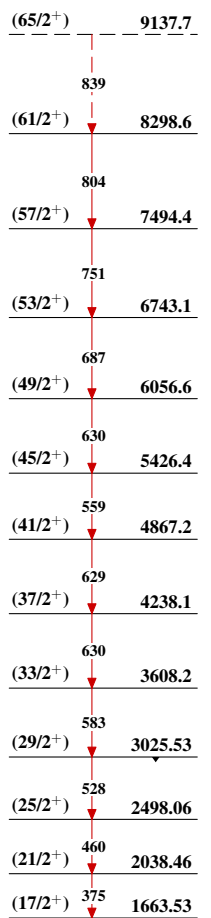
-----► γ Decay (Uncertain)


Adopted Levels, Gammas**Level Scheme (continued)**

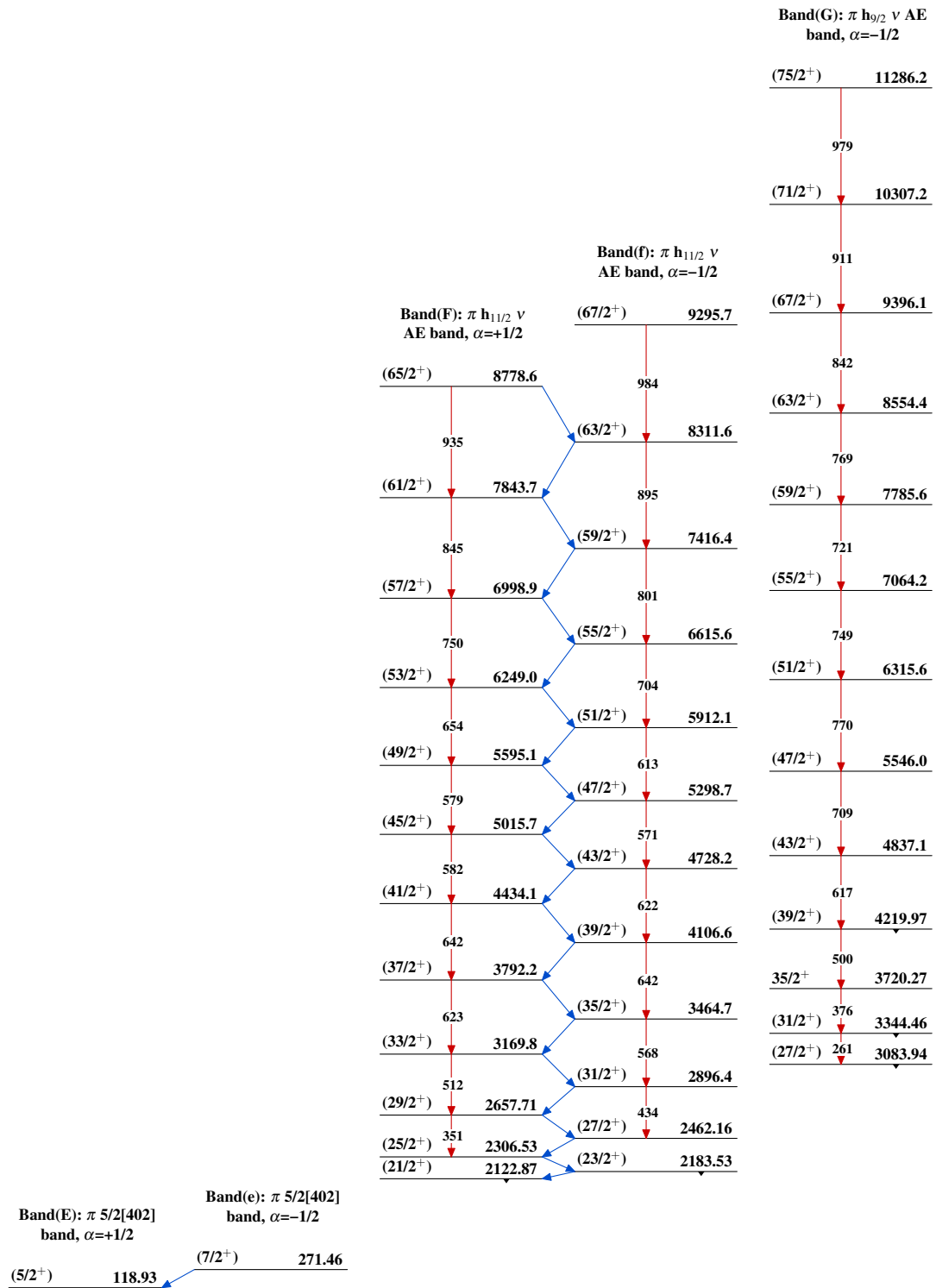
Intensities: Relative photon branching from each level

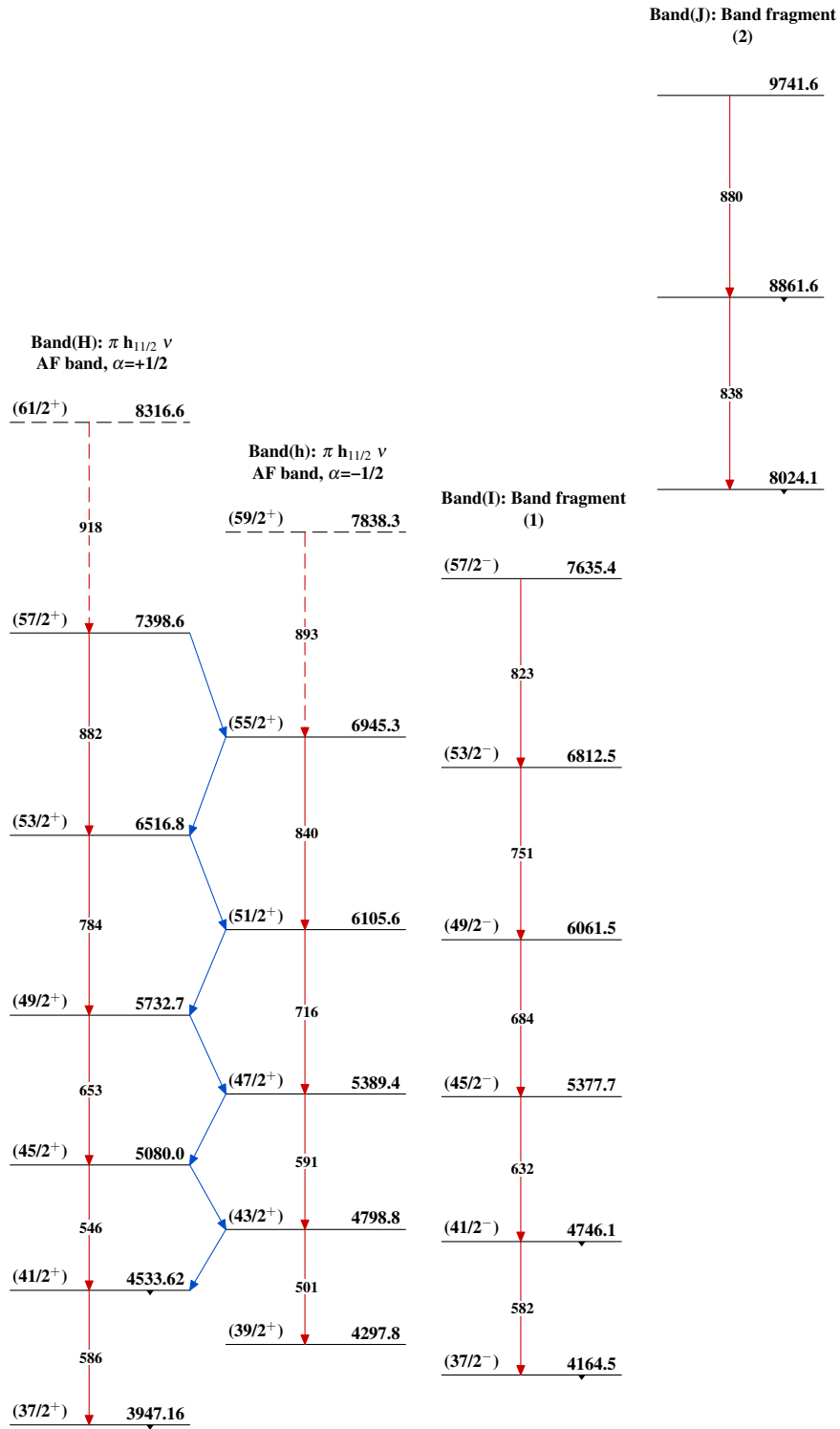


Adopted Levels, Gammas

 Band(A): $1/2[541]$ band
(2002Zh42)

 Band(B): $9/2[514]$,
 $\alpha=+1/2$ band (2002Zh42)

 Band(b): $9/2[514]$,
 $\alpha=-1/2$ band (2002Zh42)

 Band(C): $\alpha=+1/2$, 3
quasiparticle band
(2002Zh42)

 Band(c): $\alpha=-1/2$, 3
quasiparticle band
(2002Zh42)

 Band(D): $\pi 1/2[660]$
band


Adopted Levels, Gammas (continued)



Adopted Levels, Gammas (continued)

¹⁷³Ir α decay (9.3 s) 1992Sc16,2021Ha32

Parent: ¹⁷³Ir: E=0.0; J ^{π} =(1/2⁺,3/2⁺); T_{1/2}=9.3 s 6; Q(α)=5716 9; % α decay=4 2

¹⁷³Ir-J ^{π} : from 2021Ha32 based on ^{177g}Au=1/2⁺ and the unhindered or weakly hindered character of α decay to ^{173g}Ir. 2021Ha32 ruled out (5/2⁺). Other: (3/2⁺,5/2⁺) in 1995Sh21 and in the ENSDF update (by J. Tuli dated: August 15, 2015).

¹⁷³Ir-T_{1/2}: unweighted average of 9.8 s 14 (1992Sc16), 8.1 s 3 (1992Bo21), and 10 s 1 (2004GoZZ). The weighted average is 8.3 s 4 – higher precision reported in 1992Bo21. Others: 9.0 s 8 from 1995Sh21 and same in the ENSDF update (by J. Tuli dated: August 15, 2015) from average of first two values; 8.1 s 5 in 2021Ko07 – NUBASE.

¹⁷³Ir-Q(α): from 2021Wa16.

¹⁷³Ir-% α decay: from 2004GoZZ. Other % α : <6 1 (1992Sc16), <7 (1995Sh21).

1992Sc16: source from ¹⁴¹Pr(³⁶Ar,xn), E=175-204 MeV; measured α excit, E α , I α , E γ , I γ , I(K x ray), α -(K x ray) coin, $\alpha\gamma$ coin, α (t); deduced α branching; Si and Ge detectors.

2021Ha32: Source obtained from proton induced spallation of UC_x target with E=1.4 GeV protons. Selective ionization using RILIS at CERN followed by mass separation. Ions of interest transported to the Windmill decay station. Measured E α , I α , α (t) using surface barrier silicon detector and E γ , I γ , $\alpha\gamma$, γ (t) using a low energy Ge detector.

¹⁶⁹Re Levels

E(level)	J ^{π} [†]	T _{1/2} [†]	Comments
187 17	(1/2 ⁺ ,3/2 ⁺)	15.1 s 15	E(level): from 2021Ha32, based on mass and E α analysis starting with ¹⁷⁷ Au and ^{177m} Au decays. Other: 175 13 (2021Ko07 – NUBASE); If Q(α)=5716 9 (2021Wa16) is correct, E α =5418 keV 4 to this level implies 170 10; not consistent with the known E=215.88 3 J=(3/2) level in the adopted dataset.

[†] From Adopted Levels.

α radiations

E α	E(level)	I α [‡]	HF [†]	Comments
5418 4	187	100	1.2 6	E α : weighted average of 5416 10 (1992Sc16) and 5418 5 (2004GoZZ – from Table 5.1 and uncertainty from the footnote. In the text E α =5414 on page 108). Correlated with 5060 α from ¹⁶⁹ Re (2004GoZZ).

[†] The nuclear radius parameter r₀(¹⁶⁹Re)=1.5690 81 is deduced from interpolation (or unweighted average) of radius parameters of the adjacent even-even nuclides: ¹⁶⁸W=1.583 13 and ¹⁷⁰Os=1.5551 32 in 2020Si16.

[‡] For absolute intensity per 100 decays, multiply by 0.04 2.

¹⁷³Ir α decay (2.16 s) [2021Ha32](#),[1996Pa01](#),[1992Sc16](#)

Parent: ¹⁷³Ir: E=219 16; J π =11/2⁻; T_{1/2}=2.16 s 5; Q(α)=5716 9; % α decay=11 2

¹⁷³Ir-E: weighted average of 226 keV 18 ([2009An14](#)) and 213 keV 16 ([2021Ha32](#)). Uncertainty is the lower experimental one from [2021Ha32](#).

¹⁷³Ir-J π : from ¹⁷³Ir Adopted Levels in the ENSDF database (update).

¹⁷³Ir-T_{1/2}: weighted average of 2.20 s 5 ([1992Sc16](#)), 2.4 s 9 ([1996Pa01](#)) and 2.11 s 5 ([2004GoZZ](#)). Uncertainty from [1992Sc16](#), the lowest of the input uncertainties.

¹⁷³Ir-Q(α): from [2021Wa16](#).

¹⁷³Ir-% α decay: weighted average of 12 1 ([1992Sc16](#)), 7 2 ([1996Pa01](#)), and 14 3 ([2004GoZZ](#)). Other: 2.02 8 ([1986Ke03](#)), the evaluator of [2008Ba31](#) revises the value to 0.031 1 based on the [1996Pa01](#) report that only the lower energy α from ¹⁷⁷Au (I α =65% in [1986Ke03](#)) is correlated with the α from ¹⁷³Ir (2.16 s).

[2021Ha32](#): Source obtained from proton induced spallation of UC_x target with E=1.4 GeV protons. Selective ionization using RILIS at CERN followed by mass separation. Ions of interest transported to the Windmill decay station. Measured E α , I α , α (t) using surface barrier silicon detector and E γ , I γ , $\alpha\gamma$, γ (t) using a low energy Ge detector.

[1996Pa01](#): sources from heavy-ion fusion-evaporation reactions; recoil mass separator, double-sided Si strip detector (FWHM $\leq$ 20 keV); measured E α , parent T_{1/2} and % α .

[1992Sc16](#): source from ¹⁴¹Pr(³⁶Ar,xn), E=175-204 MeV; measured α excit, E α , I α , E γ , I γ , I(K x ray), α -(K x ray) coin, $\alpha\gamma$ coin, α (t); deduced α branching; Si and Ge detectors.

[1986Ke03](#): sources from ⁹⁰Zr bombardments of yttrium, zirconium and molybdenum (E(⁹⁰Zr)=321-390 MeV; velocity-filter, evaporation-residue separation); enriched targets; measured E α , I α , % α (¹⁷³Ir) (silicon surface-barrier detectors, FWHM=25, 50 keV).

[1967Si02](#): sources from ¹⁶²Er(¹⁹F,8n) E=185 MeV with 14.1% ¹⁶²Er target, ¹⁶⁴Er(¹⁹F,10n) E=145-175 MeV with 35.1% ¹⁶⁴Er target; helium-jet transport, Au-Si surface barrier detectors; measured E α , I α , parent T_{1/2}.

[1982De11](#): sources from ⁶³Cu bombardments of indium and tin (E(⁶³Cu)=245-300 MeV, helium-jet transport); enriched targets; measured E α , I α (surface-barrier detector).

¹⁶⁹Re Levels

E(level) [†]	J π [‡]	T _{1/2}
0.0	(9/2 ⁻)	8.1 s 5
136.2 2	(11/2 ⁻)	

[†] From E γ .

[‡] From Adopted Levels.

α radiations

E α	E(level)	I α ^{‡#}	HF [†]	Comments
5673 4	136.2	94 1	1.7 4	E α : weighted average of 5666 5 (5665 datum of 1967Si02 after adjustment by 1991Ry01), 5676 4 (1982De11), 5681 13 (1996Pa01), 5672 5 (2004GoZZ), and 5675 5 (2021Ha32). Coincident with 136 γ (1992Sc16).
5815 [@] 15	0.0	6 1	101 27	E α : from 2021Ha32 .

[†] The nuclear radius parameter r₀(¹⁶⁹Re)=1.5690 81 is deduced from interpolation (or unweighted average) of radius parameters of the adjacent even-even nuclides: ¹⁶⁸W (1.583 13) and ¹⁷⁰Os (1.5551 32) in [2020Si16](#).

[‡] From [2021Ha32](#).

For absolute intensity per 100 decays, multiply by 0.11 2.

@ Existence of this branch is questionable.

^{173}Ir α decay (2.16 s) [2021Ha32,1996Pa01,1992Sc16](#) (continued)

$\gamma(^{169}\text{Re})$

I $_{\gamma}$ normalization: From I(γ +ce)(136 γ)=94 I.

E_{γ}	$I_{\gamma}^{\dagger\ddagger}$	$E_i(\text{level})$	J_i^{π}	E_f	J_f^{π}	Mult.	δ	$\alpha^{\#}$	Comments
136.2 2	31 2	136.2	(11/2 ⁻)	0.0	(9/2 ⁻)	M1+E2	0.66 8	1.87 5	%I $_{\gamma}$ =32.8 7 E $_{\gamma}$: from 1992Sc16 . Other E $_{\gamma}$: 136.4 5 (2004GoZZ). Mult., δ : from α (K)exp=1.37 6 (1992Sc16).

[†] Photon intensity ([1992Sc16](#)), relative to I(Re K x ray)=41 3.

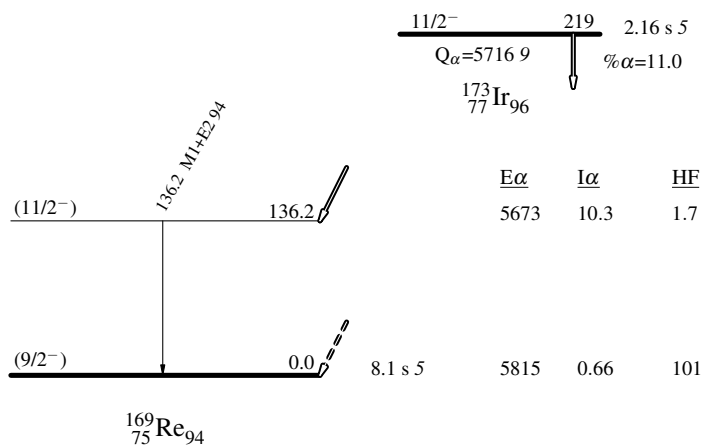
[‡] For absolute intensity per 100 decays, multiply by 1.06 7.

[#] Total theoretical internal conversion coefficients, calculated using the BrIcc code ([2008Ki07](#)) with “Frozen Orbitals” approximation based on γ -ray energies, assigned multiplicities, and mixing ratios, unless otherwise specified.

^{173}Ir α decay (2.16 s) [2021Ha32,1996Pa01,1992Sc16](#)

Decay Scheme

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



$^{118}\text{Sn}(^{55}\text{Mn}, 4n\gamma)$ 2013Ha02

Slightly edited, no significant changes compared to the ENSDF update (dated 15-Mar-2015) by C.M. Baglin.

E=260 MeV; stack of two 0.6 mg/cm² ^{118}Sn targets; GAMMASPHERE detector array (101 Compton-suppressed Ge detectors); measured $E\gamma$, $I\gamma$, $\gamma\gamma$ coin, angular distribution ratios R.

Notation for quasiparticle orbits:

ν $i_{13/2}$: A, B, C, D.

ν $h_{9/2}$: E, F.

π $h_{11/2}$: E_p, F_p.

 ^{169}Re Levels

E(level) [†]	J ^π [‡]	E(level) [†]	J ^π [‡]	E(level) [†]	J ^π [‡]	E(level) [†]	J ^π [‡]
0.0 [#]	9/2 ⁻	2462.1 ^g 4	(27/2 ⁺)	4533.3 ⁱ 4	(41/2 ⁺)	6945.0 ^j 4	(55/2 ⁺)
118.95 ^d 34	(5/2 ⁺)	2486.80 [@] 26	27/2 ⁻	4727.2 [#] 4	45/2 ⁻	6998.9 ^f 5	(57/2 ⁺)
136.40 [@] 14	11/2 ⁻	2497.96 ^c 30	25/2 ⁺	4728.2 ^g 4	(43/2 ⁺)	7064.0 ^h 5	55/2 ⁺
215.88 32	3/2	2509.40 30	(25/2 ⁺)	4745.9 ^k 4	41/2 ⁻	7248.1 ^{&} 6	57/2 ⁻
271.48 ^e 32	(7/2 ⁺)	2602.77 [#] 27	29/2 ⁻	4798.5 ^j 4	(43/2 ⁺)	7312.9 [#] 4	57/2 ⁻
278.78 24	7/2	2657.7 ^f 4	(29/2 ⁺)	4836.8 ^h 4	43/2 ⁺	7398.3 ⁱ 5	(57/2 ⁺)
382.70 [#] 15	13/2 ⁻	2743.66 [@] 30	31/2 ⁻	4867.1 ^c 5	41/2 ⁺	7416.4 ^g 5	(59/2 ⁺)
447.82 ^d 31	(9/2 ⁺)	2896.4 ^g 4	(31/2 ⁺)	5015.7 ^f 4	(45/2 ⁺)	7494.3 ^c 8	57/2 ⁺
535.98 ^{&} 24	5/2 ⁻	2903.52 ^{&} 30	29/2 ⁻	5048.6 ^{&} 5	45/2 ⁻	7635.2 ^k 6	57/2 ⁻
622.46 [@] 17	15/2 ⁻	2921.02 31		5079.7 ⁱ 4	(45/2 ⁺)	7755.9 [@] 4	59/2 ⁻
633.78 ^{&} 14	9/2 ⁻	2923.81 [#] 30	33/2 ⁻	5125.3 [@] 4	47/2 ⁻	7785.4 ^h 6	59/2 ⁺
637.66 ^e 30	(11/2 ⁺)	3025.43 ^c 32	29/2 ⁺	5298.6 ^g 5	(47/2 ⁺)	7838.0 ^j 7	(59/2 ⁺)
886.83 ^{&} 15	13/2 ⁻	3083.80 ^h 29	27/2 ⁺	5377.5 ^k 5	45/2 ⁻	7843.7 ^f 5	(61/2 ⁺)
898.01 ^d 28	(13/2 ⁺)	3141.20 [@] 31	35/2 ⁻	5389.1 ^j 4	(47/2 ⁺)	8024.0 ^l 7	
940.03 [#] 19	17/2 ⁻	3169.7 ^f 4	(33/2 ⁺)	5426.3 ^c 5	45/2 ⁺	8062.1 ^{&} 6	61/2 ⁻
1121.73 ^e 28	(15/2 ⁺)	3344.30 ^h 28	31/2 ⁺	5537.6 [#] 4	49/2 ⁻	8185.7 [#] 5	61/2 ⁻
1218.50 [@] 20	19/2 ⁻	3396.32 [#] 31	37/2 ⁻	5545.8 ^h 4	47/2 ⁺	8298.5 ^c 9	61/2 ⁺
1275.62 ^{&} 20	17/2 ⁻	3458.4 ^{&} 4	33/2 ⁻	5595.0 ^f 5	(49/2 ⁺)	8311.6 ^g 5	(63/2 ⁺)
1342.92 ^b 19	(15/2 ⁺)	3464.6 ^g 4	(35/2 ⁺)	5726.8 ^{&} 5	49/2 ⁻	8316.3 ⁱ 7	(61/2 ⁺)
1431.92 ^d 23	(17/2 ⁺)	3608.1 ^c 4	33/2 ⁺	5732.4 ⁱ 4	(49/2 ⁺)	8554.2 ^h 6	63/2 ⁺
1510.02 22		3686.65 [@] 33	39/2 ⁻	5912.0 ^g 5	(51/2 ⁺)	8626.3 [@] 7	63/2 ⁻
1583.96 [#] 21	21/2 ⁻	3720.07 ^h 31	35/2 ⁺	5973.2 [@] 4	51/2 ⁻	8778.6 ^f 5	(65/2 ⁺)
1623.39 ^a 19	(17/2 ⁺)	3792.2 ^f 4	(37/2 ⁺)	6056.5 ^c 6	49/2 ⁺	8861.5 ^l 7	
1663.45 ^c 21	17/2 ⁺	3942.6 ^{&} 4	37/2 ⁻	6061.3 ^k 5	49/2 ⁻	8918.6 ^{&} 7	65/2 ⁻
1764.78 ^{&} 26	21/2 ⁻	3946.85 ⁱ 35	(37/2 ⁺)	6105.3 ^j 4	(51/2 ⁺)	9137.6 ^c 11	(65/2 ⁺)
1799.30 ^b 20	(19/2 ⁺)	4005.78 [#] 34	41/2 ⁻	6249.0 ^f 5	(53/2 ⁺)	9295.7 ^g 7	(67/2 ⁺)
1882.29 [@] 23	23/2 ⁻	4106.5 ^g 4	(39/2 ⁺)	6315.4 ^h 5	51/2 ⁺	9395.9 ^h 6	67/2 ⁺
1991.57 ^a 22	(21/2 ⁺)	4164.3 ^k 4	37/2 ⁻	6413.9 [#] 4	53/2 ⁻	9741.5 ^l 9	
2038.37 ^c 27	21/2 ⁺	4219.74 ^h 32	39/2 ⁺	6466.5 ^{&} 6	53/2 ⁻	9812.6 ^{&} 7	69/2 ⁻
2122.86 ^f 25	(21/2 ⁺)	4238.0 ^c 4	37/2 ⁺	6516.4 ⁱ 4	(53/2 ⁺)	10307.0 ^h 8	71/2 ⁺
2183.49 ^g 25	(23/2 ⁺)	4297.5 ^j 6	(39/2 ⁺)	6615.5 ^g 5	(55/2 ⁺)	10755.8 ^{&} 9	73/2 ⁻
2257.72 [#] 25	25/2 ⁻	4356.05 [@] 35	43/2 ⁻	6743.0 ^c 6	53/2 ⁺	11286.0 ^h 10	75/2 ⁺
2306.49 ^f 32	(25/2 ⁺)	4434.0 ^f 4	(41/2 ⁺)	6812.3 ^k 5	53/2 ⁻	11764.8 ^{&} 10	77/2 ⁻
2321.04 ^{&} 28	25/2 ⁻	4452.1 ^{&} 5	41/2 ⁻	6869.5 [@] 4	55/2 ⁻		

Continued on next page (footnotes at end of table)

¹¹⁸Sn(⁵⁵Mn,4nγ) **2013Ha02 (continued)**

¹⁶⁹Re Levels (continued)

- [†] From least squares fit to E_γ .
- [‡] Authors' proposed values; consistent with deduced band structure and measured transition multiplicities.
- # Band(A): π 9/2[514] band, $\alpha=+1/2$. Initial alignment $\approx 1.5\hbar$; lower than cranked shell model prediction of $2.6\hbar$, possibly indicating mixing with K=11/2 orbital. First band crossing at $\hbar\omega=0.23$ MeV matches prediction for AB alignment. Observed B(M1)/B(E2) ratios and alignments consistent with calculated values for π 9/2[514] band. Second crossing near 0.44 MeV associated with CD alignment. Yrast at lower spins.
- @ Band(a): π 9/2[514] band, $\alpha=-1/2$. See comment on signature partner band.
- & Band(B): π 1/2[541] band. Decoupled sequence with initial alignment of $3\hbar$; delayed AB crossing at $\hbar\omega=0.27$ MeV; second crossing at $\hbar\omega=0.43$ MeV occurs at lower frequency than expected for CD alignment and alignment gain may instead result from mixing with another band.
- ^a Band(C): $\alpha=+1/2$ band fragment (3). Strongly feeds g.s. band via D transitions, possibly suggesting opposite parity; insufficient information for authors to suggest a configuration assignment.
- ^b Band(c): $\alpha=-1/2$, 3 quasiparticle band. See comment on signature partner band.
- ^c Band(D): π 1/2[660] band. Decoupled band; initial alignment of $6\hbar$ is somewhat low for a 3-quasiparticle structure but consistent with π 1/2[660]; band crossing observed near $\hbar\omega=0.30$ MeV (possibly delayed AB alignment).
- ^d Band(E): π 5/2[402] band, $\alpha=+1/2$. Strongly-coupled structure with almost zero initial alignment, suggests π 5/2[402] or π 7/2[402] and observed B(M1)/B(E2) ratios clearly favor the former.
- ^e Band(e): π 5/2[402] band, $\alpha=-1/2$. See comment on signature partner band.
- ^f Band(F): π $h_{11/2}\otimes\nu$ AE band, $\alpha=+1/2$. Strongly-coupled structure. Energy and initial alignment $\approx 10\hbar$ suggests a 3-quasiparticle structure. Band crossing at $\hbar\omega=0.30$ MeV is near predicted BC crossing (AB is blocked) and is consistent with its observation in the $\pi h_{11/2}\nu i_{13/2}$ band in ¹⁷⁰Re at 0.29 MeV. Observed B(M1)/B(E2) ratios consistent with those predicted for assigned configuration, where E is closest $\pi=-$ orbital to the Fermi surface, and with absence of CD alignment at high frequency.
- ^g Band(f): π $h_{11/2}\otimes\nu$ AE band, $\alpha=-1/2$. See comment on signature partner band.
- ^h Band(G): π $h_{9/2}\otimes\nu$ AE band, $\alpha=-1/2$. Decoupled sequence. Lowest level feeds J=25/2 and 27/2 states. Initial alignment 2-3 $\hbar$ larger than that of $\pi h_{11/2}\nu$ AE band; crossing at 0.37 MeV, between expectations for BC and CD alignments. Larger deformation driven by π $h_{9/2}$ may delay BC crossing.
- ⁱ Band(H): π $h_{11/2}\otimes\nu$ AF band, $\alpha=+1/2$. Strongly-coupled band feeding g.s. band. Observed B(M1)/B(E2) ratios agree with those predicted for the suggested configuration.
- ^j Band(h): π $h_{11/2}\otimes\nu$ AF band, $\alpha=-1/2$. See comment on signature partner band.
- ^k Band(I): $\alpha=+1/2$ band fragment (1). Decoupled sequence feeding 1/2[541] band via stretched Q transitions, suggesting $\pi=-$. Excitation energy suggests 3⁻ or 5-quasiparticle configuration. Initial alignment $\approx 13\hbar$. Decoupled character suggests involvement of π 1/2[411], π 1/2[541] or π 1/2[660]; J rules out assignment as 1/2[541] signature partner, and 1/2[660] has already been assigned elsewhere, so authors tentatively assign the π 1/2[411] $\otimes\nu$ AEBC configuration.
- ^l Band(J): Band fragment (2). Feeds into 1/2[541] band.

$\gamma(^{169}\text{Re})$

E_γ	$I_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [‡]	Comments
(61)		2183.49	(23/2 ⁺)	2122.86	(21/2 ⁺)		Expected but unobserved, possibly due to large conversion associated with the expected M1 multipolarity.
97.8 2	3.0 4	633.78	9/2 ⁻	535.98	5/2 ⁻		R=0.7 1; consistent with stretched D, but level scheme requires $\Delta J=2$.
113.4 2	0.5 1	1623.39	(17/2 ⁺)	1510.02			
116.0 2	20 1	2602.77	29/2 ⁻	2486.80	27/2 ⁻	D	R=0.60 4.
123.0 2	12 1	2306.49	(25/2 ⁺)	2183.49	(23/2 ⁺)	D	R=0.61 8.
136.4 2	≈ 79	136.40	11/2 ⁻	0.0	9/2 ⁻	D(+Q)	I_γ : authors' estimate based on intensity balance. R=0.67 3.
140.9 2	27 2	2743.66	31/2 ⁻	2602.77	29/2 ⁻	D	R=0.59 3.
152.5 2	6.8 5	271.48	(7/2 ⁺)	118.95	(5/2 ⁺)		
155.6 2	16 1	2462.1	(27/2 ⁺)	2306.49	(25/2 ⁺)	D	R=0.63 5.

Continued on next page (footnotes at end of table)

¹¹⁸Sn(⁵⁵Mn,4n γ) **2013Ha02** (continued)

 $\gamma(^{169}\text{Re})$ (continued)

E_γ	$I_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ‡	Comments
175.9 2	25 3	1799.30	(19/2 ⁺)	1623.39	(17/2 ⁺)		R=0.65 9 for doublet.
176.3 2	9.1 9	447.82	(9/2 ⁺)	271.48	(7/2 ⁺)		
180.2 2	35 2	2923.81	33/2 ⁻	2743.66	31/2 ⁻	D	R=0.65 2.
189.9 2	8.5 9	637.66	(11/2 ⁺)	447.82	(9/2 ⁺)		
191.4 2	6 1	1623.39	(17/2 ⁺)	1431.92	(17/2 ⁺)		R=0.78 9 for doublet.
191.9 2	15 2	2183.49	(23/2 ⁺)	1991.57	(21/2 ⁺)		R=0.78 9 for doublet.
192.3 2	14 3	1991.57	(21/2 ⁺)	1799.30	(19/2 ⁺)		R=0.78 9 for doublet.
195.5 2	19 2	2657.7	(29/2 ⁺)	2462.1	(27/2 ⁺)	D+Q	R=0.71 5.
215.3 2	1.0 2	1799.30	(19/2 ⁺)	1583.96	21/2 ⁻		
217.4 2	39 2	3141.20	35/2 ⁻	2923.81	33/2 ⁻	D	R=0.66 2.
223.7 2	8.0 6	1121.73	(15/2 ⁺)	898.01	(13/2 ⁺)		
229.1 2	33 2	2486.80	27/2 ⁻	2257.72	25/2 ⁻	D	R=0.67 3.
238.7 2	21 3	2896.4	(31/2 ⁺)	2657.7	(29/2 ⁺)		R=0.68 8 for doublet.
239.8 2	100	622.46	15/2 ⁻	382.70	13/2 ⁻	D+Q	R=0.81 3.
246.3 2	≈ 131	382.70	13/2 ⁻	136.40	11/2 ⁻	D+Q	R=0.78 2.
253.1 2	17 1	886.83	13/2 ⁻	633.78	9/2 ⁻		R=0.82 2.
255.2 2	38 2	3396.32	37/2 ⁻	3141.20	35/2 ⁻	D+Q	R=0.73 3.
260.4 2	8.2 7	898.01	(13/2 ⁺)	637.66	(11/2 ⁺)		
260.5 2	1.5 2	3344.30	31/2 ⁺	3083.80	27/2 ⁺		
265.2 2	3.7 4	4798.5	(43/2 ⁺)	4533.3	(41/2 ⁺)		
273.3 2	19 1	3169.7	(33/2 ⁺)	2896.4	(31/2 ⁺)	D	R=0.67 5.
278.4 2	48 3	1218.50	19/2 ⁻	940.03	17/2 ⁻	D+Q	R=0.74 3.
280.5 2	11 1	1623.39	(17/2 ⁺)	1342.92	(15/2 ⁺)	D	R=0.61 5.
281.2 2	4.0 3	5079.7	(45/2 ⁺)	4798.5	(43/2 ⁺)		
282.9 2	6.0 8	5298.6	(47/2 ⁺)	5015.7	(45/2 ⁺)	D	R=0.61 5.
287.5 2	7.1 8	5015.7	(45/2 ⁺)	4728.2	(43/2 ⁺)	D	R=0.60 5.
290.4 2	36 3	3686.65	39/2 ⁻	3396.32	37/2 ⁻		R=0.70 3.
294.2 2	8 1	4728.2	(43/2 ⁺)	4434.0	(41/2 ⁺)		R=0.66 6 for doublet.
294.8 2	17 2	3464.6	(35/2 ⁺)	3169.7	(33/2 ⁺)	D	R=0.65 4.
296.4 2	5.7 5	5595.0	(49/2 ⁺)	5298.6	(47/2 ⁺)		R=0.66 6 for doublet.
298.3 2	30 2	1882.29	23/2 ⁻	1583.96	21/2 ⁻	D	R=0.70 5.
309.4 2	2.9 2	5389.1	(47/2 ⁺)	5079.7	(45/2 ⁺)		
310.2 2	6.3 6	1431.92	(17/2 ⁺)	1121.73	(15/2 ⁺)		
314.4 2	11 1	4106.5	(39/2 ⁺)	3792.2	(37/2 ⁺)		R=0.56 9 for doublet.
317.0 2	5.0 6	5912.0	(51/2 ⁺)	5595.0	(49/2 ⁺)		R=0.56 9 for doublet.
317.6 2	72 4	940.03	17/2 ⁻	622.46	15/2 ⁻		R=0.79 5 for doublet.
319.1 2	25 1	4005.78	41/2 ⁻	3686.65	39/2 ⁻		R=0.79 5 for doublet.
320.1 2	≈ 10	535.98	5/2 ⁻	215.88	3/2	D(+Q)	R=0.71 3.
321.0 2	4.0 9	2923.81	33/2 ⁻	2602.77	29/2 ⁻		
323.6 2	1.6 2	2122.86	(21/2 ⁺)	1799.30	(19/2 ⁺)		
327.5 2	9 1	4434.0	(41/2 ⁺)	4106.5	(39/2 ⁺)		
327.6 2	13 2	3792.2	(37/2 ⁺)	3464.6	(35/2 ⁺)		
328.9 2	1.6 2	447.82	(9/2 ⁺)	118.95	(5/2 ⁺)		
337.0 2	4.5 4	6249.0	(53/2 ⁺)	5912.0	(51/2 ⁺)		
343.2 2	2.0 1	5732.4	(49/2 ⁺)	5389.1	(47/2 ⁺)		
345.0 2	2.7 8	2602.77	29/2 ⁻	2257.72	25/2 ⁻		
350.3 2	18 1	4356.05	43/2 ⁻	4005.78	41/2 ⁻	D+Q	R=0.72 5.
351.2 2	3.6 3	2657.7	(29/2 ⁺)	2306.49	(25/2 ⁺)		
355.0 2	1.4 2	633.78	9/2 ⁻	278.78	7/2	D	R=0.6 1.
365.4 2	41 3	1583.96	21/2 ⁻	1218.50	19/2 ⁻	D+Q	R=0.86 4.
366.2 2	3.6 3	637.66	(11/2 ⁺)	271.48	(7/2 ⁺)		
366.6 2	3.9 3	6615.5	(55/2 ⁺)	6249.0	(53/2 ⁺)		
367.5 2	1.6 3	1799.30	(19/2 ⁺)	1431.92	(17/2 ⁺)		
368.2 2	3.0 4	1991.57	(21/2 ⁺)	1623.39	(17/2 ⁺)		
371.2 2	10 1	4727.2	45/2 ⁻	4356.05	43/2 ⁻	D+Q	R=0.75 6.

Continued on next page (footnotes at end of table)

$^{118}\text{Sn}(^{55}\text{Mn}, 4n\gamma)$ **2013Ha02** (continued) $\gamma(^{169}\text{Re})$ (continued)

E_γ	$I_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ‡	Comments
372.9 2	1.5 1	6105.3	(51/2 ⁺)	5732.4	(49/2 ⁺)		
374.9 2	3.3 4	2038.37	21/2 ⁺	1663.45	17/2 ⁺	Q	R=0.9 1.
375.4 2	27 2	2257.72	25/2 ⁻	1882.29	23/2 ⁻	(D+Q)	R=0.76 4.
375.8 2	2.4 3	3720.07	35/2 ⁺	3344.30	31/2 ⁺		
382.7 2	≈31	382.70	13/2 ⁻	0.0	9/2 ⁻		R=0.76 5; low for $\Delta J=2$ required by level scheme.
383.4 2	2.8 2	6998.9	(57/2 ⁺)	6615.5	(55/2 ⁺)		
384.2 2	3.2 5	2183.49	(23/2 ⁺)	1799.30	(19/2 ⁺)		
387.8 2	0.8 2	1663.45	17/2 ⁺	1275.62	17/2 ⁻		
388.8 2	17 2	1275.62	17/2 ⁻	886.83	13/2 ⁻	(Q)	R=0.89 2.
397.5 2	6.3 6	3141.20	35/2 ⁻	2743.66	31/2 ⁻		R=0.9 1 for doublet.
398.0 2	6.5 5	5125.3	47/2 ⁻	4727.2	45/2 ⁻		R=0.9 1 for doublet.
404.9 2	12 1	1623.39	(17/2 ⁺)	1218.50	19/2 ⁻	D	R=0.58 8.
411.1 2	1.0 1	6516.4	(53/2 ⁺)	6105.3	(51/2 ⁺)		
412.3 2	3.7 4	5537.6	49/2 ⁻	5125.3	47/2 ⁻	D+Q	R=0.87 9.
417.5 2	1.7 1	7416.4	(59/2 ⁺)	6998.9	(57/2 ⁺)		
423.3 5	<0.3	3344.30	31/2 ⁺	2921.02			
427.3 2	1.3 1	7843.7	(61/2 ⁺)	7416.4	(59/2 ⁺)		
428.6 2	0.8 1	6945.0	(55/2 ⁺)	6516.4	(53/2 ⁺)		
429.7 2	0.6 1	8185.7	61/2 ⁻	7755.9	59/2 ⁻		
434.3 2	4.6 5	2896.4	(31/2 ⁺)	2462.1	(27/2 ⁺)		
435.7 2	2.5 4	5973.2	51/2 ⁻	5537.6	49/2 ⁻		
440.7 2	2.1 3	6413.9	53/2 ⁻	5973.2	51/2 ⁻		
440.8 2	0.3 1	3344.30	31/2 ⁺	2903.52	29/2 ⁻		
443.0 2	0.5 1	7755.9	59/2 ⁻	7312.9	57/2 ⁻		
443.4 2	1.0 2	7312.9	57/2 ⁻	6869.5	55/2 ⁻		
450.1 2	5.1 5	898.01	(13/2 ⁺)	447.82	(9/2 ⁺)		
453.4 2	0.5 1	7398.3	(57/2 ⁺)	6945.0	(55/2 ⁺)		
455.4 2	1.2 1	6869.5	55/2 ⁻	6413.9	53/2 ⁻		
459.6 2	2.4 2	2497.96	25/2 ⁺	2038.37	21/2 ⁺	Q	R=1.0 1.
467.0 2	0.5 2	8778.6	(65/2 ⁺)	8311.6	(63/2 ⁺)		
467.9 2	0.6 2	8311.6	(63/2 ⁺)	7843.7	(61/2 ⁺)		
471.0 2	1.0 2	2509.40	(25/2 ⁺)	2038.37	21/2 ⁺		
472.5 2	9 1	3396.32	37/2 ⁻	2923.81	33/2 ⁻	Q	R=1.00 8.
484.1 2	4.9 4	1121.73	(15/2 ⁺)	637.66	(11/2 ⁺)		
484.2 2	11 1	3942.6	37/2 ⁻	3458.4	33/2 ⁻	Q	R=1.06 5.
486.0	67 5	622.46	15/2 ⁻	136.40	11/2 ⁻		R=0.86 4.
489.2 2	15 1	1764.78	21/2 ⁻	1275.62	17/2 ⁻	Q	R=0.87 2.
497.4 2	5.9 8	633.78	9/2 ⁻	136.40	11/2 ⁻	(D)	R=0.96 5. Interpreted by authors as D, $\Delta J=0$ transition, but compatible with Q, $\Delta J=2$ also.
499.7 2	1.9 2	4219.74	39/2 ⁺	3720.07	35/2 ⁺		
501.0 5	<0.3	4798.5	(43/2 ⁺)	4297.5	(39/2 ⁺)		
509.5 2	9.5 9	4452.1	41/2 ⁻	3942.6	37/2 ⁻	Q	R=1.03 3.
512.0 2	4.8 4	3169.7	(33/2 ⁺)	2657.7	(29/2 ⁺)		
516.0 2	0.8 1	3025.43	29/2 ⁺	2509.40	(25/2 ⁺)		
527.5 2	1.1 1	3025.43	29/2 ⁺	2497.96	25/2 ⁺	Q	R=0.92 8.
533.9 2	5.4 5	1431.92	(17/2 ⁺)	898.01	(13/2 ⁺)		
545.4 2	10.5 6	3686.65	39/2 ⁻	3141.20	35/2 ⁻	Q	R=1.02 8.
546.4 2	0.7 1	5079.7	(45/2 ⁺)	4533.3	(41/2 ⁺)		
554.9 2	13 2	3458.4	33/2 ⁻	2903.52	29/2 ⁻		R=0.99 5 for doublet.
556.3 2	14 2	2321.04	25/2 ⁻	1764.78	21/2 ⁻		R=0.99 5 for doublet.
557.3 2	43 4	940.03	17/2 ⁻	382.70	13/2 ⁻	Q	R=1.03 5.
559.2 2	1.0 1	5426.3	45/2 ⁺	4867.1	41/2 ⁺	Q	R=1.1 1.
568.3 2	8.3 8	3464.6	(35/2 ⁺)	2896.4	(31/2 ⁺)	Q	R=0.91 5.
570.5 2	5.6 5	5298.6	(47/2 ⁺)	4728.2	(43/2 ⁺)	Q	R=0.91 5.
574.4 5	<0.3	3083.80	27/2 ⁺	2509.40	(25/2 ⁺)		

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$^{118}\text{Sn}(^{55}\text{Mn},4n\gamma)$ **2013Ha02** (continued) $\gamma(^{169}\text{Re})$ (continued)

E_γ	$I_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ‡	Comments
579.3 2	3.3 4	5595.0	(49/2 ⁺)	5015.7	(45/2 ⁺)		R=1.07 9 for doublet.
581.6 2	0.8 1	4745.9	41/2 ⁻	4164.3	37/2 ⁻		
581.6 2	5.9 8	5015.7	(45/2 ⁺)	4434.0	(41/2 ⁺)		R=1.07 9 for doublet.
582.5 2	13 2	2903.52	29/2 ⁻	2321.04	25/2 ⁻	Q	R=1.10 3.
582.7 2	1.7 2	3608.1	33/2 ⁺	3025.43	29/2 ⁺	Q	R=1.2 1.
585.7 5	<0.3	3083.80	27/2 ⁺	2497.96	25/2 ⁺		
586.4 2	0.7 1	4533.3	(41/2 ⁺)	3946.85	(37/2 ⁺)		
590.6 2	1.1 1	5389.1	(47/2 ⁺)	4798.5	(43/2 ⁺)		
596.0 2	74 5	1218.50	19/2 ⁻	622.46	15/2 ⁻	Q	R=0.9 1.
596.5 2	8.6 6	5048.6	45/2 ⁻	4452.1	41/2 ⁻	Q	R=0.96 3.
597.0 5	<0.3	3083.80	27/2 ⁺	2486.80	27/2 ⁻		
604.5 2	46 3	2486.80	27/2 ⁻	1882.29	23/2 ⁻		R=0.79 4; low for $\Delta J=2$ required by level scheme.
609.5 2	14 1	4005.78	41/2 ⁻	3396.32	37/2 ⁻		
613.4 2	3.2 4	5912.0	(51/2 ⁺)	5298.6	(47/2 ⁺)		
617.1 2	2.4 2	4836.8	43/2 ⁺	4219.74	39/2 ⁺		
621.7 2	6.0 5	4728.2	(43/2 ⁺)	4106.5	(39/2 ⁺)		R=0.99 6 for doublet.
622.5 2	7.9 7	3792.2	(37/2 ⁺)	3169.7	(33/2 ⁺)		R=0.99 6 for doublet.
629.1 2	1.1 2	4867.1	41/2 ⁺	4238.0	37/2 ⁺		R=0.9 2 for doublet.
629.9 2	1.4 2	4238.0	37/2 ⁺	3608.1	33/2 ⁺		R=0.9 2 for doublet.
630.2 2	0.6 1	6056.5	49/2 ⁺	5426.3	45/2 ⁺		R=0.9 2 for doublet.
631.6 2	1.0 1	5377.5	45/2 ⁻	4745.9	41/2 ⁻		
633.8 2	1.7 2	633.78	9/2 ⁻	0.0	9/2 ⁻		
641.8 2	7.4 6	4106.5	(39/2 ⁺)	3464.6	(35/2 ⁺)		R=1.03 6 for doublet.
641.9 2	6.7 8	4434.0	(41/2 ⁺)	3792.2	(37/2 ⁺)		R=1.03 6 for doublet.
643.9 2	45 4	1583.96	21/2 ⁻	940.03	17/2 ⁻		R=0.81 5; low for $\Delta J=2$ transition implied by level scheme.
652.7 2	1.3 1	5732.4	(49/2 ⁺)	5079.7	(45/2 ⁺)		
653.9 2	2.5 2	6249.0	(53/2 ⁺)	5595.0	(49/2 ⁺)		
663.3 2	0.3 1	2921.02		2257.72	25/2 ⁻		
663.8 2	59 4	1882.29	23/2 ⁻	1218.50	19/2 ⁻	Q	R=1.01 4.
669.4 2	7.9 5	4356.05	43/2 ⁻	3686.65	39/2 ⁻		
673.8	30 2	2257.72	25/2 ⁻	1583.96	21/2 ⁻	Q	R=0.89 8.
678.2 2	6.8 4	5726.8	49/2 ⁻	5048.6	45/2 ⁻	Q	R=1.02 4.
683.4 2	6.4 6	1623.39	(17/2 ⁺)	940.03	17/2 ⁻		R=0.75 6.
683.8 2	0.7 1	6061.3	49/2 ⁻	5377.5	45/2 ⁻		
686.5 2	0.5 1	6743.0	53/2 ⁺	6056.5	49/2 ⁺		
690.9 2	2.1 3	2122.86	(21/2 ⁺)	1431.92	(17/2 ⁺)		
703.5 2	2.1 2	6615.5	(55/2 ⁺)	5912.0	(51/2 ⁺)		
705.9 2	1.0 1	4164.3	37/2 ⁻	3458.4	33/2 ⁻	Q	R=0.98 5.
708.9 2	1.9 2	5545.8	47/2 ⁺	4836.8	43/2 ⁺		
716.2 2	1.1 1	6105.3	(51/2 ⁺)	5389.1	(47/2 ⁺)		
720.5 2	14 1	1342.92	(15/2 ⁺)	622.46	15/2 ⁻		R=0.76 6; interpreted by authors as a $\Delta J=0$ transition.
721.4 2	9.2 6	4727.2	45/2 ⁻	4005.78	41/2 ⁻		
721.4 2	1.0 1	7785.4	59/2 ⁺	7064.0	55/2 ⁺		
739.7 2	5.4 4	6466.5	53/2 ⁻	5726.8	49/2 ⁻		R=1.24 6; $\Delta J=2$ required by level scheme.
748.6 2	1.3 1	7064.0	55/2 ⁺	6315.4	51/2 ⁺		
749.9 2	1.8 1	6998.9	(57/2 ⁺)	6249.0	(53/2 ⁺)		
751.0 2	0.5 1	6812.3	53/2 ⁻	6061.3	49/2 ⁻		
751.3 5	<0.3	7494.3	57/2 ⁺	6743.0	53/2 ⁺		
762.9 5	<0.3	3083.80	27/2 ⁺	2321.04	25/2 ⁻		
768.8 2	0.8 1	8554.2	63/2 ⁺	7785.4	59/2 ⁺		
769.2 2	5.4 3	5125.3	47/2 ⁻	4356.05	43/2 ⁻		
769.6 2	1.7 2	6315.4	51/2 ⁺	5545.8	47/2 ⁺		
773.0 2	0.4 1	1991.57	(21/2 ⁺)	1218.50	19/2 ⁻		
775.9 5	<0.3	8024.0		7248.1	57/2 ⁻		

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$^{118}\text{Sn}(^{55}\text{Mn}, 4n\gamma)$ **2013Ha02** (continued) $\gamma(^{169}\text{Re})$ (continued)

E_γ	$I_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ‡	Comments
781.6 2	3.2 3	7248.1	57/2 ⁻	6466.5	53/2 ⁻	Q	R=1.12 7.
784.1 2	1.0 1	6516.4	(53/2 ⁺)	5732.4	(49/2 ⁺)		
799.3 5	<0.3	8861.5		8062.1	61/2 ⁻		
800.8 2	1.3 1	7416.4	(59/2 ⁺)	6615.5	(55/2 ⁺)		
803.3 2	0.3 1	4745.9	41/2 ⁻	3942.6	37/2 ⁻	Q	R=1.05 7.
804.2 5	<0.3	8298.5	61/2 ⁺	7494.3	57/2 ⁺		
805.6 2	0.7 1	3946.85	(37/2 ⁺)	3141.20	35/2 ⁻		
810.4 2	4.1 3	5537.6	49/2 ⁻	4727.2	45/2 ⁻		
814.0 2	1.9 2	8062.1	61/2 ⁻	7248.1	57/2 ⁻	Q	R=1.2 1.
822.9 2	0.3 1	7635.2	57/2 ⁻	6812.3	53/2 ⁻		
823.4 2	0.4 1	4219.74	39/2 ⁺	3396.32	37/2 ⁻		
837.5 5	<0.3	8861.5		8024.0			
839.0 [#] 5	<0.3	9137.6?	(65/2 ⁺)	8298.5	61/2 ⁺		
839.7 2	0.8 1	6945.0	(55/2 ⁺)	6105.3	(51/2 ⁺)		
841.7 2	0.4 1	9395.9	67/2 ⁺	8554.2	63/2 ⁺		
844.8 2	1.0 1	7843.7	(61/2 ⁺)	6998.9	(57/2 ⁺)		
846.7 2	3.6 4	4533.3	(41/2 ⁺)	3686.65	39/2 ⁻		
847.9 2	2.9 4	5973.2	51/2 ⁻	5125.3	47/2 ⁻		
856.5 2	0.9 1	8918.6	65/2 ⁻	8062.1	61/2 ⁻		
859.3 2	3.7 3	1799.30	(19/2 ⁺)	940.03	17/2 ⁻	D	R=0.74 5; level scheme requires E1.
870.4	0.6 1	8626.3	63/2 ⁻	7755.9	59/2 ⁻		
872.8 2	0.8 1	8185.7	61/2 ⁻	7312.9	57/2 ⁻		
876.3 2	2.4 3	6413.9	53/2 ⁻	5537.6	49/2 ⁻		
880.0 5	<0.3	9741.5		8861.5			
881.8 2	0.5 1	7398.3	(57/2 ⁺)	6516.4	(53/2 ⁺)		
886.5 2	1.4 1	7755.9	59/2 ⁻	6869.5	55/2 ⁻		
886.8 2	1.6 2	886.83	13/2 ⁻	0.0	9/2 ⁻	Q	R=0.9 1.
887.6 2	0.3 1	1510.02		622.46	15/2 ⁻		
893.0 [#] 5	<0.3	7838.0?	(59/2 ⁺)	6945.0	(55/2 ⁺)		
894.0 2	0.4 1	9812.6	69/2 ⁻	8918.6	65/2 ⁻		
895.2 2	1.0 1	8311.6	(63/2 ⁺)	7416.4	(59/2 ⁺)		
896.4 2	2.1 2	6869.5	55/2 ⁻	5973.2	51/2 ⁻		
898.9 2	1.6 2	7312.9	57/2 ⁻	6413.9	53/2 ⁻		
911.1 5	<0.3	10307.0	71/2 ⁺	9395.9	67/2 ⁺		
918.0 [#] 5	<0.3	8316.3?	(61/2 ⁺)	7398.3	(57/2 ⁺)		
934.9 2	0.7 1	8778.6	(65/2 ⁺)	7843.7	(61/2 ⁺)		
943.2 5	<0.3	10755.8	73/2 ⁻	9812.6	69/2 ⁻		
960.2 2	5.5 5	1342.92	(15/2 ⁺)	382.70	13/2 ⁻		R=0.41 5 d.
979.0 5	<0.3	11286.0	75/2 ⁺	10307.0	71/2 ⁺		
984.1 5	<0.3	9295.7	(67/2 ⁺)	8311.6	(63/2 ⁺)		
1000.9 2	5.7 4	1623.39	(17/2 ⁺)	622.46	15/2 ⁻	D	R=0.52 5.
1009.0 5	<0.3	11764.8	77/2 ⁻	10755.8	73/2 ⁻		
1041.0 2	3.2 4	1663.45	17/2 ⁺	622.46	15/2 ⁻		R=0.71 9; level scheme requires E1.
1127.3 5	<0.3	1510.02		382.70	13/2 ⁻		

[†] Photon intensity relative to I(240 γ)=100.[‡] Assigned by evaluator based on R, the ratio of summed I γ from the 5 rings of detectors nearest to 90° (71°, 81°, 90°, 99°, 101°) to that from detectors at backward angles (122°, 130°, 143°, 148°, 163°), normalized so known pure D ($\Delta J=1$) and pure Q ($\Delta J=2$) transitions have values of R=0.6 and 1.0, respectively.[#] Placement of transition in the level scheme is uncertain.

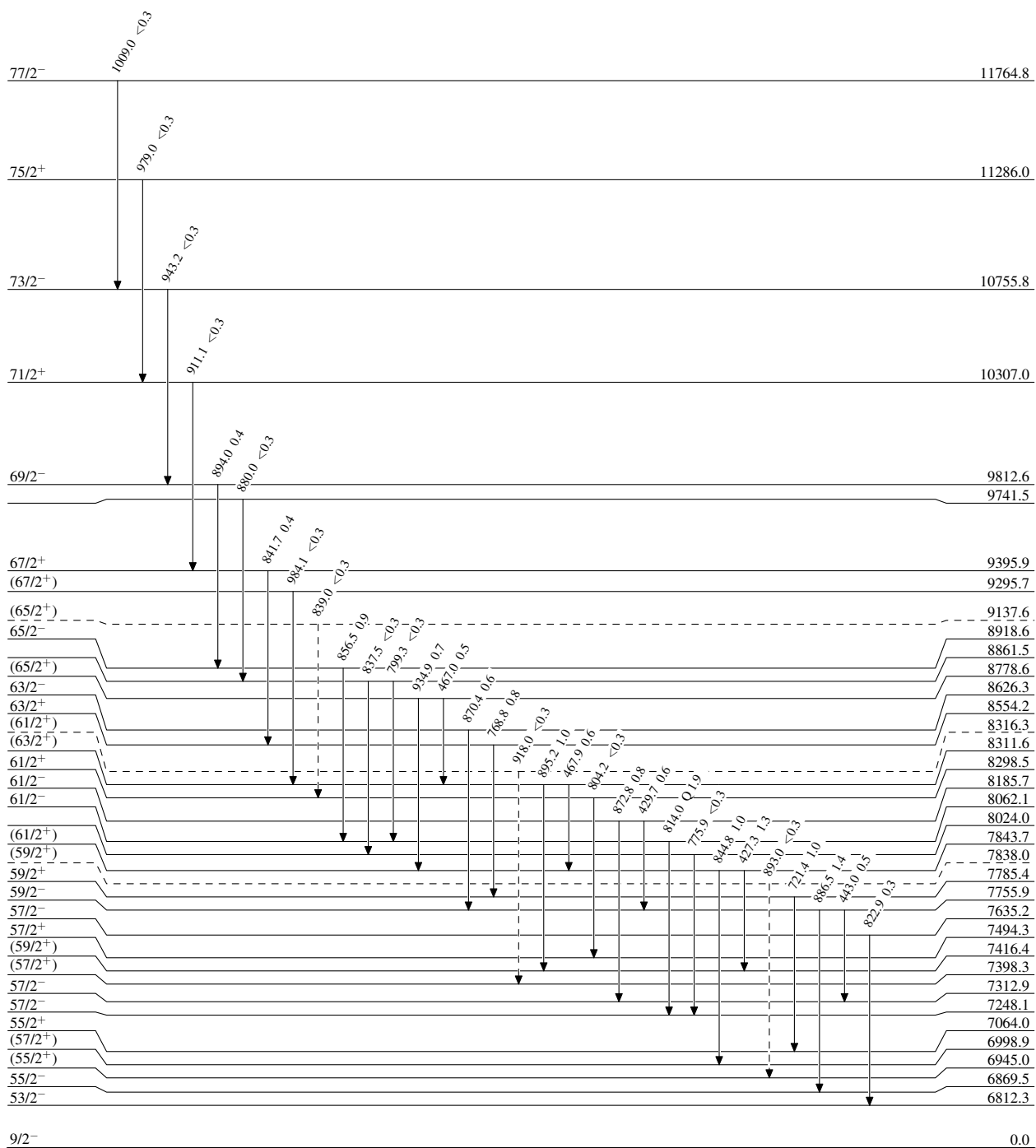
$^{118}\text{Sn}(^{55}\text{Mn}, 4n\gamma)$ 2013Ha02

Legend

Level Scheme

Intensities: Relative I_γ

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\cdots\cdots\cdots$ γ Decay (Uncertain)

 $^{169}_{75}\text{Re}_{94}$

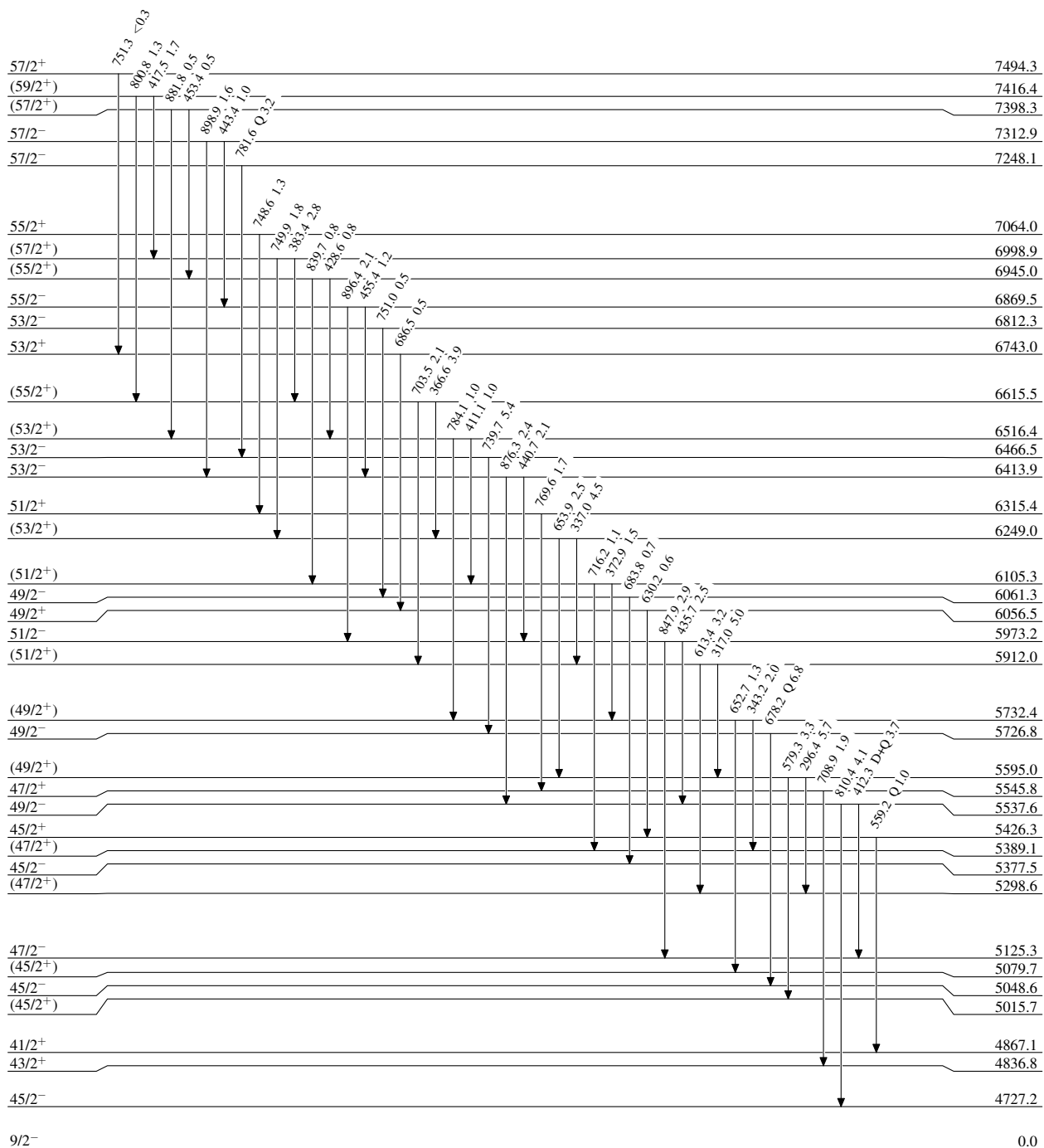
$^{118}\text{Sn}(^{55}\text{Mn},4n\gamma)$ 2013Ha02

Level Scheme (continued)

Intensities: Relative I_γ

Legend

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$



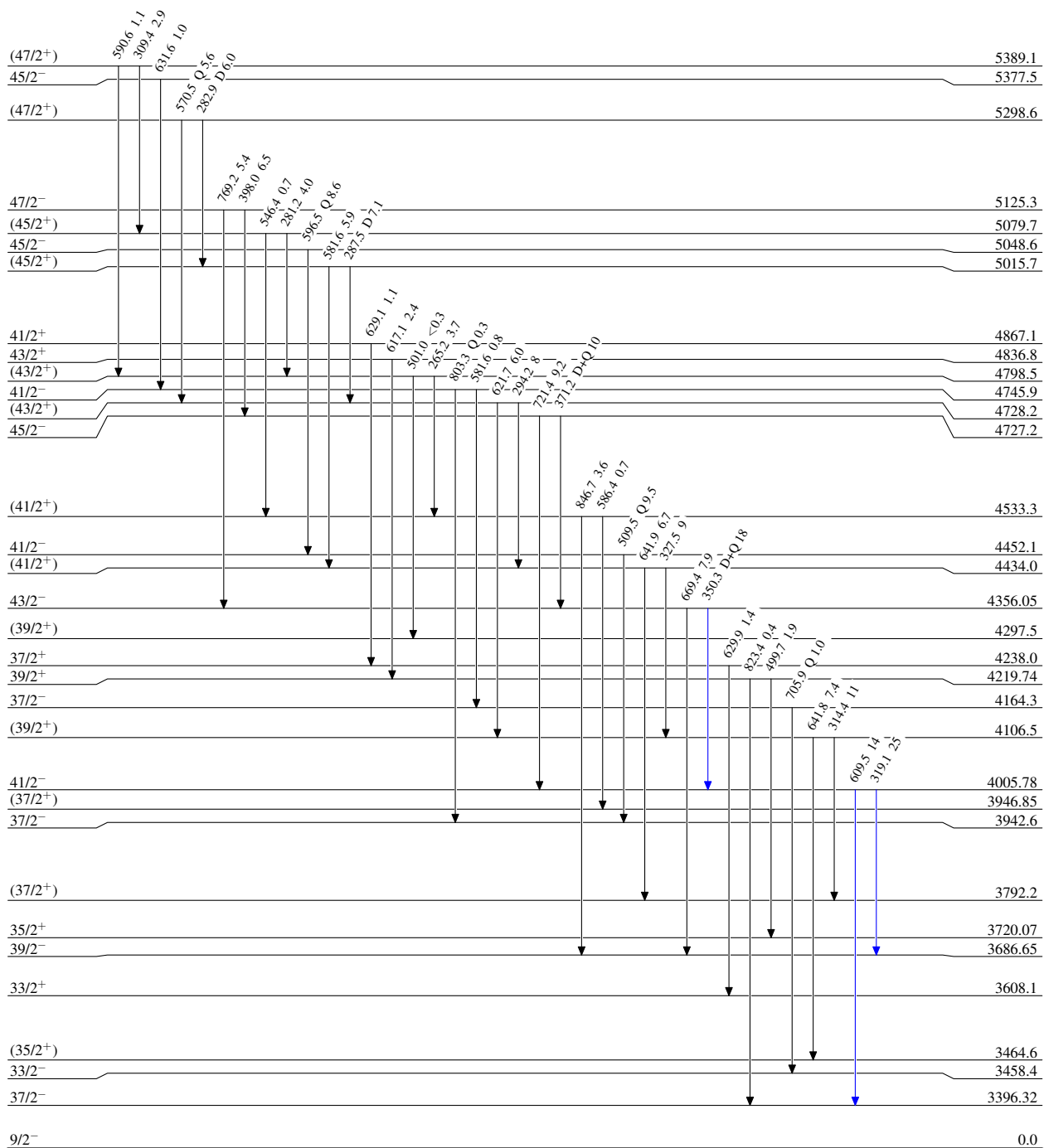
$^{118}\text{Sn}(^{55}\text{Mn}, 4n\gamma)$ 2013Ha02

Level Scheme (continued)

 Intensities: Relative I_γ

Legend

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$



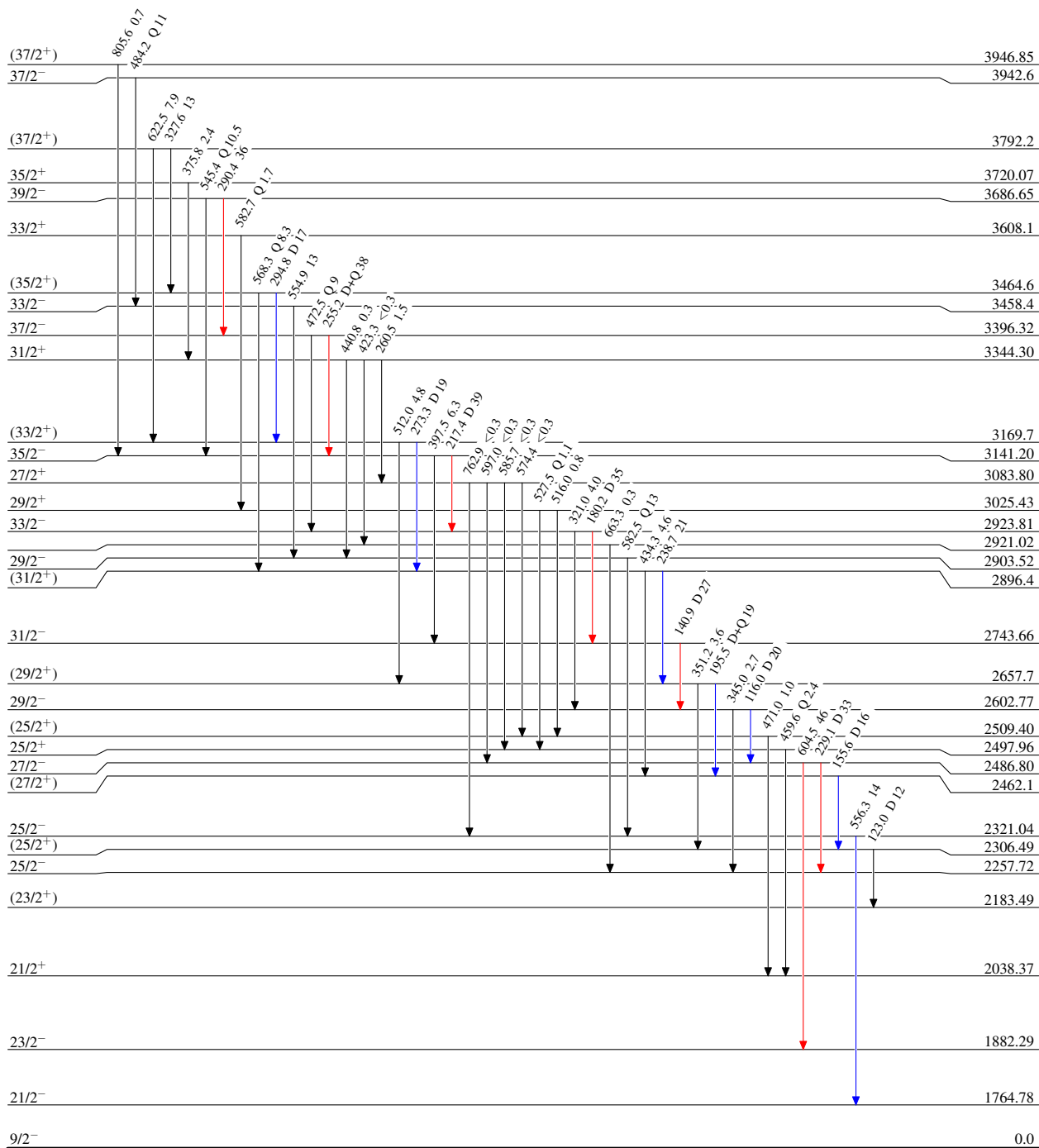
$^{118}\text{Sn}(^{55}\text{Mn},4n\gamma)$ 2013Ha02

Level Scheme (continued)

Intensities: Relative I_γ

Legend

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$



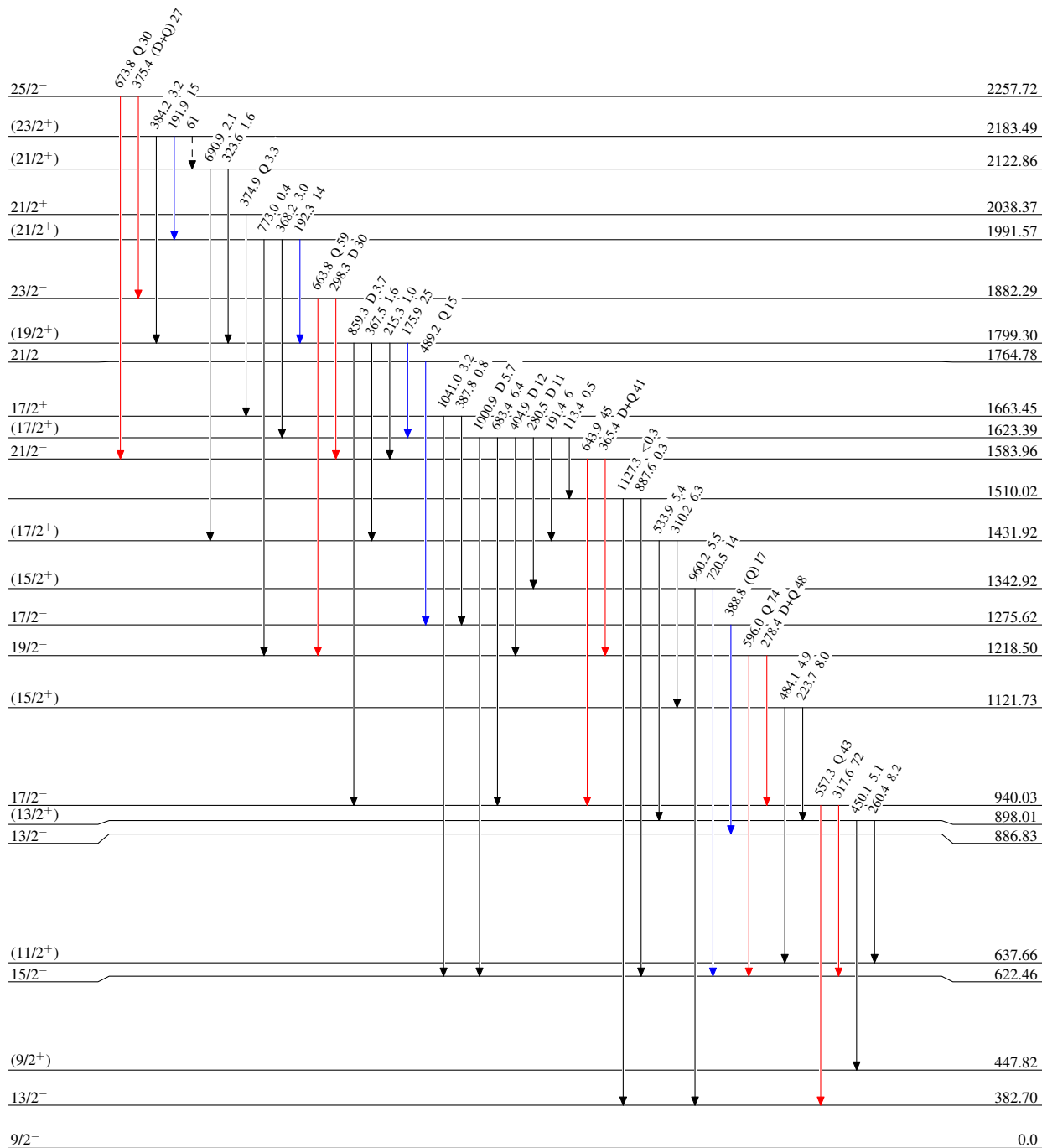
$^{118}\text{Sn}(^{55}\text{Mn}, 4n\gamma)$ 2013Ha02

Legend

Level Scheme (continued)

Intensities: Relative I_γ

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$
- - - - - γ Decay (Uncertain)



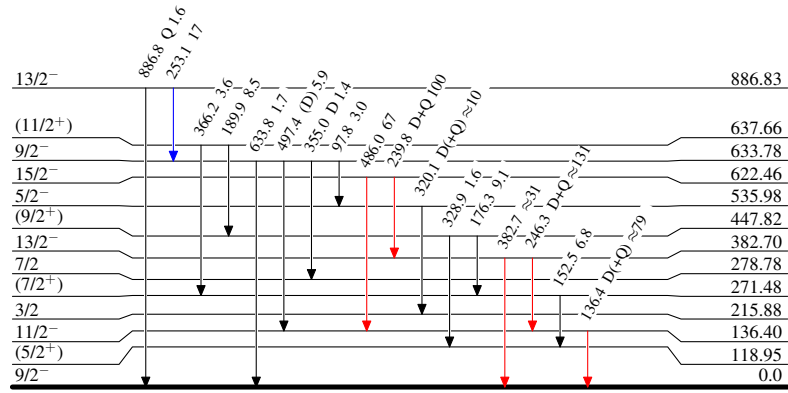
$^{118}\text{Sn}(^{55}\text{Mn}, 4n\gamma)$ 2013Ha02

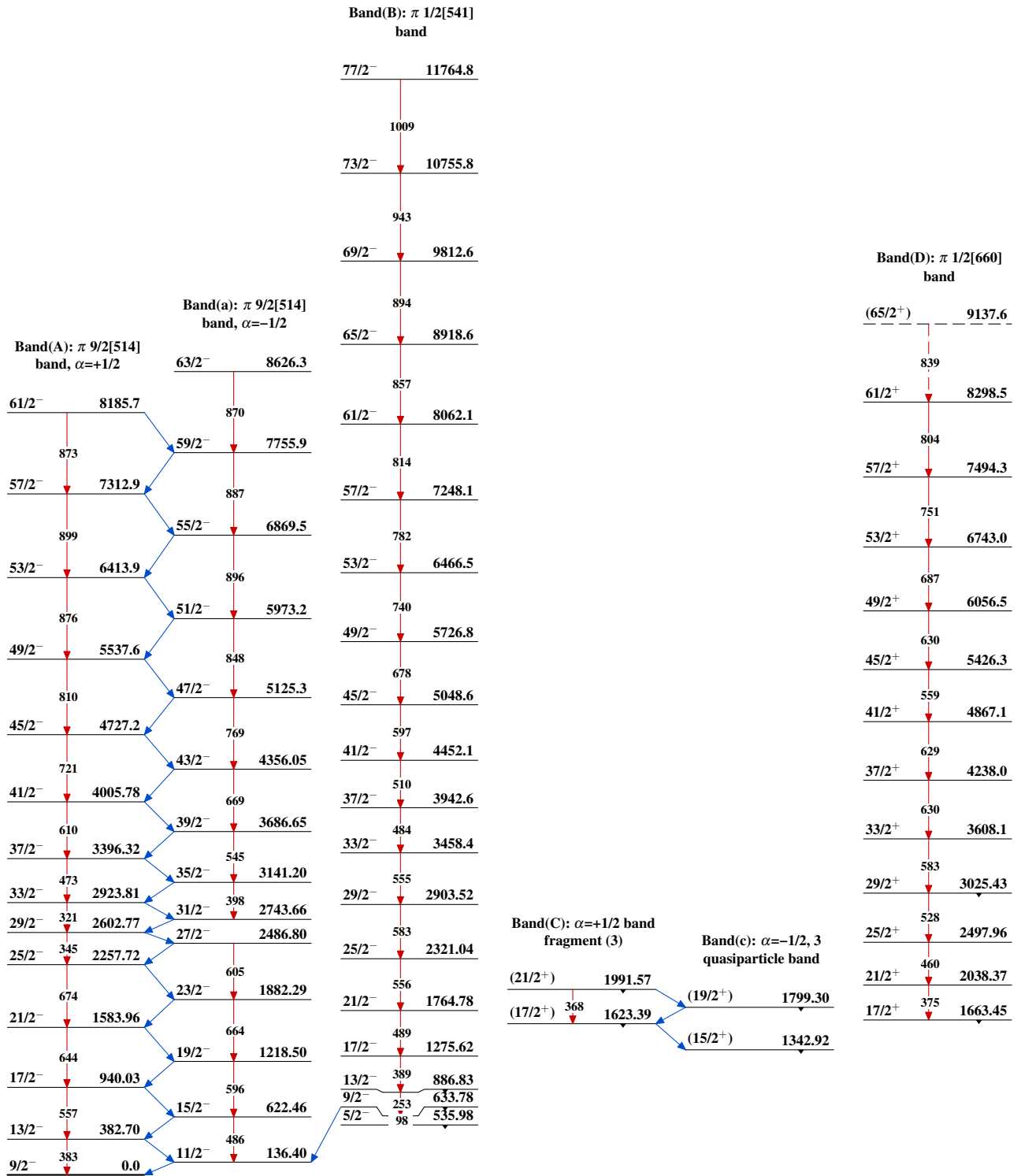
Level Scheme (continued)

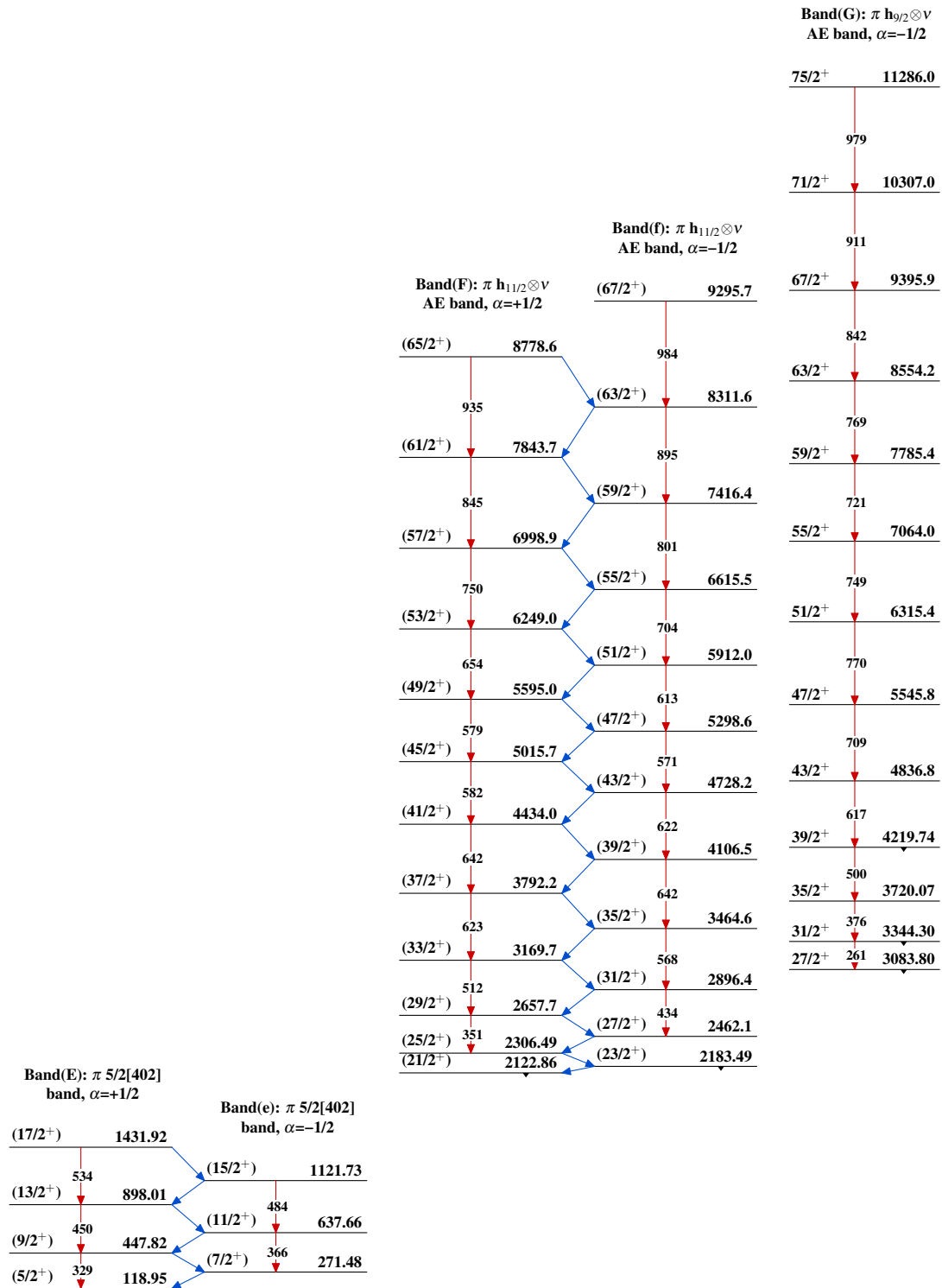
Intensities: Relative I_γ

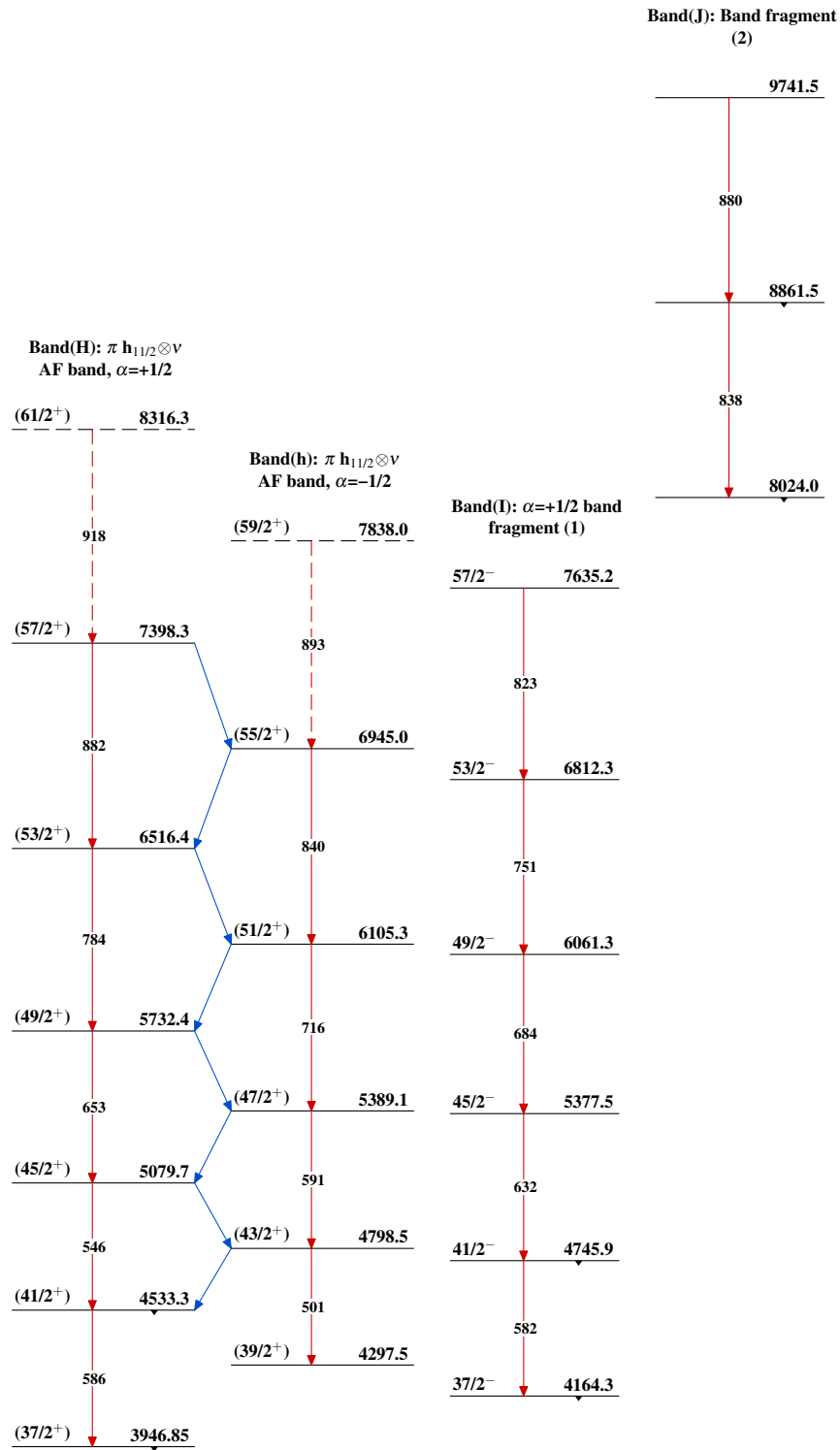
Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\text{max}}$
- $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\text{max}}$
- $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\text{max}}$

 $^{169}_{75}\text{Re}_{94}$

$^{118}\text{Sn}(^{55}\text{Mn}, 4n\gamma)$ 2013Ha02

$^{118}\text{Sn}(^{55}\text{Mn}, 4n\gamma)$ 2013Ha02 (continued)


$^{118}\text{Sn}(^{55}\text{Mn},4n\gamma)$ 2013Ha02 (continued)

 $^{169}_{75}\text{Re}_{94}$

$^{144}\text{Sm}(^{28}\text{Si}, p2n\gamma)$ 2004Zh05, 2002Zh42

2004Zh05, 2002Zh42: E=140, 145, 150 MeV; isotopically enriched ^{144}Sm metallic foil target with Pb backing; GEMINI detector array (12 HPGe detectors with BGO anti-Compton shields); measured $E\gamma$, $I\gamma$, DCO ratios ($\theta=32^\circ$ (or 148°), 58° (or 122°) and 90°), anisotropy, $x\text{-}\gamma(t)$, $\gamma\gamma(t)$.

Other: 1992DrZZ (observe a number of bands; severe perturbations at low frequencies; no further details given).

 ^{169}Re Levels

E(level) [†]	J^π [‡]	Comments
0.0@	(9/2 ⁻)	
136.48& 16	(11/2 ⁻)	
215.88 3	(3/2)	E(level): from Adopted Levels, unknown in 2004Zh05.
382.72@ 16	(13/2 ⁻)	
536.18# 30	(5/2 ⁻)	
622.74& 19	(15/2 ⁻)	
634.2# 6	(9/2 ⁻)	
887.3# 6	(13/2 ⁻)	
940.15@ 21	(17/2 ⁻)	
1218.85& 22	(19/2 ⁻)	
1276.2# 7	(17/2 ⁻)	
1343.28 ^b 25	(15/2)	
1431.51 ^a 31		
1584.13@ 24	(21/2 ⁻)	
1623.83 ^b 28	(19/2)	
1765.4# 7	(21/2 ⁻)	
1799.83 ^a 32	(21/2)	
1815.81 34		
1882.48& 26	(23/2 ⁻)	
1922.7 ^b 4	(23/2)	
2078.2 ^a 4	(25/2)	E(level): absent in ($^{55}\text{Mn}, 4n\gamma$), depopulating 155.6 γ placed from 2462.16 (27/2 ⁺) in the Adopted Levels. Level energy not adopted.
2258.15@ 27	(25/2 ⁻)	
2274.0 ^b 4	(27/2)	E(level): absent in ($^{55}\text{Mn}, 4n\gamma$), comparable depopulating 155.2 γ and 351.2 γ placed from 2657.71 (29/2 ⁺) in the Adopted Levels. Level energy not adopted.
2320.2# 7	(25/2 ⁻)	
2487.10& 29	(27/2 ⁻)	
2512.9 ^a 4	(29/2)	E(level): absent in ($^{55}\text{Mn}, 4n\gamma$), comparable depopulating 240.1 γ and 434.3 γ placed from 2896.4 (31/2 ⁺) in the Adopted Levels. Level energy not adopted.
2603.16@ 33	(29/2 ⁻)	
2744.2& 4	(31/2 ⁻)	
2786.4 ^b 5	(31/2)	E(level): absent in ($^{55}\text{Mn}, 4n\gamma$), comparable depopulating 273.3 γ and 512.0 γ placed from 3169.8 (33/2 ⁺) in the Adopted Levels. Level energy not adopted.
2902.5# 7	(29/2 ⁻)	
2924.4@ 4	(33/2 ⁻)	
3081.4 ^a 5	(33/2)	E(level): absent in ($^{55}\text{Mn}, 4n\gamma$), comparable depopulating 294.8 γ and 568.3 γ placed from 3464.7 (35/2 ⁺) in the Adopted Levels. Level energy not adopted.
3141.9& 4	(35/2 ⁻)	
3397.0@ 4	(37/2 ⁻)	
3408.8 ^b 5	(35/2)	E(level): adopted value (3792.2) differs because adopted order of 622 γ -642 γ cascade is the reverse of that shown here.

Continued on next page (footnotes at end of table)

$^{144}\text{Sm}(^{28}\text{Si}, p2n\gamma)$ **2004Zh05, 2002Zh42** (continued) ^{169}Re Levels (continued)

E(level) [†]	J ^π [‡]	Comments
3459.3 [#] 8	(33/2 ⁻)	
3687.6 ^{&} 4	(39/2 ⁻)	
3723.1 ^a 5	(37/2)	E(level): absent in ($^{55}\text{Mn}, 4n\gamma$), comparable depopulating 314.4 γ and 641.8 γ placed from 4106.6 (39/2 ⁺) in the Adopted Levels. Level energy not adopted.
3943.7 [#] 9	(37/2 ⁻)	
4006.3 [@] 5	(41/2 ⁻)	
4050.4 ^b 5	(39/2)	E(level): absent in ($^{55}\text{Mn}, 4n\gamma$), comparable depopulating 327.6 γ and 641.9 γ placed from 4434.1 (41/2 ⁺) in the Adopted Levels. Level energy not adopted.
4337.4 ^a 7		E(level): not adopted; see comment on 287.0 γ .
4356.9 ^{&} 5	(43/2 ⁻)	
4452.7 [#] 10	(41/2 ⁻)	
4728.2 [@] 6	(45/2 ⁻)	

[†] From least-squares fit to E_γ , assigning 0.5 keV uncertainty to all E_γ data. Placement of some of the gammas are different in the adopted dataset, as a result a few excited level level energies are different. These levels are noted in the comments.

[‡] From **2002Zh42**, based on transition multiplicities, deduced band structure, alignment, band crossing frequencies and comparison with neighboring odd-A Re isotopes.

[#] Band(A): 1/2[541] band. Decoupled band built on π h_{9/2} intruder orbital; ν AB crossing observed at $\hbar\omega=0.27$ MeV (**2002Zh42**).

[@] Band(B): 9/2[514], $\alpha=+1/2$ band. Strongly-coupled band; ν AB crossing observed at $\hbar\omega=0.23$ MeV.

[&] Band(b): 9/2[514], $\alpha=-1/2$ band. See comment on signature partner of this band.

^a Band(C): $\alpha=+1/2$, 3-quasiparticle band (**2002Zh42**). Possible configuration: (π 9/2[514]) $\otimes$ (ν i_{13/2})(ν f_{7/2} or h_{9/2}).

^b Band(c): $\alpha=-1/2$, 3-quasiparticle band (**2002Zh42**). See comment on signature partner of this band.

 $\gamma(^{169}\text{Re})$

E_γ [†]	I_γ [‡]	E_i (level)	J_i^π	E_f	J_f^π	Mult. [#]	Comments
88.0 5	[@]	1431.51		1343.28	(15/2)		
98.0 5	5	634.2	(9/2 ⁻)	536.18	(5/2 ⁻)		
107.0 5	[@]	1922.7	(23/2)	1815.81			
116.1 2	30	2603.16	(29/2 ⁻)	2487.10	(27/2 ⁻)	D	DCO=0.66 15 Anisotropy=0.67 10 (2004Zh05).
122.8 2	25	1922.7	(23/2)	1799.83	(21/2)	D	DCO=0.63 15 Anisotropy=0.65 10 (2004Zh05).
136.4 2	100	136.48	(11/2 ⁻)	0.0	(9/2 ⁻)	D+Q	DCO=0.89 15 Anisotropy=1.08 10 (2004Zh05).
141.0 2	65	2744.2	(31/2 ⁻)	2603.16	(29/2 ⁻)	D	DCO=0.68 15 Anisotropy=0.70 10 (2004Zh05).
155.6 2	49	2078.2	(25/2)	1922.7	(23/2)	D	DCO=0.83 15 Anisotropy=0.79 10 (2004Zh05).
176.0 2	45	1799.83	(21/2)	1623.83	(19/2)	D	DCO=0.58 15 Anisotropy=0.66 10 (2004Zh05).
180.2 2	101	2924.4	(33/2 ⁻)	2744.2	(31/2 ⁻)	D	DCO=0.65 15 Anisotropy=0.71 10 (2004Zh05).
192.0 2	30	1815.81		1623.83	(19/2)		
192.3 2	35	1623.83	(19/2)	1431.51			
195.8 2	65	2274.0	(27/2)	2078.2	(25/2)	D	DCO=0.79 15 Anisotropy=0.80 10 (2004Zh05).
217.6 2	77	3141.9	(35/2 ⁻)	2924.4	(33/2 ⁻)	D	DCO=0.54 15 Anisotropy=0.57 10 (2004Zh05).

Continued on next page (footnotes at end of table)

¹⁴⁴Sm(²⁸Si,p2n γ) **2004Zh05,2002Zh42** (continued)

 $\gamma(^{169}\text{Re})$ (continued)

E_γ †	I_γ ‡	E_i (level)	J_i^π	E_f	J_f^π	Mult. #	Comments
229.0 2	85	2487.10	(27/2 ⁻)	2258.15	(25/2 ⁻)	D	DCO=0.60 15 Anisotropy=0.67 10 (2004Zh05).
239.0 2	60	2512.9	(29/2)	2274.0	(27/2)	D	DCO=0.69 20 Anisotropy=0.71 20 (2004Zh05).
240.1 2	218	622.74	(15/2 ⁻)	382.72	(13/2 ⁻)	D	DCO=0.69 15 Anisotropy=0.76 10 (2004Zh05).
246.3 2	302	382.72	(13/2 ⁻)	136.48	(11/2 ⁻)	D+Q	DCO=0.81 15 Anisotropy=0.86 10 (2004Zh05).
253.1 2	30	887.3	(13/2 ⁻)	634.2	(9/2 ⁻)	Q	DCO=0.96 15 Anisotropy=1.24 10 (2004Zh05).
255.1 2	73	3397.0	(37/2 ⁻)	3141.9	(35/2 ⁻)	D	DCO=0.52 15 Anisotropy=0.54 10 (2004Zh05).
257.0 5	≤7	2744.2	(31/2 ⁻)	2487.10	(27/2 ⁻)		I(257 γ)/I(141 γ)≤0.10 (2004Zh05).
273.5 2	55	2786.4	(31/2)	2512.9	(29/2)	D	DCO=0.64 20 Anisotropy=0.70 20 (2004Zh05).
278.7 2	110	1218.85	(19/2 ⁻)	940.15	(17/2 ⁻)	D	DCO=0.60 15 Anisotropy=0.66 10 (2004Zh05).
280.5 3	19	1623.83	(19/2)	1343.28	(15/2)		DCO=1.08 20 Anisotropy=1.19 20 (2004Zh05) suggest stretched Q; however, this conflicts with D assigned in Adopted Gammas based on data from (⁵⁵ Mn,4n γ).
287.0 5	@	4337.4		4050.4	(39/2)		E γ : placement not adopted; presumed to be the 287.5 γ known from (⁵⁵ Mn,4n γ) and placed differently in that study.
290.6 2	47	3687.6	(39/2 ⁻)	3397.0	(37/2 ⁻)	D	DCO=0.57 15 Anisotropy=0.55 10 (2004Zh05).
295.0 2	51	3081.4	(33/2)	2786.4	(31/2)	D	DCO=0.64 20 Anisotropy=0.69 20 (2004Zh05).
298.4 2	74	1882.48	(23/2 ⁻)	1584.13	(21/2 ⁻)	D	DCO=0.55 15 Anisotropy=0.64 10 (2004Zh05).
314.3 2	25	3723.1	(37/2)	3408.8	(35/2)	D	DCO=0.64 20 Anisotropy=0.60 20 (2004Zh05).
317.5 2	190	940.15	(17/2 ⁻)	622.74	(15/2 ⁻)	D	DCO=0.66 20 Anisotropy=0.68 20 (2004Zh05).
318.8 2	36	4006.3	(41/2 ⁻)	3687.6	(39/2 ⁻)	D	DCO=0.59 20 Anisotropy=0.64 20 (2004Zh05).
320.3 3	17	536.18	(5/2 ⁻)	215.88	(3/2)	D	DCO=0.58 15 Anisotropy=0.71 10 (2004Zh05).
321.3 3	13	2924.4	(33/2 ⁻)	2603.16	(29/2 ⁻)	Q	DCO=0.97 20 Anisotropy=1.20 20 (2004Zh05).
327.5 2	60	3408.8	(35/2)	3081.4	(33/2)		I(321 γ)/I(180 γ)=0.10 2 (2004Zh05).
327.5 5	10	4050.4	(39/2)	3723.1	(37/2)		DCO=0.63 20 Anisotropy=0.68 20 (2004Zh05) for doublet.
344.8 5	≤10	2603.16	(29/2 ⁻)	2258.15	(25/2 ⁻)		Anisotropy=0.68 20 (2004Zh05) for doublet.
350.5 3	14	4356.9	(43/2 ⁻)	4006.3	(41/2 ⁻)	D	I(345 γ)/I(116 γ)≤0.30 (2004Zh05).
351.3 3	15	2274.0	(27/2)	1922.7	(23/2)	Q	DCO=0.62 20 Anisotropy=0.67 20 (2004Zh05).
365.3 2	91	1584.13	(21/2 ⁻)	1218.85	(19/2 ⁻)	D	DCO=0.93 20 Anisotropy=1.17 20 (2004Zh05).
368.3 2	25	1799.83	(21/2)	1431.51			I(351 γ)/I(196 γ)=0.24 6 (2004Zh05).
371.2 5	@	4728.2	(45/2 ⁻)	4356.9	(43/2 ⁻)		DCO=0.56 15 Anisotropy=0.67 10 (2004Zh05).

Continued on next page (footnotes at end of table)

$^{144}\text{Sm}(^{28}\text{Si}, p2n\gamma)$ **2004Zh05, 2002Zh42** (continued) $\gamma(^{169}\text{Re})$ (continued)

E_γ †	I_γ ‡	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. #	Comments
375.6 2	85	2258.15	(25/2 ⁻)	1882.48	(23/2 ⁻)	D	DCO=0.57 15 Anisotropy=0.62 10 (2004Zh05).
382.8 2	38	382.72	(13/2 ⁻)	0.0	(9/2 ⁻)	Q	DCO=0.99 15 Anisotropy=1.08 10 (2004Zh05).
388.9 2	35	1276.2	(17/2 ⁻)	887.3	(13/2 ⁻)	Q	I(383 γ)/I(246 γ)=0.13 2 (2004Zh05). DCO=1.02 15 Anisotropy=1.32 10 (2004Zh05).
397.7 2	21	3141.9	(35/2 ⁻)	2744.2	(31/2 ⁻)	Q	DCO=0.96 20 Anisotropy=1.14 20 (2004Zh05). I(398 γ)/I(218 γ)=0.33 10 (2004Zh05).
403.0 5	@	1343.28	(15/2)	940.15	(17/2 ⁻)		
405.0 3	15	1623.83	(19/2)	1218.85	(19/2 ⁻)		
434.6 3	16	2512.9	(29/2)	2078.2	(25/2)	Q	DCO=1.09 27 Anisotropy=1.17 20 (2004Zh05). I(435 γ)/I(239 γ)=0.27 (2004Zh05).
472.4 3	18	3397.0	(37/2 ⁻)	2924.4	(33/2 ⁻)	Q	DCO=1.11 20 Anisotropy=1.48 20 (2004Zh05). I(472 γ)/I(255 γ)=0.25 8 (2004Zh05).
484.4 3	12	3943.7	(37/2 ⁻)	3459.3	(33/2 ⁻)	Q	DCO=1.04 20 Anisotropy=1.20 20 (2004Zh05).
486.1 2	187	622.74	(15/2 ⁻)	136.48	(11/2 ⁻)	Q	DCO=1.03 15 Anisotropy=1.19 10 (2004Zh05). I(486 γ)/I(240 γ)=0.90 18 (2004Zh05).
489.2 2	31	1765.4	(21/2 ⁻)	1276.2	(17/2 ⁻)	Q	DCO=1.06 15 Anisotropy=1.18 10 (2004Zh05).
509.0 5	7	4452.7	(41/2 ⁻)	3943.7	(37/2 ⁻)	Q	DCO=0.92 20 Anisotropy=1.12 20 (2004Zh05).
512.3 3	20	2786.4	(31/2)	2274.0	(27/2)	Q	DCO=1.08 20 Anisotropy=1.24 20 (2004Zh05). I(512 γ)/I(274 γ)=0.35 8 (2004Zh05).
545.8 3	15	3687.6	(39/2 ⁻)	3141.9	(35/2 ⁻)	Q	DCO=1.06 20 Anisotropy=1.34 20 (2004Zh05). I(546 γ)/I(291 γ)=0.38 11 (2004Zh05).
554.8 2	26	2320.2	(25/2 ⁻)	1765.4	(21/2 ⁻)	Q	DCO=1.01 15 Anisotropy=1.32 10 (2004Zh05).
556.8 3	16	3459.3	(33/2 ⁻)	2902.5	(29/2 ⁻)	Q	DCO=1.03 20 Anisotropy=1.36 20 (2004Zh05).
557.5 2	125	940.15	(17/2 ⁻)	382.72	(13/2 ⁻)	Q	DCO=1.01 15 Anisotropy=1.25 10 (2004Zh05). I(558 γ)/I(318 γ)=0.68 14 (2004Zh05).
568.6 3	19	3081.4	(33/2)	2512.9	(29/2)	Q	DCO=0.99 20 Anisotropy=1.14 20 (2004Zh05). I(569 γ)/I(295 γ)=0.37 6 (2004Zh05).
582.3 2	22	2902.5	(29/2 ⁻)	2320.2	(25/2 ⁻)	Q	DCO=0.97 15 Anisotropy=1.18 10 (2004Zh05).
596.0 2	189	1218.85	(19/2 ⁻)	622.74	(15/2 ⁻)	Q	DCO=1.04 15 Anisotropy=1.18 10 (2004Zh05). I(596 γ)/I(279 γ)=1.8 4 (2004Zh05).
604.6 2	110	2487.10	(27/2 ⁻)	1882.48	(23/2 ⁻)	Q	DCO=1.06 15 Anisotropy=1.21 10 (2004Zh05). I(605 γ)/I(229 γ)=1.2 3 (2004Zh05).
609.2 3	12	4006.3	(41/2 ⁻)	3397.0	(37/2 ⁻)	Q	DCO=1.07 20 Anisotropy=1.24 20 (2004Zh05). I(609 γ)/I(319 γ)=0.35 10 (2004Zh05).
622.3 2	21	3408.8	(35/2)	2786.4	(31/2)	Q	DCO=1.09 20 Anisotropy=1.15 20 (2004Zh05).

Continued on next page (footnotes at end of table)

$^{144}\text{Sm}(^{28}\text{Si}, p2n\gamma)$ **2004Zh05, 2002Zh42** (continued) $\gamma(^{169}\text{Re})$ (continued)

E_γ [†]	I_γ [‡]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [#]	Comments
641.6 2	60	4050.4	(39/2)	3408.8	(35/2)		DCO=1.06 20 Anisotropy=1.24 20 (2004Zh05) for 641.8 γ +641.6 γ doublet.
641.8 3	15	3723.1	(37/2)	3081.4	(33/2)		DCO=1.06 20 Anisotropy=1.24 20 (2004Zh05) for 641.8 γ +641.6 γ doublet.
644.1 2	89	1584.13	(21/2 ⁻)	940.15	(17/2 ⁻)	Q	DCO=1.08 15 Anisotropy=1.34 10 (2004Zh05). I(644 γ)/I(365 γ)=1.04 20 (2004Zh05).
663.5 2	150	1882.48	(23/2 ⁻)	1218.85	(19/2 ⁻)	Q	DCO=0.99 15 Anisotropy=1.19 10 (2004Zh05). I(664 γ)/I(298 γ)=2.21 4 (2004Zh05); uncertainty probably an order of magnitude too low since uncertainty in each I γ is at least 5%.
669.3 5	@	4356.9	(43/2 ⁻)	3687.6	(39/2 ⁻)	Q	DCO=0.99 20 Anisotropy=1.20 20 (2004Zh05). I(669 γ)/I(351 γ)=0.50 20 (2004Zh05).
674.1 2	93	2258.15	(25/2 ⁻)	1584.13	(21/2 ⁻)	Q	DCO=1.01 15 Anisotropy=1.29 10 (2004Zh05). I(674 γ)/I(376 γ)=1.22 25 (2004Zh05).
684.0 5	@	1623.83	(19/2)	940.15	(17/2 ⁻)		
720.5 2	40	1343.28	(15/2)	622.74	(15/2 ⁻)	Q	DCO=1.04 20 Anisotropy=1.17 20 (2004Zh05).
722.0 5	10	4728.2	(45/2 ⁻)	4006.3	(41/2 ⁻)		

[†] Uncertainties vary from 0.1 to 0.5 keV (2004Zh05). The evaluator assigned 0.5 keV for $I_\gamma < 10$, 0.3 keV for $10 < I_\gamma < 20$ and 0.2 keV for $I_\gamma > 20$.

[‡] Intensities are from 2004Zh05, relative to I(136.5 γ)=100; uncertainties are 5% to 30%.

[#] Based on measured DCO ratio and/or γ anisotropy data in 2004Zh05. 2004Zh05 assign stretched Q to transitions with DCO $\approx$ 1.0 and anisotropy $\approx$ 1.3, D to transitions having DCO $\leq$ 0.7 (anisotropy $\approx$ 0.7 for pure stretched D transitions).

@ Very weak transition (2004Zh05).

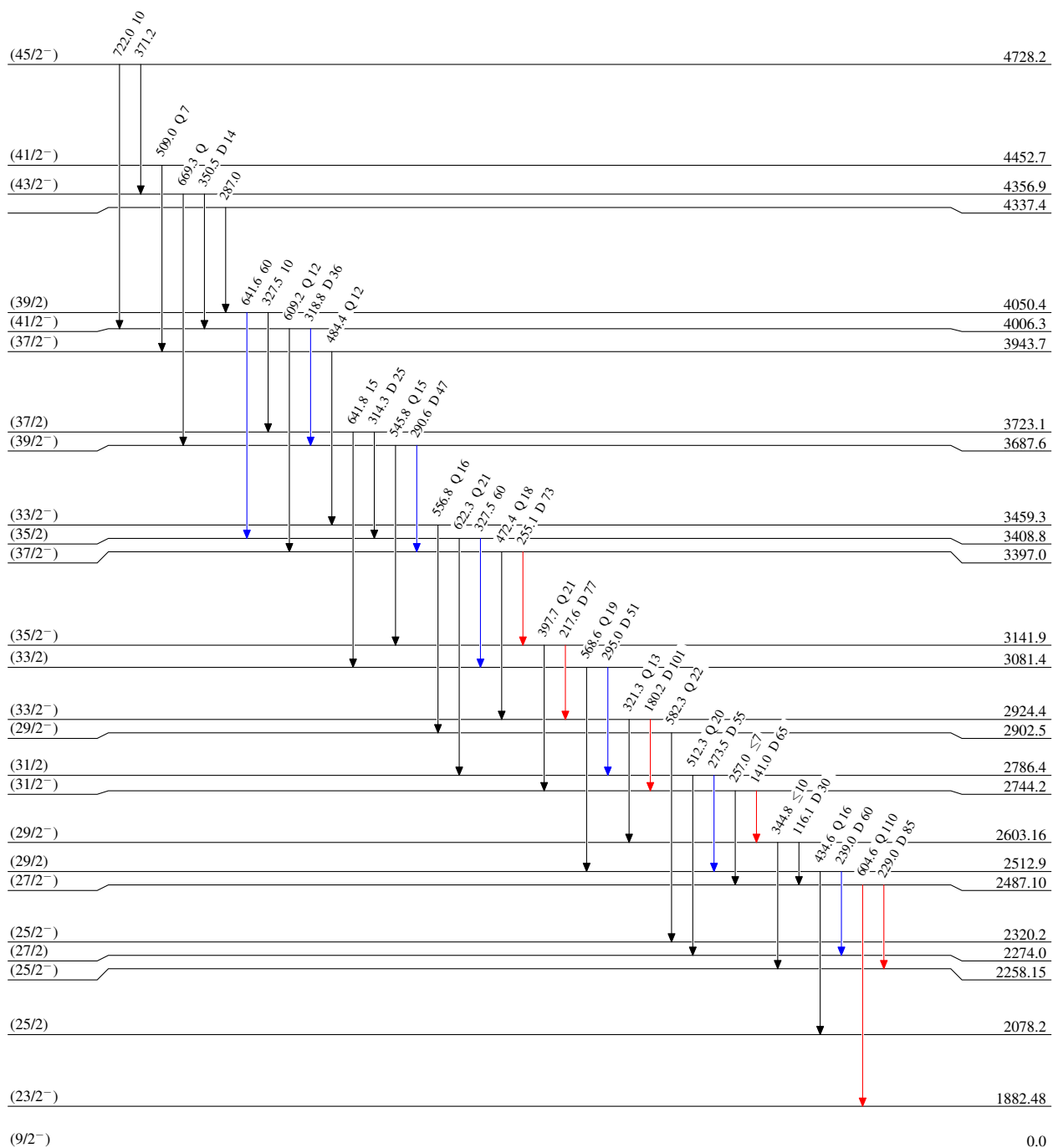
$^{144}\text{Sm}(^{28}\text{Si}, p2n\gamma)$ 2004Zh05,2002Zh42

Level Scheme

Intensities: Relative I_γ

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$



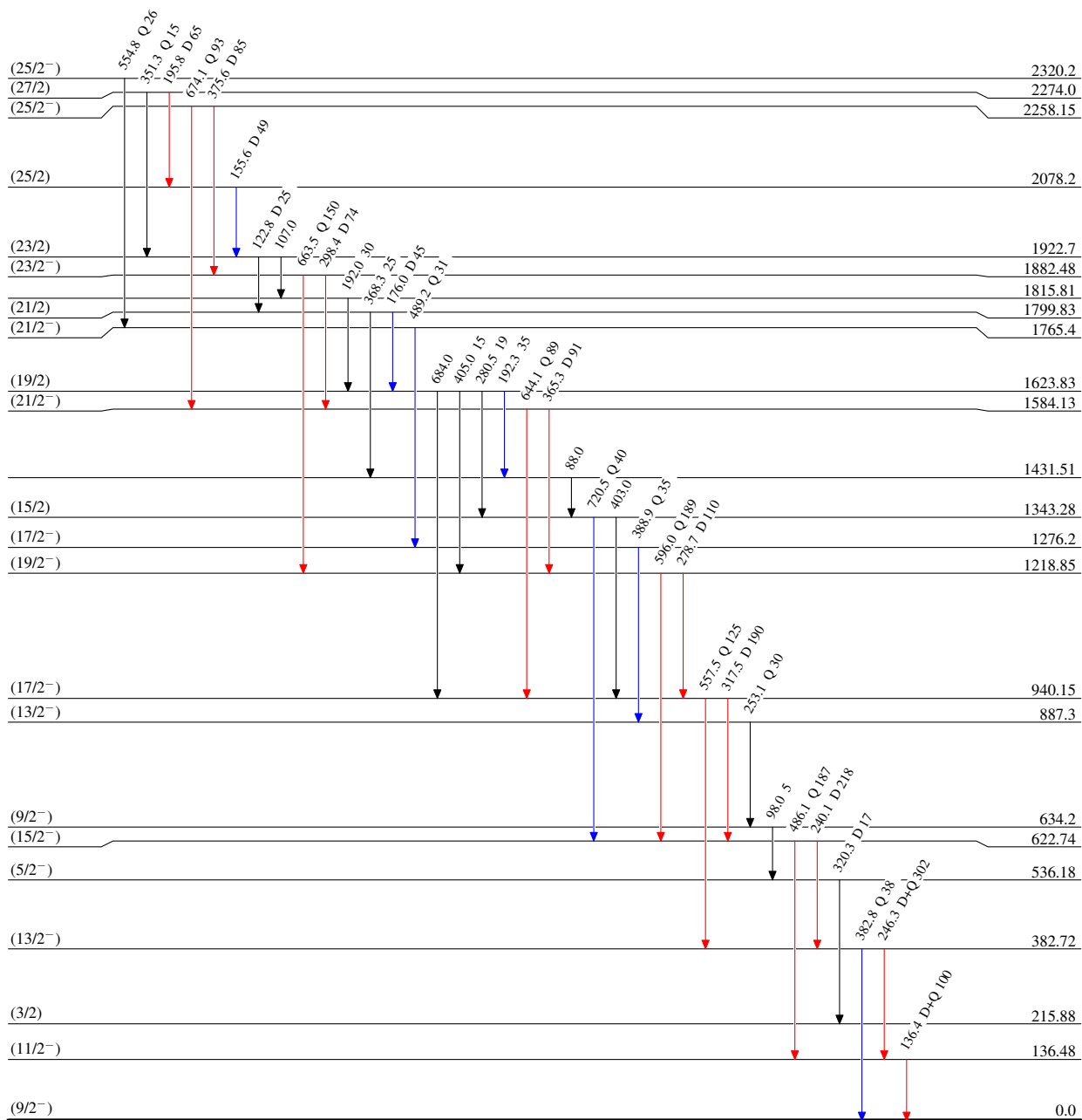
$^{144}\text{Sm}(^{28}\text{Si}, p2n\gamma)$ 2004Zh05,2002Zh42

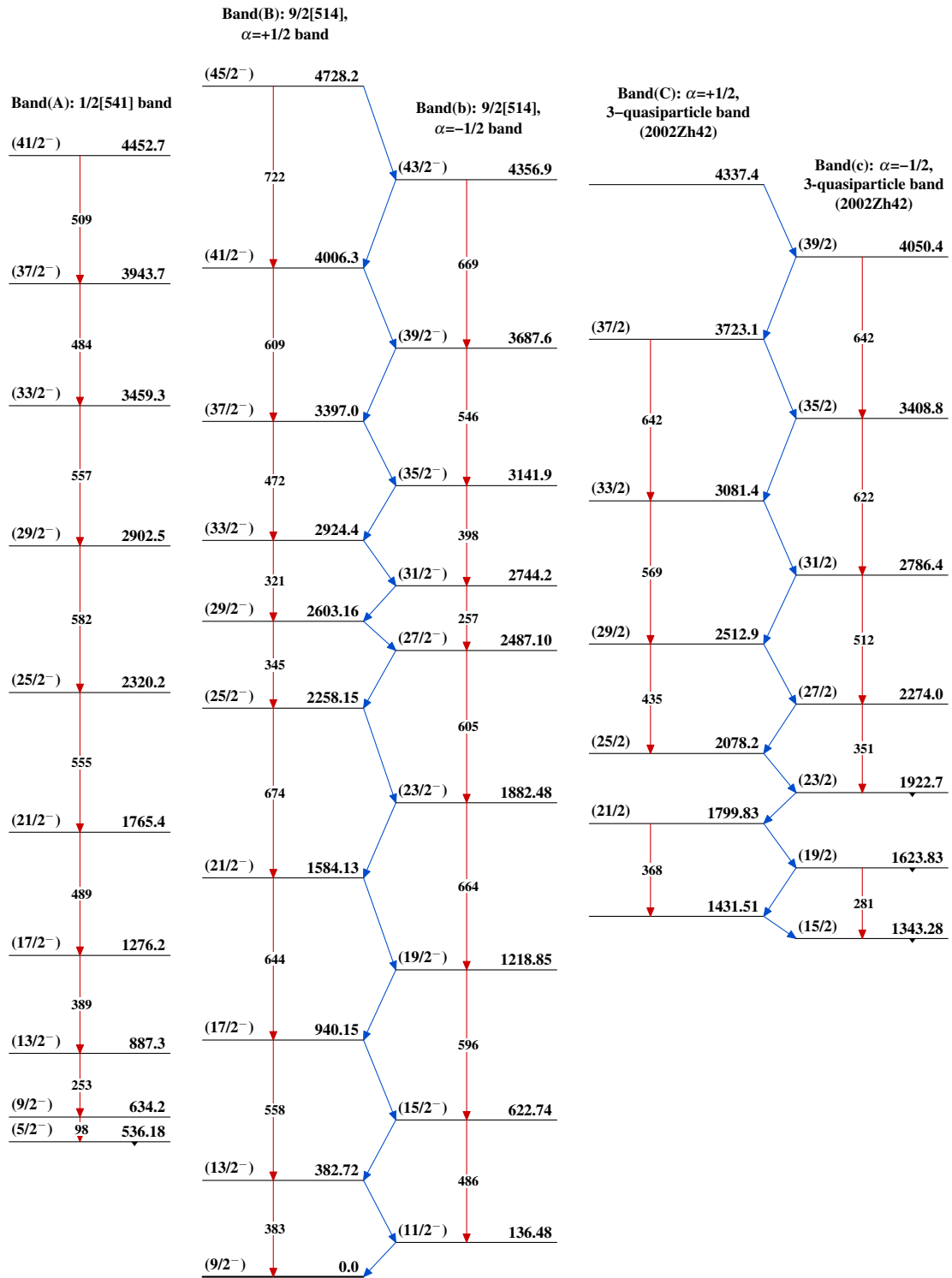
Level Scheme (continued)

Intensities: Relative I_γ

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$

 $^{169}_{75}\text{Re}_{94}$

$^{144}\text{Sm}(^{28}\text{Si,p2n}\gamma)$ 2004Zh05,2002Zh42 $^{169}_{75}\text{Re}_{94}$

Adopted Levels, Gammas

$Q(\beta^-) = -8630$ 30; $S(n) = 8799$ 28; $S(p) = 2220$ 40; $Q(\alpha) = 5713$ 3 [2021Wa16](#)

$S(2n) = 20370$ 80, $S(2p) = 3210$ 30, $Q(\epsilon p) = 6881$ 29 ([2021Wa16](#)).

Identification: excitation functions for ^{20}Ne and ^{19}F bombardments of Dy ([1972To19](#)); excitation functions for krypton bombardments of niobium and yttrium ([1978Sc26](#)).

 ^{169}Os LevelsCross Reference (XREF) Flags

- A** ^{173}Pt α decay (381 ms)
B $^{92}\text{Mo}({}^{83}\text{Kr}, 4n2p\gamma), ({}^{82}\text{Sr}, \alpha p2n\gamma)$
C $^{112}\text{Sn}({}^{60}\text{Ni}, 2pn\gamma)$

E(level) [†]	J^π [‡]	$T_{1/2}$ [#]	XREF	Comments
0.0	(7/2 ⁻)	3.4 s 2	AB	$\% \epsilon + \% \beta^+ = 86.3$ 8; $\% \alpha = 13.7$ 8 $\% \alpha$: weighted average of 15 4 (2004GoZZ ; 12% 3 for 5581 α), 13.8 13 (1996Pa01 ; 11% 1 for 5576 α), 13 2 (1995Hi02), 13.8 13 (1982En03 ; 11% 1 for 5572 α) assuming 5580 α constitutes 80% of ^{169}Os α decay (1984Sc06). $\% \epsilon + \% \beta^+$ not observed. J^π : unhindered α decay from (7/2 ⁻) ^{173}Pt g.s.. $T_{1/2}$: weighted average of 3.0 s 5 (1972To19 , 5560 α), 3.2 s 2 (1978Sc26 , 5570 α), 3.4 s 2 (1982En03 , 5572 α), 3.5 s 2 (1984Sc06 , 5564 α – also 3.5 s 2 from 5470 α -5540 α), 3.2 s 3 (1995Hi02 , 5578 α – also 3.4 s 8 from 5536 α and 6 s 3 from 5508 α), 3.6 s 2 (1996Pa01 , 5576 α), and 4.1 s 4 (2004GoZZ , 5581 α).
34.84 18	(5/2 ⁻)		A	J^π : 5/2 ⁻ in 2014ThZZ (α decay), authors assumed 34.84 γ is of M1 character to 7/2 ⁻ g.s.. Relatively more hindered α transition from (7/2 ⁻) ^{173}Pt compared to that of the g.s.
112.3 3	(9/2 ⁻)		AB	J^π : 9/2 ⁻ in 2014ThZZ , authors state that 112.3 γ is more consistent with an M1 transition to (7/2 ⁻) g.s.
136.12 19			A	
170.97 20			A	
192.3 @ 11	(13/2 ⁺)	17.3 μs 12	BC	
472.3 @ 15	(17/2 ⁺)	51 ps 6	BC	
950.8 @ 17	(21/2 ⁺)	4.9 ps 7	BC	
1215.8 @ 17	(19/2 ⁺)		C	
1561.8 @ 19	(25/2 ⁺)		BC	
1812.3 @ 18	(23/2 ⁺)		C	
2025.8 & 19	(23/2 ⁻)		C	
2169.8 22	(25/2 ⁻)		C	J^π : possible EAB configuration state.
2265.8 @ 22	(29/2 ⁺)		BC	
2374.8 & 20	(27/2 ⁻)		C	
2722.8 & 22	(31/2 ⁻)		C	
3033.8 @ 24	(33/2 ⁺)		C	
3168.8 & 25	(35/2 ⁻)		C	
3749 & 3	(39/2 ⁻)		C	
3817 @ 3	(37/2 ⁺)		C	

[†] From E_γ .

Adopted Levels, Gammas (continued)

¹⁶⁹Os Levels (continued)

‡ From (⁶⁰Ni,2pnγ); based on likely quasiparticle configurations and comparison with similar structures in neighboring odd-A nuclei, except where otherwise noted.

From (⁸³Kr,4n2pγ),(⁸²Sr,αp2nγ), except where otherwise noted.

@ Band(A): (ν i_{13/2}), α=+1/2 A band (2002Jo20).

& Band(B): π=−, α=−1/2 band (2002Jo20). Large alignment (14.4 ħ at ħω=0.25 MeV) suggests three-quasiparticle structure, possibly EAB or FAB, analogous to ¹⁷¹Os band; drop in alignment at ħω≈0.17 MeV may indicate presence of mixing with octupole vibrational bands. The E and F orbitals are expected to originate from the f_{7/2} or h_{9/2} subshell, A and B orbitals from ν i_{13/2}.

^a Band(C): π=+, α=−1/2 band (2002Jo20). Possibly the (ν i_{13/2}), α=−1/2 B band or the A band coupled to a collective phonon excitation.

$\gamma(^{169}\text{Os})$								Comments
E _i (level)	J ^π _i	E _γ [†]	I _γ	E _f	J ^π _f	Mult.	α [#]	
34.84	(5/2 [−])	34.84 [‡] 18	100	0.0	(7/2 [−])	[M1]	21.5 4	
112.3	(9/2 [−])	112.3 [‡] 3	100	0.0	(7/2 [−])	[M1]	4.03 6	
136.12		136.12 [‡] 19	100	0.0	(7/2 [−])			
170.97		170.97 [‡] 20	100	0.0	(7/2 [−])			
192.3	(13/2 ⁺)	80 [@]	100	112.3	(9/2 [−])	[M2]	115.9 16	B(M2)(W.u.)=0.153 +16−13 E _γ : From (⁸³ Kr,4n2pγ),(⁸² Sr,αp2nγ). B(E2)(W.u.)=104 +14−11 B(E2)(W.u.)=81 +14−10
472.3	(17/2 ⁺)	280 1	100	192.3	(13/2 ⁺)	[E2]	0.1125 20	
950.8	(21/2 ⁺)	478 1	100	472.3	(17/2 ⁺)	[E2]	0.0255 4	
1215.8	(19/2 ⁺)	744 1	100	472.3	(17/2 ⁺)			
1561.8	(25/2 ⁺)	611 1	100	950.8	(21/2 ⁺)			
1812.3	(23/2 ⁺)	597 1		1215.8	(19/2 ⁺)			
		861 1	100	950.8	(21/2 ⁺)			I _γ : from (⁶⁰ Ni,2pnγ), I(861γ)>I(597γ).
2025.8	(23/2 [−])	1075 1	100	950.8	(21/2 ⁺)			
2169.8	(25/2 [−])	608 1	100	1561.8	(25/2 ⁺)			
2265.8	(29/2 ⁺)	704 1	100	1561.8	(25/2 ⁺)			
2374.8	(27/2 [−])	349 1		2025.8	(23/2 [−])			
		813 1		1561.8	(25/2 ⁺)			I _γ : from (⁶⁰ Ni,2pnγ), I(813γ) and I(349γ) are comparable.
2722.8	(31/2 [−])	348 1	100	2374.8	(27/2 [−])			
3033.8	(33/2 ⁺)	768 1	100	2265.8	(29/2 ⁺)			
3168.8	(35/2 [−])	446 1	100	2722.8	(31/2 [−])			
3749	(39/2 [−])	580 1	100	3168.8	(35/2 [−])			
3817	(37/2 ⁺)	783 1	100	3033.8	(33/2 ⁺)			

† From (⁶⁰Ni,2pnγ), except where otherwise noted.

‡ From ¹⁷³Pt α Decay (381 ms).

Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with “Frozen Orbitals” approximation based on γ-ray energies, assigned multiplicities, and mixing ratios, unless otherwise specified.

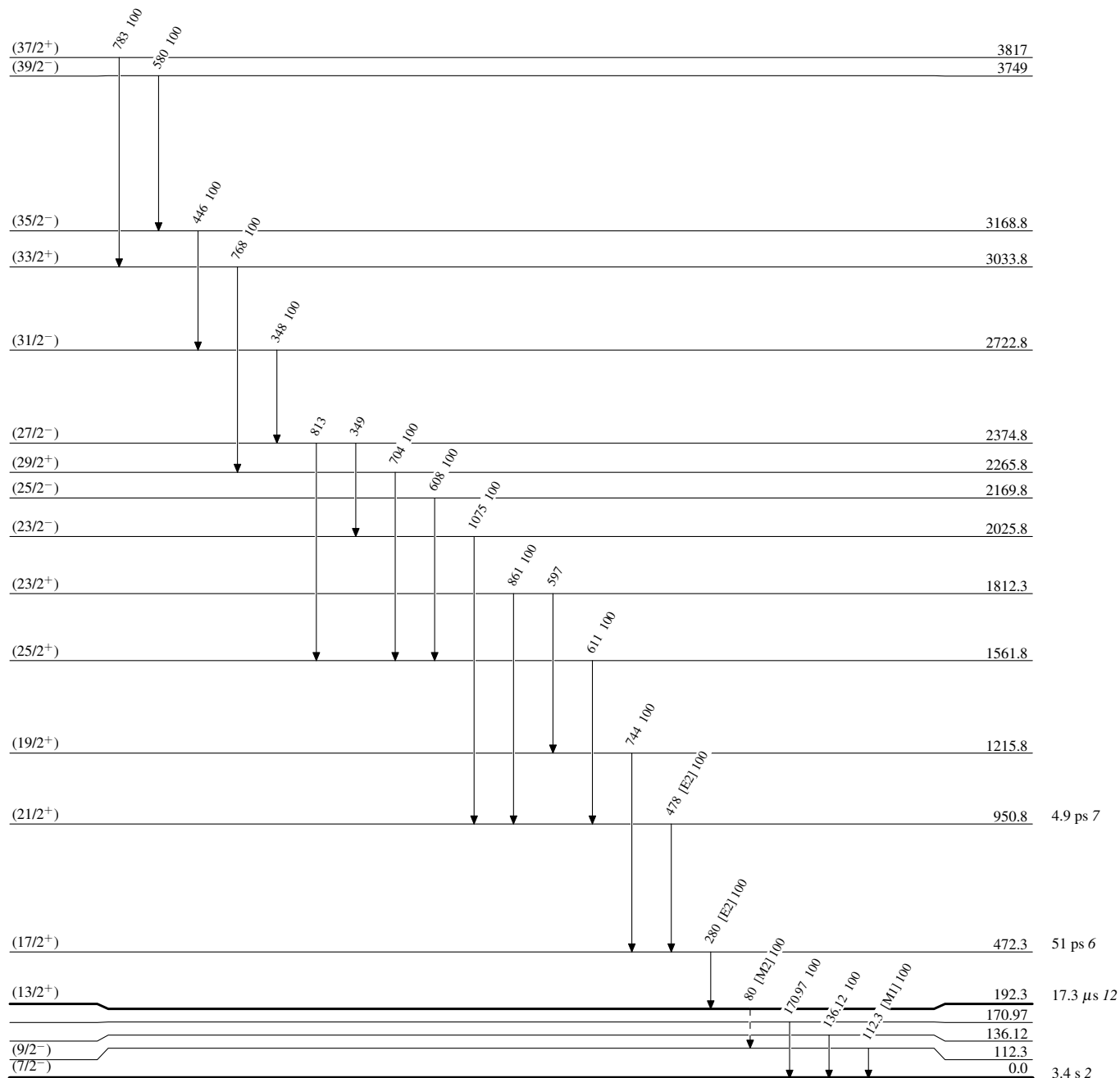
@ Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

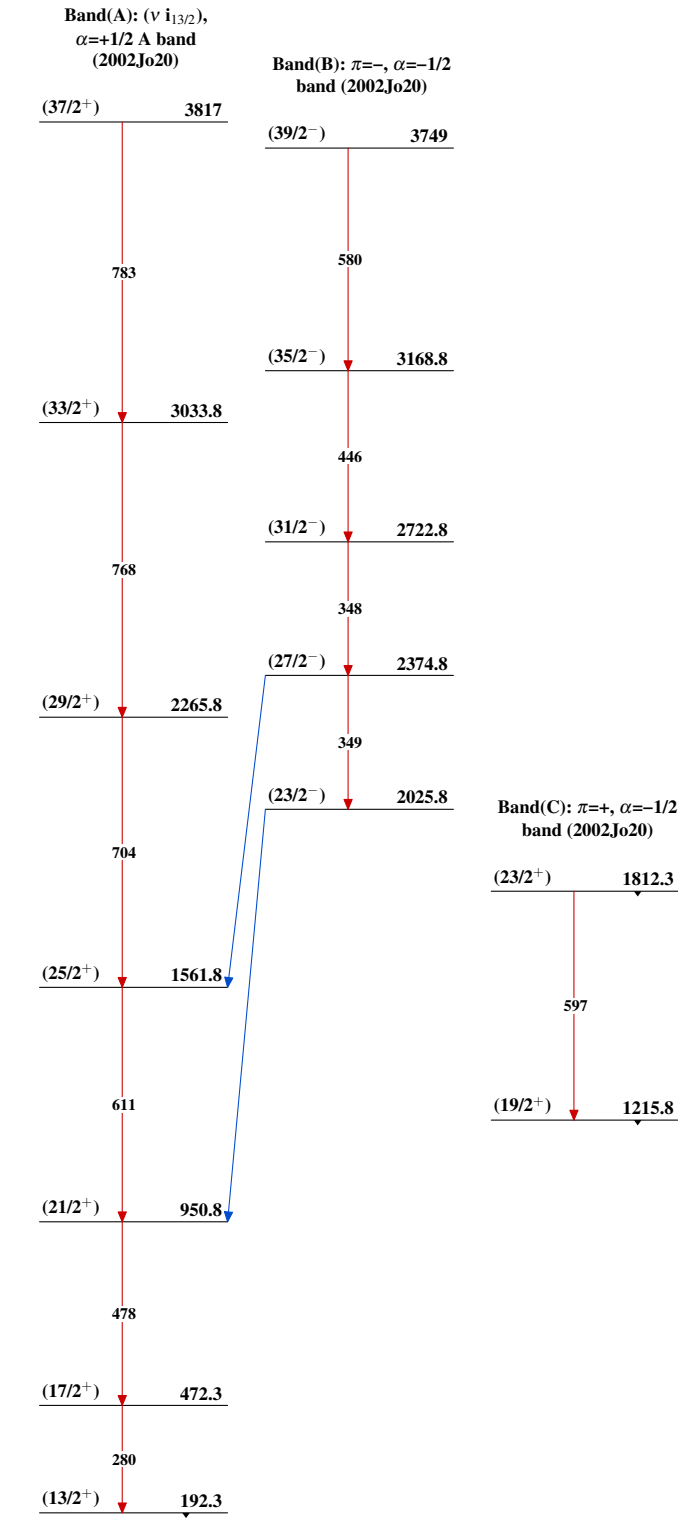
Legend

Level Scheme

Intensities: Relative photon branching from each level

 - - - - - $\rightarrow$ γ Decay (Uncertain)


Adopted Levels, Gammas



¹⁷³Pt α decay (381 ms) 2014ThZZ,1996Pa01,1981De22

Parent: ¹⁷³Pt: E=0.0; J ^{π} =(7/2⁻); T_{1/2}=381 ms 3; Q(α)=6360 60; % α decay=100 5

¹⁷³Pt-J ^{π} : from 2014ThZZ, based on the 104 γ (M1) multipolarity from (9/2⁻) state at 104. Consistent with the ¹⁷¹Pt and ¹⁷⁵Pt g.s. assignments.

¹⁷³Pt-T_{1/2}: weighted average of 382 ms 2 (2004GoZZ). Others: 325 ms 20 (1981De22), 360 ms 20 (1982En03), 290 ms 60 (1992ToZX), 376 ms 11 (1996Pa01), 370 ms 13 (2002Ro17), 430 ms 40 (2009An20). Other: 382 ms 2 in the ENSDF (update).

¹⁷³Pt-Q(α): from 2021Wa16.

¹⁷³Pt-% α decay: Measured in 2009An20. Others: 86 4 in (1995Sh21) and in ENSDF, based on 84 6 (from ratio of I α for α group for ¹⁷³Pt daughter and for ¹⁷⁷Hg parent in the same spectrum) (1979Ha10 – where %I α (6580)=85 of ¹⁷⁷Hg was an estimated value), 83 14 (1996Pa01, 6225 α) and 82 6 (2004GoZZ, 6232 α).

2014ThZZ: Source was produced from ⁹²Mo(⁸²Sr,x); E=392, 400 MeV; Experiment performed at Accelerator Laboratory, JYFL Finland. Measured reaction products, E α , I α , E γ , $\alpha\gamma$ using planer and Double Sided Silicon Detectors; Deduced excited level energies.

1996Pa01: source from 354 MeV ⁷⁰Ge bombardment of ¹⁰⁶Cd; recoil mass separator, double-sided Si strip detector (FWHM $\leq$ 20 keV); measured E α , parent and daughter T_{1/2} and % α .

1981De22: sources from ^{112,116}Sn, ¹¹³In(⁶³Cu,xnyp) (E(⁶³Cu)=245-300 MeV, helium-jet transport); enriched targets; measured E α , I α (annular Si detector).

1979Ha10: sources from decay of ¹⁷⁷Hg parent activity; measured E α , I α (Si surface-barrier detector).

1982En03: sources from ¹⁴⁴Sm(³²S,3n) (E(³²S)=139.5-201 MeV, recoil-mass selection); Sm targets enriched to 96.33% in ¹⁴⁴Sm; measured E α , I α (thin gas Δ E, surface-barrier E detectors).

2009An20: ¹⁷³Pt obtained as granddaughter of ¹⁸¹Pb α decay produced in ¹⁴⁴Sm(⁴⁰Ca,3n) at beam energy of 196 MeV at GSI SHIP facility. Measured: E α , (recoil) α , $\alpha\alpha$ correlations, half-lives, α decay branching ratios. Evaporation residues were detected with position- sensitive silicon detector with Δ E $\approx$ 25 keV FWHM. α - energy calibration was performed using α -lines from ^{176–182}Hg and their daughters. Distinction between the reaction and production channels was performed with three tof detectors.

Others: 1966Si08, 1973Ga08, 1982En03, 2002Ro17, 2004GoZZ.

¹⁶⁹Os Levels

E(level) [†]	J ^{π}	T _{1/2}	Comments
0.0	(7/2 ⁻)	3.4 s 2	J ^{π} : from unhindered α decay from (7/2 ⁻) ¹⁷³ Pt. T _{1/2} : from Adopted Levels.
34.84 18	(5/2 ⁻)		J ^{π} : 5/2 ⁻ in 2014ThZZ, authors assumed 34.84 γ is of M1 character to 7/2 ⁻ g.s.. Relatively more hindered α transition from (7/2 ⁻) ¹⁷³ Pt compared to that of the g.s.
112.3 3	(9/2 ⁻)		J ^{π} : 9/2 ⁻ in 2014ThZZ, authors state that 112.3 γ is more consistent M1 transition to (7/2 ⁻) g.s.
136.12 19			
170.97 20			

[†] From E γ .

α radiations

E α	E(level)	I α ^{†@}	HF [#]	Comments
6067 [‡]	170.97	0.5 4	67 56	E α : same value in 2014ThZZ and 2004GoZZ. I α : same in 2014ThZZ. Other: $\approx$ 1 (2004GoZZ).
6099 5	136.12	0.5 4	92 77	E α : weighted average of 6097 5 (2014ThZZ) and 6100 5 (2004GoZZ). I α : same in 2014ThZZ. Other: $\approx$ 1 (2004GoZZ).
6132 [‡] 6	112.3	0.15 3	3.8 $\times$ 10 ² 12	E α : weighted average of 6130 6 (2014ThZZ) and 6133 5 (2004GoZZ). I α : same in 2014ThZZ. Other: $\approx$ 2 (2004GoZZ).
6203 4	34.84	15.2 10	7.4 17	E α : weighted average of 6201 4 (2014ThZZ), 6190 20 (1966Si08), 6190 10 (1973Ga08), 6212 8 (6213 8 of 1979Ha10 after adjustment by 1991Ry01), and 6205 3 (1981De22). Assumed g.s. transition assumed – correlated with 5575 α from ¹⁶⁹ Os(g.s.) (2002Ro17). I α : 15.2 11 (2014ThZZ).
6232 4	0.0	83.6 11	1.8 4	E α : weighted average of 6235 4 (2014ThZZ), 6240 15 (2009An20), 6232 5

Continued on next page (footnotes at end of table)

^{173}Pt α decay (381 ms) [2014ThZZ,1996Pa01,1981De22](#) (continued)

 α radiations (continued)

E_α	$E(\text{level})$	Comments
		(2004GoZZ), 6225 9 (1996Pa01), and 6222 10 (1982En03). I_α : 83.6 17 (2014ThZZ). Other: 96 1 (2004GoZZ).

[†] Relative intensity of [2004GoZZ](#) (except where otherwise noted) normalized to yield $\Sigma I_\alpha=100$. I_α values from the articles are listed in the comments.

[‡] Correlated with 5581 α and 5537 α from ^{169}Os ([2004GoZZ](#)).

[#] The nuclear radius parameter $r_0(^{169}\text{Os})=1.5564\ 36$ is deduced from interpolation (or unweighted average) of radius parameters of the adjacent even-even nuclides: $^{170}\text{Os}=1.5551\ 32$ and $^{168}\text{Os}=1.5578\ 40$ in [2020Si16](#).

[@] For absolute intensity per 100 decays, multiply by 1.00 5.

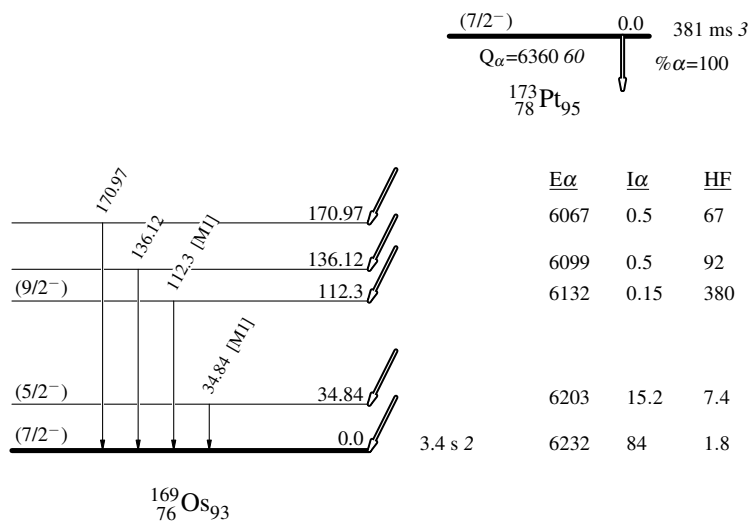
 $\gamma(^{169}\text{Os})$

E_γ [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	Comments
34.84 18	34.84	(5/2 ⁻)	0.0	(7/2 ⁻)	[M1]	
112.3 3	112.3	(9/2 ⁻)	0.0	(7/2 ⁻)	[M1]	Mult.: M1 assumed in 2014ThZZ .
136.12 19	136.12		0.0	(7/2 ⁻)		E_γ : from 2014ThZZ . Other: 136.2 5 (2004GoZZ).
170.97 20	170.97		0.0	(7/2 ⁻)		E_γ : from 2014ThZZ . Other: 171.2 5 (2004GoZZ).

[†] From [2014ThZZ](#).

 ^{173}Pt α decay (381 ms) [2014ThZZ,1996Pa01,1981De22](#)

Decay Scheme



$^{92}\text{Mo}({}^{83}\text{Kr},4n2p\gamma),({}^{82}\text{Sr},\alpha p2n\gamma)$ 2021Zh52,2014ThZZ

2021Zh52: (${}^{83}\text{Kr},4n2p\gamma$): Experiment performed at Accelerator Laboratory, JYFL Finland. $E({}^{83}\text{Kr})=383$ MeV. Target: ^{92}Mo (0.52 mg/cm², stretched) with Mg (1 mg/cm²) degrader with nine different degrader distances ranging from 11 μm to 2 mm. 15 JUROGAM II Ge detectors (ten at 133.6° and five at 157.6°), 24 Euroball clover detectors for prompt gamma rays. Gas filled electromagnetic ion separator (RITU) for separating recoiling fusion products. Double-sided planar Ge detector (absolute efficiency up to 30% at 100 keV) for low-energy γ and x-ray measurement. The lifetimes of low-lying excited states in ^{169}Os have been measured by recoil-distance Doppler-shift (RDDS) method. Selection of ^{169}Os was through recoil isomer tagging using 112 keV transition ($9/2^- \rightarrow 7/2^-$). $B(E2)$ and Q_t values deduced from lifetimes.

2014ThZZ: (${}^{82}\text{Sr},\alpha p2n\gamma$): $E=392, 400$ MeV; assumed ^{169}Os was produced from compound formation of ^{176}Hg via $\alpha p2n$ evaporation channel; Experiment performed at Accelerator Laboratory, JYFL Finland. Measured reaction products, $E\gamma$, $I\gamma$, $\alpha\gamma$, $\gamma\gamma$ -coin using JUROGAM II, an array of Compton suppressed hyperpure germanium (HP-Ge) detectors made up of 15 EUROGAM Phase-I type detectors and 24 segmented Clover detectors. Deduced excited level energies, spin-parity, half-life.

The authors (**2021Zh52**) assume that the unobserved feeding does not significantly perturb the measured lifetime values in this singles RDDS analysis.

 ^{169}Os Levels

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$T_{1/2}^\#$	Comments
0.0	($7/2^-$)		
112.3 3	($9/2^-$)		J^π : from Adopted Levels.
192.3 @ 11	($13/2^+$)	17.3 μs 12	$T_{1/2}$: from 112 γ (t) (2014ThZZ).
472.5 @ 15	($17/2^+$)	51 ps 6	Transition quadrupole moment $Q_t=4.3$ eb 5 (2021Zh52). $T_{1/2}$: from $\tau=74$ ps 9.
950.6 @ 18	($21/2^+$)	4.9 ps 7	Transition quadrupole moment $Q_t=3.7$ eb 5 (2021Zh52). $T_{1/2}$: from $\tau=7.0$ ps 10.
1561.9 @ 21	($25/2^+$)		$E(\text{level})$: presented in Fig. 7.8 (2014ThZZ).
2265.9 @ 23	($29/2^+$)		$E(\text{level})$: presented in Fig. 7.8 (2014ThZZ).

[†] From $E\gamma$ values, assuming uncertainty of 1 keV for missing $\Delta E\gamma$. In **2014ThZZ** (Fig. 7.8), two levels 3033 ($(33/2^+)$) and 3817 ($(37/2^+)$) are depopulating 768 γ and 784 γ , respectively. However, these two gammas are not available in the gamma-ray spectra (Figs 7.5 and 7.7) – presumably taken from the literature. Thus, these two levels and corresponding gammas are not presented in this data set.

[‡] As assigned in **2021Zh52**.

[#] From **2021Zh52** using recoil gated singles spectra unless otherwise stated.

@ Band(A): $\nu_{13/2}$ band. Band assignment from Adopted Levels and (${}^{60}\text{Ni},2p\gamma$) (**2002Jo20**).

 $\gamma(^{169}\text{Os})$

$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [‡]	$\alpha^\#$	Comments
80 @	192.3	($13/2^+$)	112.3	($9/2^-$)			E_γ : tentative assignment (2014ThZZ). 2021Zh52 state “the 80 keV transition was extremely weak and its correlation with 112 keV was barely visible above the background, presumably due to its large internal conversion coefficient”. In 2014ThZZ , a weak 80-keV γ is shown in spectral Fig. 7.7a.
112.3 3	112.3	($9/2^-$)	0.0	($7/2^-$)			
280.2	472.5	($17/2^+$)	192.3	($13/2^+$)	[E2]	0.1125 16	$B(E2)(\text{W.u.})=104$ 15 (2021Zh52)
478.1	950.6	($21/2^+$)	472.5	($17/2^+$)	[E2]	0.0255 4	$B(E2)(\text{W.u.})=82$ 12 (2021Zh52)
611.3	1561.9	($25/2^+$)	950.6	($21/2^+$)			
704	2265.9	($29/2^+$)	1561.9	($25/2^+$)			

[†] From **2014ThZZ** (Table 7.4 or Fig. 7.7). In **2014ThZZ** (Fig. 7.8), 768 γ and 784 γ are depopulating 3033 ($(33/2^+)$) and 3817

$^{92}\text{Mo}(^{83}\text{Kr},4\text{n}2\text{p}\gamma),(^{82}\text{Sr},\alpha\text{p}2\text{n}\gamma)$ **2021Zh52,2014ThZZ (continued)**

$\gamma(^{169}\text{Os})$ (continued)

((37/2⁺)) levels, respectively. These two depopulating gammas are not available in the gamma spectra (Figs 7.5 and 7.7) – presumably taken from the literature. These two gammas and corresponding levels are not presented in this data set.

‡ Implied from J^π values.

Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with “Frozen Orbitals” approximation based on γ -ray energies, assigned multiplicities, and mixing ratios, unless otherwise specified.

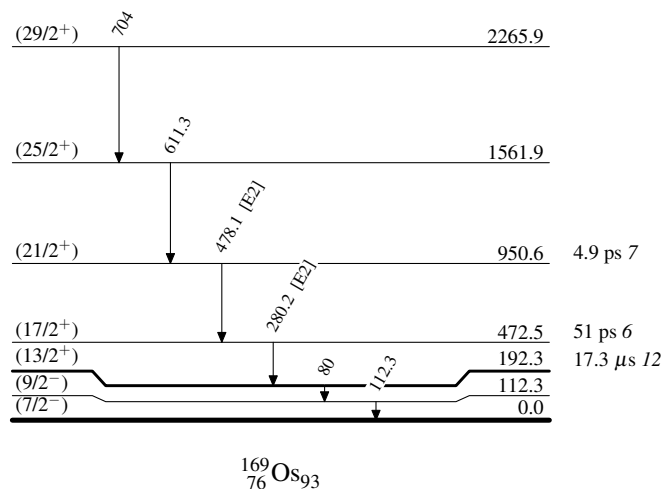
@ Placement of transition in the level scheme is uncertain.

$^{92}\text{Mo}(^{83}\text{Kr},4\text{n}2\text{p}\gamma),(^{82}\text{Sr},\alpha\text{p}2\text{n}\gamma)$ **2021Zh52,2014ThZZ**

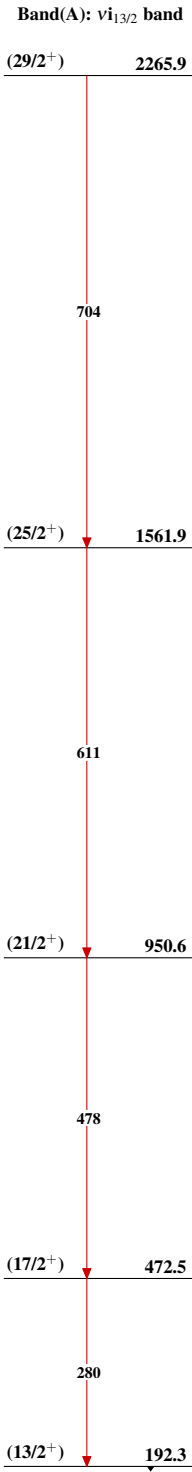
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Level Scheme

-----► γ Decay (Uncertain)



⁹²Mo(⁸³Kr,4n2pγ),(⁸²Sr,αp2nγ) 2021Zh52,2014ThZZ



¹⁶⁹₇₆Os₉₃

¹¹²Sn(⁶⁰Ni,2pn γ) **2002Jo20**

E(⁶⁰Ni)=265 MeV; RITU gas-filled recoil separator with Si strip detector in focal plane, JUROSPHERE detector array (13 EUROGAM and 12 TESSA-type Compton-suppressed Ge detectors); recoil α decay tagging technique; measured 5576 α - γ correlations, E γ , I γ , recoil- $\gamma\gamma$ coin, E α .

¹⁶⁹Os Levels

Notation used for orbitals:

A, B: (ν i_{13/2}) orbital.

E, F: f_{7/2} or h_{9/2} orbital.

E(level) [†]	J π [‡]	Comments
192.3 [#] 11	(13/2 ⁺)	E(level): from Adopted Levels. Unknown in 2002Jo20 .
472.3 [#] 15	(17/2 ⁺)	
950.8 [#] 17	(21/2 ⁺)	
1215.8 ^{&} 17	(19/2 ⁺)	
1561.8 [#] 19	(25/2 ⁺)	
1812.3 ^{&} 18	(23/2 ⁺)	
2025.8 [@] 19	(23/2 ⁻)	
2169.8 22	(25/2 ⁻) ^a	
2265.8 [#] 22	(29/2 ⁺)	
2374.8 [@] 20	(27/2 ⁻)	
2722.8 [@] 22	(31/2 ⁻)	
3033.8 [#] 24	(33/2 ⁺)	
3168.8 [@] 25	(35/2 ⁻)	
3748.8 [@] 26	(39/2 ⁻)	
3816.8 [#] 26	(37/2 ⁺)	

[†] From E γ .

[‡] Authors' values based on likely quasiparticle configurations and comparison with similar structures in neighboring odd-A nuclei.

[#] Band(A): (ν i_{13/2}), $\alpha=+1/2$ A band.

[@] Band(B): $\pi=-$, $\alpha=-1/2$ band. Large alignment (14.4 $\hbar$ at $\hbar\omega=0.25$ MeV) suggests three-quasiparticle structure, possibly EAB or FAB, analogous to ¹⁷¹Os band; drop in alignment at $\hbar\omega\approx 0.17$ MeV may indicate presence of mixing with octupole vibrational bands. The E and F orbitals are expected to originate from the f_{7/2} or h_{9/2} subshell, A and B orbitals from ν i_{13/2}.

[&] Band(C): $\pi=+$, $\alpha=-1/2$ band. Possibly the (ν i_{13/2}), $\alpha=-1/2$ B band or the A band coupled to a collective phonon excitation.

^a Possible EAB configuration state.

 $\gamma(^{169}\text{Os})$

E γ [†]	E _i (level)	J π _i	E _f	J π _f	Comments
280 1	472.3	(17/2 ⁺)	192.3	(13/2 ⁺)	I γ : see comment on 813 γ .
348 1	2722.8	(31/2 ⁻)	2374.8	(27/2 ⁻)	
349 1	2374.8	(27/2 ⁻)	2025.8	(23/2 ⁻)	
446 1	3168.8	(35/2 ⁻)	2722.8	(31/2 ⁻)	
478 1	950.8	(21/2 ⁺)	472.3	(17/2 ⁺)	
580 1	3748.8	(39/2 ⁻)	3168.8	(35/2 ⁻)	I γ : see comment on 861 γ .
597 1	1812.3	(23/2 ⁺)	1215.8	(19/2 ⁺)	
608 1	2169.8	(25/2 ⁻)	1561.8	(25/2 ⁺)	
611 1	1561.8	(25/2 ⁺)	950.8	(21/2 ⁺)	
704 1	2265.8	(29/2 ⁺)	1561.8	(25/2 ⁺)	

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$^{112}\text{Sn}(^{60}\text{Ni},2\text{pn}\gamma)$ **2002Jo20** (continued)

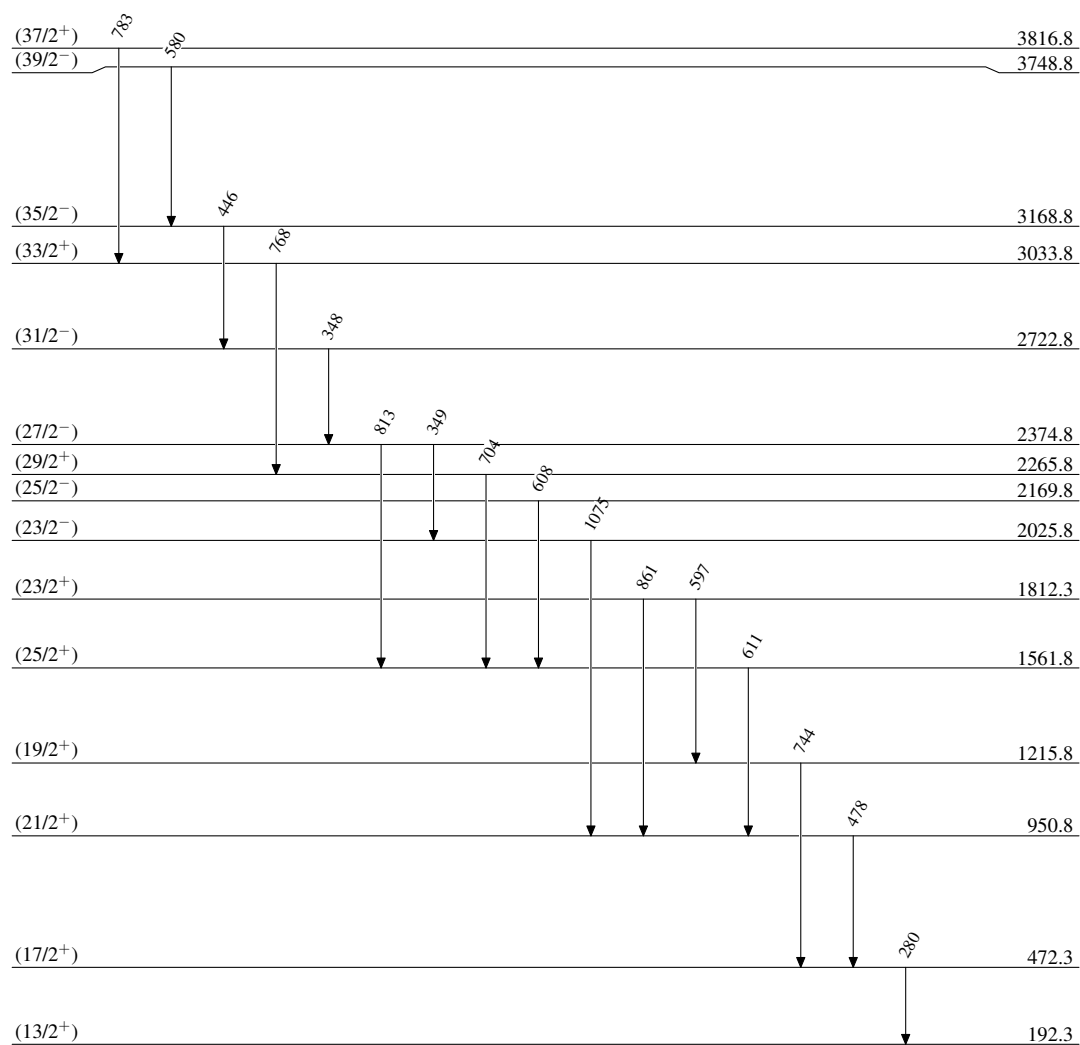
 $\gamma(^{169}\text{Os})$ (continued)

$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
744 <i>I</i>	1215.8	(19/2 ⁺)	472.3	(17/2 ⁺)	
768 <i>I</i>	3033.8	(33/2 ⁺)	2265.8	(29/2 ⁺)	
783 <i>I</i>	3816.8	(37/2 ⁺)	3033.8	(33/2 ⁺)	
813 <i>I</i>	2374.8	(27/2 ⁻)	1561.8	(25/2 ⁺)	I_γ : based on fig. 2 (^{169}Os level scheme) of 2002Jo20 , $I(813\gamma)$ and $I(349\gamma)$ are comparable.
861 <i>I</i>	1812.3	(23/2 ⁺)	950.8	(21/2 ⁺)	I_γ : based on fig. 2 (^{169}Os level scheme) of 2002Jo20 , $I(861\gamma) > I(597\gamma)$.
1075 <i>I</i>	2025.8	(23/2 ⁻)	950.8	(21/2 ⁺)	

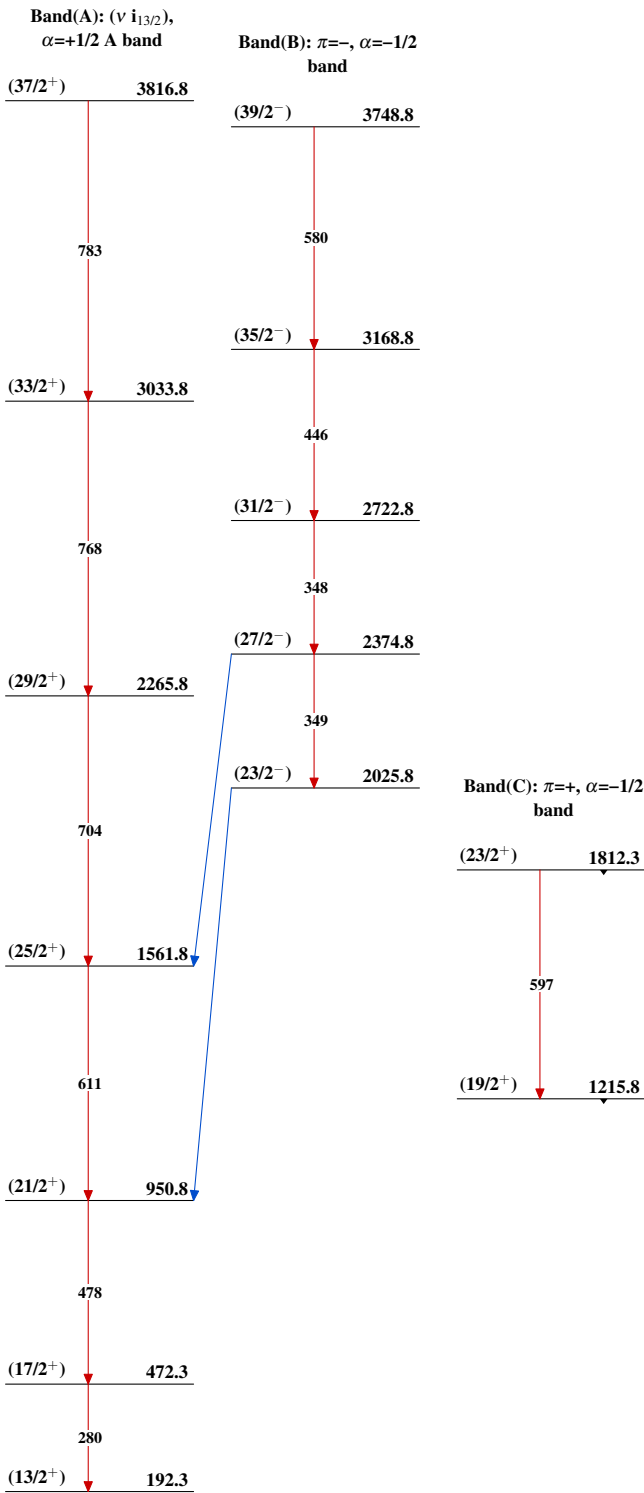
[†] From **2002Jo20**.

$^{112}\text{Sn}(^{60}\text{Ni}, 2\text{pn}\gamma)$ 2002Jo20

Level Scheme

 $^{169}_{76}\text{Os}_{93}$

$^{112}\text{Sn}(^{60}\text{Ni},2\text{pn}\gamma)$ 2002Jo20



$^{169}_{76}\text{Os}_{93}$

Adopted Levels, Gammas

$Q(\beta^-) = -9630$ syst; $S(n) = 11500$ 60; $S(p) = -613$ 22; $Q(\alpha) = 6141$ 4 [2021Wa16](#)

$\Delta Q(\beta^-) = 200$ (syst, [2021Wa16](#)).

$S(2n) = 21164$ 30, $S(2p) = 1840$ 50 (syst), $Q(\epsilon p) = 6410$ 40 ([2021Wa16](#)).

Identification: excitation functions for ^{63}Cu bombardments of cadmium, silver, and palladium ([1978Ca11](#)); excitation functions for krypton bombardments of niobium and yttrium ([1978Sc26](#)).

 ^{169}Ir LevelsCross Reference (XREF) Flags

A ^{173}Au α decay (25.5 ms)
B ^{173}Au α decay (12.2 ms)
C $^{112}\text{Sn}(^{60}\text{Ni}, p2n\gamma)$

E(level) [†]	J^π [‡]	$T_{1/2}$	XREF	Comments
0.0	(1/2 ⁺)	0.570 s 30	A C	$\% \alpha = 56$ 9; $\% \epsilon + \% \beta^+ = ?$; $\% p = ?$ $\% \alpha$: weighted average of 57 9 (2012Th13) and 50 18 (1999Po09). Other: 42 15 (2005Sc22). $\% p$: see 1983Al09 and 1984Gr14 for discussions of expected proton decay. J^π: unhindered α decay from (1/2⁺) ^{173}Au. The configuration of the α-decaying ground state in ^{169}Ir is proposed to be an equal mixture of the $p_{1/2}$ and $p_{3/2}$ orbitals (2007Sa33). $T_{1/2}$: from 2012Th13 (6019$\alpha(t)$). Others: 0.64 s +46–24 (1999Po09 – listed as 638 ms +462–237 – 6005$\alpha(t)$), 0.8 s 5 (2004GoZZ), 0.353 s 4 (2005Sc22 – 5993$\alpha(t)$). The datum in 2005Sc22 is discrepant and the evaluator accepts the value of 2012Th13 as it is from the same lab of 2005Sc22.
153 24	(11/2 ⁻)	0.280 s 1	BC	$\% \alpha = 79$ 6; $\% \epsilon + \% \beta^+ = ?$; $\% p = ?$ $\% \alpha$: weighted average of 78 6 (2012Th13), 84 8 (1999Po09), and 72 13 (1996Pa01). Others: 59 4 (2005Sc22), 83 +17–42 (1984ScZQ). E(level): from ^{173}Au α decay (14.0 ms). J^π: unhindered α decay from (11/2⁻) ^{173}Au. The configuration of the isomeric α-decaying state is assigned a $\pi h_{11/2}$ configuration (2007Sa33). $T_{1/2}$: weighted average of 0.280 s 1 (2012Th13 – from a least square fit of α decay), 0.29 s 1 (2004GoZZ), 0.308 s 22 (1996Pa01 – 6119$\alpha(t)$), 0.32 s +9–7 (1999Po09 – listed as 323 ms +90–66 – 6106$\alpha(t)$). Others: 0.4 s 1 (1978Ca11 – 6110$\alpha(t)$), 0.4 s 2 (1978Sc26 – 6070$\alpha(t)$), 0.280 s 3 (2005Sc22 – 6117$\alpha(t)$).
610.08 [#] 18	(13/2 ⁻)		C	
811.35 [@] 21	(15/2 ⁻)		C	
1243.18 27	(15/2 ⁻)		C	
1330.69 [#] 23	(17/2 ⁻)		C	
1547.07 ^{&} 28	(17/2 ⁻)		C	
1573.49 [@] 25	(19/2 ⁻)		C	
1724.73 ^{&} 33	(19/2 ⁻)		C	J^π : D, $\Delta J = 1$ 393 γ to (17/2 ⁻) member of 11/2[505] band.
1803.08 33	(17/2 ⁻)		C	
1803.73 25	(19/2 ⁻)		C	
1998.29 ^{&} 31	(21/2 ⁻)		C	
2045.51 35	(21/2 ⁻)		C	
2116.24 [#] 25	(21/2 ⁻)		C	
2221.9 ^{&} 4	(23/2 ⁻)		C	
2261.93 26	(21/2 ⁻)		C	
2263.93 35	(23/2 ⁻)		C	
2319.00 ^a 28	(23/2 ⁻)		C	
2406.90 [@] 35	(23/2 ⁻)		C	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{169}Ir Levels (continued)

E(level) [†]	J ^π [‡]	XREF	E(level) [†]	J ^π [‡]	XREF	E(level) [†]	J ^π [‡]	XREF
2449.50 ^a 30	(25/2 ⁻)	C	2609.0 ^a 4	(27/2 ⁻)	C	3118.5 ^a 8	(31/2 ⁻)	C
2468.43 28	(23/2 ⁻)	C	2852.14 35	(25/2 ⁻)	C	3442.1 ^a 8	(33/2 ⁻)	C
2574.5 4	(25/2 ⁻)	C	2861.9 ^a 7	(29/2 ⁻)	C			

[†] From least-squares fit to E_γ , excluding the 152.3 and 393.3 γ s from 1724.64 keV level and 317.6 γ from 2319.0 keV level – fit very poorly. Energies are given assuming E=153 for the $h_{11/2}$ isomeric state and without considering the 24 keV uncertainty in that energy.

[‡] Based on band structure deduced in ($^{60}\text{Ni}, p2n\gamma$), transition multiplicities and similarity of level scheme to that for ^{171}Ir , except where otherwise noted.

Band(A): π 11/2[505], $\alpha=+1/2$ band. Configuration supported by measured B(M1) to B(E2) ratios for in-band transitions.

@ Band(a): π 11/2[505], $\alpha=-1/2$ band. See comment on signature partner band.

& Band(B): $\pi=(-)$ sideband 1. Based on (17/2⁻).

^a Band(C): $\pi=(-)$ sideband 2. Based on (23/2⁻).

 $\gamma(^{169}\text{Ir})$

$E_i(\text{level})$	J _i ^π	E_γ [‡]	I _γ [‡]	E_f	J _f ^π	Mult. [#]	α [@]	Comments
610.08	(13/2 ⁻)	457.1 2	100	153	(11/2 ⁻)	(M1)	0.0910 13	
811.35	(15/2 ⁻)	201.7 3	31.5 8	610.08	(13/2 ⁻)	(M1)	0.838 12	
		658.3 3	100.0 13	153	(11/2 ⁻)	(E2)	0.01250 18	
1243.18	(15/2 ⁻)	633.1 2	100	610.08	(13/2 ⁻)			
1330.69	(17/2 ⁻)	519.3 4	100.0 21	811.35	(15/2 ⁻)	(M1)	0.0651 9	
		720.3 2	63.5 19	610.08	(13/2 ⁻)	(E2)	0.01026 14	
1547.07	(17/2 ⁻)	937.3 3	100	610.08	(13/2 ⁻)			
1573.49	(19/2 ⁻)	242.5 ^{&} 4	<58 ^{&}	1330.69	(17/2 ⁻)			242 γ +243 γ doublet; I _γ shared between the two components. D multipolarity for one or both components of doublet.
		762.4 4	100.0 21	811.35	(15/2 ⁻)	(E2)	0.00909 13	
1724.73	(19/2 ⁻)	152.3 [†] 1	58.0 17	1573.49	(19/2 ⁻)			E_γ : very poor fit and omitted in the fitting; level-energy difference=151.24.
		178.0 3	29.5 12	1547.07	(17/2 ⁻)			
		393.3 [†] 1	100.0 22	1330.69	(17/2 ⁻)	D		E_γ : very poor fit and omitted in the fitting; level-energy difference=394.04.
1803.08	(17/2 ⁻)	559.9 2	100	1243.18	(15/2 ⁻)			
1803.73	(19/2 ⁻)	256.6 ^{&} 4	100 ^{&} 3	1547.07	(17/2 ⁻)			Transition is a self-coincident doublet.
		992.5 2	35.4 21	811.35	(15/2 ⁻)			
1998.29	(21/2 ⁻)	273.9 ^{&} 3	100 ^{&}	1724.73	(19/2 ⁻)			273 γ +274 γ doublet, dominated by the 274 γ component.
2045.51	(21/2 ⁻)	242.5 ^{&} 4	100 ^{&}	1803.73	(19/2 ⁻)			$E_\gamma, I_\gamma, \text{Mult.}$: see comment on 243 γ from 1420 level.
2116.24	(21/2 ⁻)	542.8 1	100 10	1573.49	(19/2 ⁻)			
		785.3 2	83 6	1330.69	(17/2 ⁻)	(E2)	0.00854 12	
2221.9	(23/2 ⁻)	223.6 2	100	1998.29	(21/2 ⁻)			
2261.93	(21/2 ⁻)	263.8 2	24.7 26	1998.29	(21/2 ⁻)			
		688.4 1	100 3	1573.49	(19/2 ⁻)			
2263.93	(23/2 ⁻)	539.2 1	100	1724.73	(19/2 ⁻)			
2319.00	(23/2 ⁻)	273.9 ^{&} 3	<260 ^{&}	2045.51	(21/2 ⁻)			$E_\gamma, I_\gamma, \text{Mult.}$: see comment on 274 γ from 1846 level.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{169}\text{Ir})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\ddagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Comments
2319.00	(23/2 ⁻)	317.6 [†] 4	100 3	1998.29	(21/2 ⁻)	E_γ : very poor fit and omitted in the fitting; level-energy difference=320.72. E_γ : fits placement very poorly; E_γ is $>5\sigma$ from expected value. Level energy difference is 320.7 3.
		515.1 3	24 9	1803.73	(19/2 ⁻)	
		745.4 2	51 3	1573.49	(19/2 ⁻)	
2406.90	(23/2 ⁻)	290.6 3	<18	2116.24	(21/2 ⁻)	
		833.5 4	100 5	1573.49	(19/2 ⁻)	
2449.50	(25/2 ⁻)	130.5 1	100	2319.00	(23/2 ⁻)	
2468.43	(23/2 ⁻)	206.5 1	100	2261.93	(21/2 ⁻)	
2574.5	(25/2 ⁻)	310.6 2	100	2263.93	(23/2 ⁻)	
2609.0	(27/2 ⁻)	159.5 2	100	2449.50	(25/2 ⁻)	
2852.14	(25/2 ⁻)	383.7 2	100	2468.43	(23/2 ⁻)	
2861.9	(29/2 ⁻)	252.9 6	100	2609.0	(27/2 ⁻)	
3118.5	(31/2 ⁻)	256.6 ^{&} 4	100 ^{&}	2861.9	(29/2 ⁻)	Transition is a self-coincident doublet.
3442.1	(33/2 ⁻)	323.6 2	100	3118.5	(31/2 ⁻)	

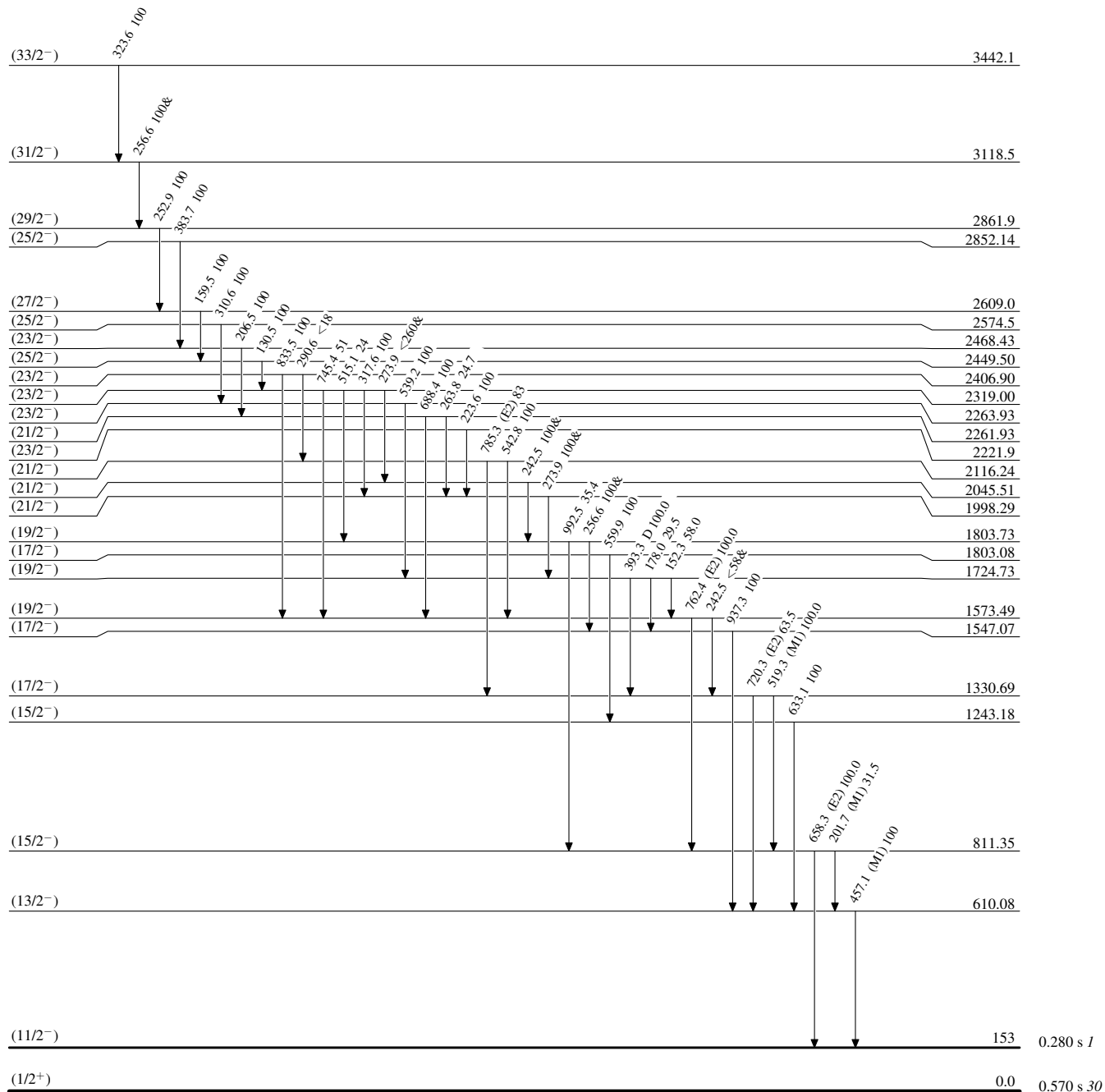
[†] Very Poor fit and omitted in the fitting.[‡] From $^{112}\text{Sn}(^{60}\text{Ni}, p2n\gamma)$ (2007Sa33).# From $^{112}\text{Sn}(^{60}\text{Ni}, p2n\gamma)$ based on measured $(I_\gamma(158^\circ))/(I_\gamma(86^\circ)+I_\gamma(94^\circ))$ and assigning $\Delta\pi=(\text{no})$ to intraband transitions.@ Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with "Frozen Orbitals" approximation based on γ -ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

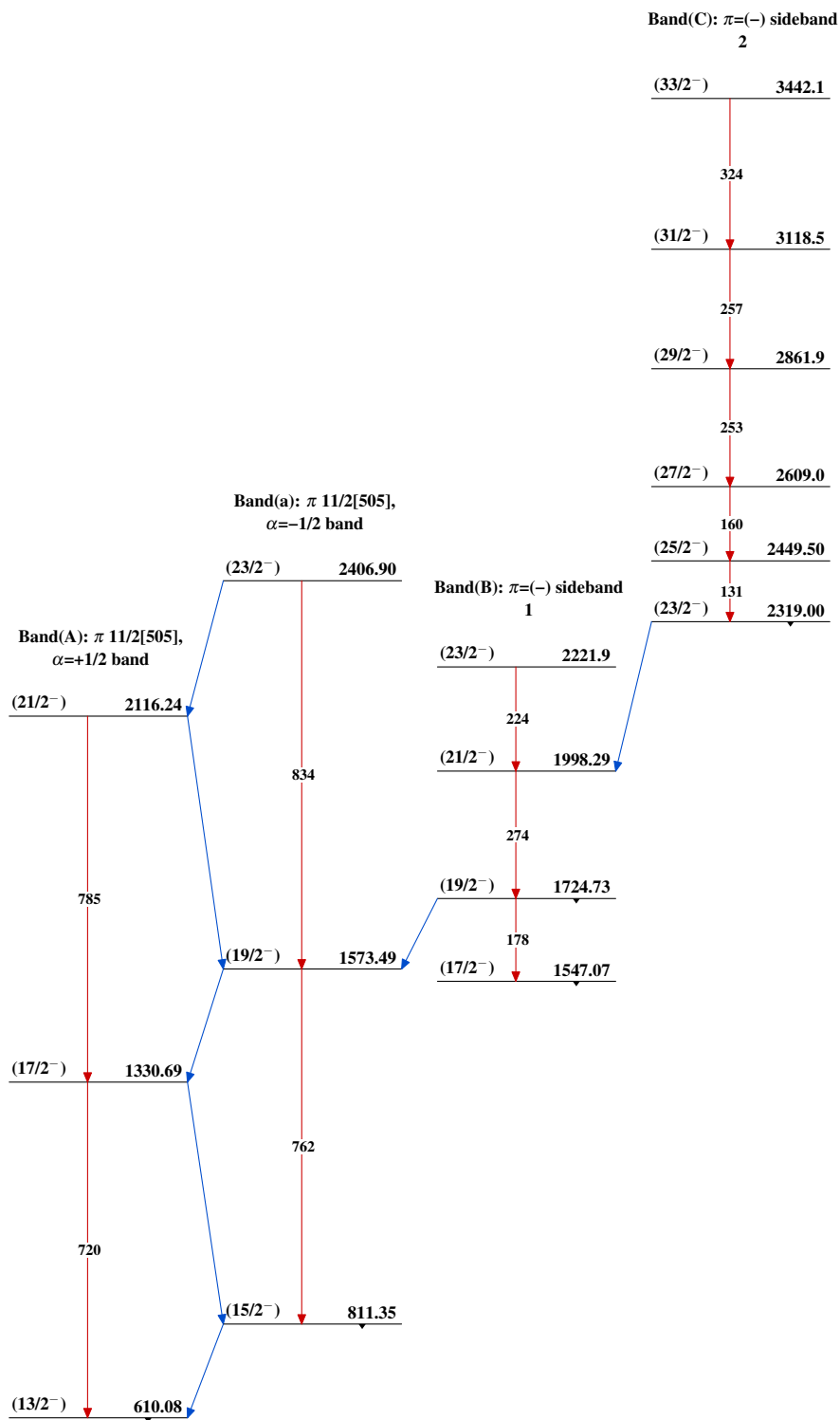
& Multiply placed with undivided intensity.

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level
 & Multiply placed: undivided intensity given



Adopted Levels, Gammas $^{169}_{77}\text{Ir}_{92}$

^{173}Au α decay (25.5 ms) [1999Po09,2004GoZZ,2012Th13](#)

Parent: ^{173}Au : $E=0.0$; $J^\pi=(1/2^+)$; $T_{1/2}=25.5$ ms *10*; $Q(\alpha)=6836$ 5; $\% \alpha$ decay ≈ 94

^{173}Au - E, J^π : from the Adopted Levels of ^{173}Au in ENSDF (update).

^{173}Au - $T_{1/2}$: weighted average of 26.3 ms *12* ([2012Th13](#) α - $\gamma(t)$) and 25 ms *1* ([2001Ko44](#), [2004GoZZ](#)). Others: 20 ms +9–6 ([1999Po09](#)), 26.3 ms *12* in the Adopted Levels of ^{173}Au in ENSDF (update).

^{173}Au - $Q(\alpha)$: from [2021Wa16](#).

^{173}Au - $\% \alpha$ decay: 94 *19* in [1999Po09](#). Note that the reported $\% \alpha$ branch in [1999Po09](#) exceeds 100 within the uncertainty.

[1999Po09](#): Source was obtained from ^{177}Tl , produced from $^{102}\text{Pd}(^{78}\text{Kr}+^{1n}2n)$ fusion–evaporation channel, $E=370$ MeV, at the Argonne ATLAS accelerator facility. 78% enriched target. After passing through the parallel grid avalanche counter (PGAC) and ions were implanted into a double-sided silicon strip detector (DSSD). Measured $E\alpha$, ^{173}Au $\% \alpha$ branching and half-life.

[2004GoZZ](#): ^{173}Au was produced from $^{92}\text{Mo}(^{84}\text{Sr}, X)$, $E=390, 395$ MeV; The ^{84}Sr beam was delivered by the ATLAS superconducting linear accelerator at ANL. The targets were isotopically enriched ($\approx 98\%$) and had a thickness ≈ 0.7 mg/cm². Prompt γ rays were detected using 101 escape-suppressed Ge detectors of Gammasphere. The recoiling evaporation residues were separated by Fragment Mass Analyzer and implanted in a thick DSSD – Recoil Decay Tagging. Measured $E\alpha$, $\alpha\alpha$ coin, ^{173}Au half-life.

[2012Th13](#): ^{173}Au nuclei were produced via fusion-evaporation reactions by bombarding a 0.5 mg/cm² ^{92}Mo target of 97% isotopic enrichment with a beam of $^{84}\text{Sr}^{16+}$ ions provided by the K130 cyclotron of the Accelerator Laboratory of the University of Jyväskylä with $E=392$ MeV for about 140 hours and $E=400$ MeV for about 145 hours with an average beam intensity of 150 enA. Prompt γ rays were detected by 34 HPGe detectors at the target position; recoiling residues were separated using the RITU He-filled magnetic separator and implanted into a 300- μm -thick DSSD in the GREAT spectrometer at the focal plane; delayed γ rays were detected by Ge detectors in the GREAT spectrometer. Measured $E\alpha$, $I\alpha$, $E\gamma$, $I\gamma$, recoil- α -correlation, $\alpha\gamma$ -delayed coin, α -tagged $\gamma\gamma$ -coin, $\alpha(t)$. Deduced isomers, Q_α , α -decay branching ratios, $T_{1/2}$, reduced widths, hindrance factors and mass excesses.

Other: [2001Ko44](#).

 ^{169}Ir Levels

<u>$E(\text{level})$</u>	<u>$J^\pi^\dagger$</u>	<u>$T_{1/2}^\dagger$</u>
0.0	(1/2 ⁺)	0.570 s <i>30</i>

[†] From Adopted Levels.

 α radiations

<u>$E\alpha$</u>	<u>$E(\text{level})$</u>	<u>$I\alpha^\ddagger$</u>	<u>$\text{HF}^\dagger$</u>	<u>Comments</u>
6683 6	0.0	100	≈ 1.9	$E\alpha$: weighted average of 6688 <i>14</i> (2012Th13), 6672 6 (1999Po09) and 6690 5 (2004GoZZ). Other $E\alpha$: 6690 (2001Ko44 ; probably superseded by 2004GoZZ). Correlated with 6005 α from ^{169}Ir (2004GoZZ).

[†] The nuclear radius parameter $r_0(^{169}\text{Ir})=1.5529$ 80 is deduced from interpolation (or unweighted average) of radius parameters of the adjacent even-even nuclides: $^{168}\text{Os}=1.5578$ 40 $^{170}\text{Pt}=1.548$ 12 in [2020Si16](#).

[‡] For absolute intensity per 100 decays, multiply by ≈ 0.94 .

^{173}Au α decay (12.2 ms) [1999Po09](#), [1996Pa01](#), [1983Sc24](#)

Parent: ^{173}Au : $E=214\ 23$; $J^\pi=(11/2^-)$; $T_{1/2}=12.2\ \text{ms}$ I ; $Q(\alpha)=6836\ 5$; $\% \alpha$ decay ≈ 92

^{173}Au - E, J^π : from the Adopted Levels of ^{173}Au in ENSDF (update).

^{173}Au - $T_{1/2}$: from $\alpha(t)$ [2012Th13](#). Others: 14 ms I ([2001Ko44](#), [2004GoZZ](#)), 12 ms $+3-2$ ([1999Po09](#)), 15 ms 2 ([1996Pa01](#)), 59 ms $+45-18$ ([1983Sc24](#)).

^{173}Au - $Q(\alpha)$: from [2021Wa16](#).

^{173}Au - $\% \alpha$ decay: 92 $I3$ in [1999Po09](#). Note that the reported $\% \alpha$ branch in [1999Po09](#) exceeds 100 within the uncertainty.

[1999Po09](#): produced ^{177}Tl grandparent using $^{102}\text{Pd}(^{78}\text{Kr}, p2n)$ reaction at 370 MeV; fragment mass analyzer, recoils implanted into double-sided Si strip detector; measured $E\alpha$, $E(p)$, $p-\alpha$ and $\alpha-\alpha$ correlations, $T_{1/2}$, $\% \alpha$, $\% p$.

[1996Pa01](#): sources from heavy-ion fusion-evaporation reactions; recoil mass separator, double-sided Si strip detector (FWHM ≤ 20 keV); measured $E\alpha$, parent and daughter $T_{1/2}$ and $\% \alpha(^{169}\text{Ir})$.

[1983Sc24](#): sources from ^{92}Mo bombardments of rubidium-molybdenum targets (velocity-filter, evaporation-residue separation); measured $E\alpha$, $I\alpha$ (position-sensitive Si surface-barrier detectors).

[2012Th13](#): ^{173}Au nuclei were produced via fusion-evaporation reactions by bombarding a $0.5\ \text{mg}/\text{cm}^2$ ^{92}Mo target of 97% isotopic enrichment with a beam of $^{84}\text{Sr}^{16+}$ ions provided by the K130 cyclotron of the Accelerator Laboratory of the University of Jyväskylä with $E=392\ \text{MeV}$ for about 140 hours and $E=400\ \text{MeV}$ for about 145 hours with an average beam intensity of 150 enA. Prompt γ rays were detected by 34 HPGe detectors at the target position; recoiling residues were separated using the RITU He-filled magnetic separator and implanted into a $300\text{--}\mu\text{m}$ -thick DSSD in the GREAT spectrometer at the focal plane; delayed γ rays were detected by Ge detectors in the GREAT spectrometer. Measured $E\alpha$, $I\alpha$, $E\gamma$, $I\gamma$, recoil- α -correlation, $\alpha\gamma$ -delayed coin, α -tagged $\gamma\gamma$ -coin, $\alpha(t)$. Deduced isomers, $Q\alpha$, α -decay branching ratios, $T_{1/2}$, reduced widths, hindrance factors and mass excesses.

Other: [2001Ko44](#).

 ^{169}Ir Levels

<u>E(level)</u>	<u>J^π</u>	<u>$T_{1/2}$</u>	<u>Comments</u>
153 24	(11/2 ⁻)	0.280 s I	$E(\text{level})$: based on $E\alpha=6737\ 4$ from 214 23 parent level and $Q(\alpha)=6836\ 5$. $J^\pi, T_{1/2}$: from Adopted Levels.

 α radiations

<u>$E\alpha$</u>	<u>E(level)</u>	<u>$I\alpha^\ddagger$</u>	<u>HF[†]</u>	<u>Comments</u>
6737 4	153	100	≈ 1.5	$E\alpha$: weighted average of 6739 15 (2012Th13), 6742 5 (2004GoZZ), 6732 4 (1999Po09), 6749 9 (1996Pa01), and 6720 20 (1983Sc24). Other $E\alpha$: 6740 (2001Ko44 ; probably superseded by 2004GoZZ). Correlated with 6119 α from ^{169}Ir (2004GoZZ).

[†] The nuclear radius parameter $r_0(^{169}\text{Ir})=1.5529\ 80$ is deduced from interpolation (or unweighted average) of radius parameters of the adjacent even-even nuclides: $^{168}\text{Os}=1.5578\ 40$ $^{170}\text{Pt}=1.548\ 12$ in [2020Si16](#).

[‡] For absolute intensity per 100 decays, multiply by ≈ 0.92 .

$^{112}\text{Sn}(^{60}\text{Ni}, \text{p}2\text{n}\gamma)$ 2007Sa33

Slightly edited, no significant changes compared to that in the previous evaluation (2008Ba31) by C.M. Baglin.

2007Sa33: E(^{60}Ni)=266 MeV; 93% isotopically-enriched target; JUROGAM detector array (43 EUROGAM phase I and GASP type escape-suppressed Ge detectors); RITU gas-filled recoil separator with GREAT spectrometer (2 double-sided Si strip detectors, multiwire proportional counter, 28 PIN diode detectors and 2 segmented Ge detectors) in its focal plane; measured α decay correlated singles γ spectra, E γ , I γ , $\gamma\gamma$ coin. See also 2005Sc22.

 ^{169}Ir Levels

E(level) [†]	J π [‡]	Comments
0.0		
153 [@] 24	(11/2 ⁻)	E(level), J π : from Adopted Levels.
610.08 [#] 18	13/2 ⁻	
811.35 [@] 21	15/2 ⁻	
1243.18 27	(15/2 ⁻)	
1330.69 [#] 23	17/2 ⁻	
1547.07 ^{&} 28	(17/2 ⁻)	
1573.49 [@] 25	19/2 ⁻	
1724.73 ^{&} 33	(19/2 ⁻)	
1803.08 33	(17/2 ⁻)	
1803.73 25	(19/2 ⁻)	
1998.29 ^{&} 31	(21/2 ⁻)	
2045.51 35	(21/2 ⁻)	
2116.24 [#] 25	21/2 ⁻	
2221.9 ^{&} 4	(23/2 ⁻)	
2261.93 26	(21/2 ⁻)	
2263.93 35	(23/2 ⁻)	
2319.00 ^a 28	(23/2 ⁻)	
2406.90 [@] 35	23/2 ⁻	
2449.50 ^a 30	(25/2 ⁻)	
2468.43 28	(23/2 ⁻)	
2574.5 4	(25/2 ⁻)	
2609.0 ^a 4	(27/2 ⁻)	
2852.14 35	(25/2 ⁻)	
2861.9 ^a 7	(29/2 ⁻)	
3118.5 ^a 8	(31/2 ⁻)	
3442.1 ^a 8	(33/2 ⁻)	

[†] From least-squares fit to E γ , excluding the 152.3 and 393.3 γ s from 1724.64 keV level and 317.6 γ from 2319.0 keV level – fit very poorly. Energies are given assuming E=153 for the h_{11/2} isomeric state and without considering the 24 keV uncertainty in that energy.

[‡] Authors' values based on deduced band structure, transition multipolarities and similarity of level scheme to that for ^{171}Ir , except as noted. In Adopted Levels, all values are shown in parentheses.

[#] Band(A): π 11/2[505], α =+1/2 band. Configuration assignment supported by measured B(M1) to B(E2) ratios for in-band transitions.

[@] Band(a): π 11/2[505], α =-1/2 band. See comment on signature partner band.

[&] Band(B): π =(-) sideband 1. Based on 17/2⁻.

^a Band(C): π =(-) sideband 2. Based on 23/2⁻.

$^{112}\text{Sn}(^{60}\text{Ni},\text{p}2\text{n}\gamma)$ **2007Sa33** (continued)

$\gamma(^{169}\text{Ir})$							Comments
E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [‡]	
$^{x101.4}$ 1	6.1 5						
$^{x121.1}$ 1	6.6 5						
130.5 1	24.3 7	2449.50	(25/2 ⁻)	2319.00	(23/2 ⁻)		
152.3 [†] 1	23.6 7	1724.73	(19/2 ⁻)	1573.49	19/2 ⁻		E_γ : very poor fit and omitted in the fitting; level-energy difference=151.24.
159.5 2	16.4 6	2609.0	(27/2 ⁻)	2449.50	(25/2 ⁻)		
178.0 3	12.0 5	1724.73	(19/2 ⁻)	1547.07	(17/2 ⁻)		
$^{x190.6}$ 3	5.5 4						
201.7 3	31.5 8	811.35	15/2 ⁻	610.08	13/2 ⁻	D	R=0.76 3.
206.5 1	14.3 6	2468.43	(23/2 ⁻)	2261.93	(21/2 ⁻)		
223.6 2	17.0 6	2221.9	(23/2 ⁻)	1998.29	(21/2 ⁻)		
$^{x232.5}$ 4	2.7 4						
242.5 [#] 4	26.8 [#] 7	1573.49	19/2 ⁻	1330.69	17/2 ⁻		242 γ +243 γ doublet; I_γ shared between the two components. R=0.67 2 for doublet, implying D multipolarity for one or both components.
242.5 [#] 4	26.8 [#] 7	2045.51	(21/2 ⁻)	1803.73	(19/2 ⁻)		$E_\gamma, I_\gamma, \text{Mult.}$: see comment on 242.5 γ from 1420 level.
252.9 6	14.0 5	2861.9	(29/2 ⁻)	2609.0	(27/2 ⁻)		
256.6 [#] 4	28.0 [#] 8	1803.73	(19/2 ⁻)	1547.07	(17/2 ⁻)		Transition is a self-coincident doublet.
256.6 [#] 4	28.0 [#] 8	3118.5	(31/2 ⁻)	2861.9	(29/2 ⁻)		Transition is a self-coincident doublet.
263.8 2	4.7 5	2261.93	(21/2 ⁻)	1998.29	(21/2 ⁻)		
273.9 [#] 3	62.6 [#] 11	1998.29	(21/2 ⁻)	1724.73	(19/2 ⁻)		E_γ, I_γ : Authors mention of two gammas: 273 γ +274 γ doublet, however, listed E_γ as 273.9 only and while noted dominated by the 274 γ component. R=0.87 3 for doublet.
273.9 [#] 3	62.6 [#] 11	2319.00	(23/2 ⁻)	2045.51	(21/2 ⁻)		$E_\gamma, I_\gamma, \text{Mult.}$: see comment on 274 γ from 1997.8 level.
290.6 3	<2.0	2406.90	23/2 ⁻	2116.24	21/2 ⁻		
310.6 2	5.8 5	2574.5	(25/2 ⁻)	2263.93	(23/2 ⁻)		
317.6 [†] 4	24.5 7	2319.00	(23/2 ⁻)	1998.29	(21/2 ⁻)		E_γ : very poor fit and omitted in the fitting; level-energy difference=320.72. E_γ : fits placement very poorly; E_γ is $>5\sigma$ from expected value. Level energy difference is 320.7 3.
323.6 2	7.7 4	3442.1	(33/2 ⁻)	3118.5	(31/2 ⁻)		
$^{x328.6}$ 1	7.3 4						
$^{x335.1}$ 2	6.5 4						
$^{x341.2}$ 2	4.1 4						
$^{x353.2}$ 2	8.0 4						
$^{x361.0}$ 2	5.2 4						
383.7 2	5.6 7	2852.14	(25/2 ⁻)	2468.43	(23/2 ⁻)		
393.3 [†] 1	40.7 9	1724.73	(19/2 ⁻)	1330.69	17/2 ⁻	D	E_γ : very poor fit and omitted in the fitting; level-energy difference=394.04. R=0.64 7. R=0.92 2.
457.1 2	96.5 12	610.08	13/2 ⁻	153	(11/2 ⁻)	D	
$^{x497.0}$ 3	5.7 4						
515.1 3	5.8 21	2319.00	(23/2 ⁻)	1803.73	(19/2 ⁻)		
519.3 4	46.6 10	1330.69	17/2 ⁻	811.35	15/2 ⁻	D	R=0.89 2.
539.2 1	18.4 8	2263.93	(23/2 ⁻)	1724.73	(19/2 ⁻)		
542.8 1	8.1 8	2116.24	21/2 ⁻	1573.49	19/2 ⁻		
559.9 2	6.4 9	1803.08	(17/2 ⁻)	1243.18	(15/2 ⁻)		
$^{x601.8}$ 2	11.1 9						
$^{x610.5}$ 3	5.3 10						
633.1 2	13.6 6	1243.18	(15/2 ⁻)	610.08	13/2 ⁻		
658.3 3	100.0 13	811.35	15/2 ⁻	153	(11/2 ⁻)	Q	R=1.15 2.
688.4 1	19.0 6	2261.93	(21/2 ⁻)	1573.49	19/2 ⁻		

Continued on next page (footnotes at end of table)

$^{112}\text{Sn}(^{60}\text{Ni},\text{p}2\text{n}\gamma)$ **2007Sa33** (continued) $\gamma(^{169}\text{Ir})$ (continued)

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [‡]	Comments
720.3 2	29.6 9	1330.69	17/2 ⁻	610.08	13/2 ⁻	Q	R=1.29 5.
745.4 2	12.4 7	2319.00	(23/2 ⁻)	1573.49	19/2 ⁻		
762.4 4	47.6 10	1573.49	19/2 ⁻	811.35	15/2 ⁻	Q	R=1.26 10.
785.3 2	6.7 5	2116.24	21/2 ⁻	1330.69	17/2 ⁻	Q	R=1.42 10.
833.5 4	11.0 5	2406.90	23/2 ⁻	1573.49	19/2 ⁻		
937.3 3	19.6 7	1547.07	(17/2 ⁻)	610.08	13/2 ⁻		
992.5 2	9.9 6	1803.73	(19/2 ⁻)	811.35	15/2 ⁻		

[†] Very Poor fit and omitted in the fitting.

[‡] Based on I_γ ratio $R=2(I_\gamma(158^\circ))/(I_\gamma(86^\circ)+I_\gamma(94^\circ))$; measured values of this ratio are 1.26 2 for the stretched Q 463 γ in ^{170}Os and 0.87 6 for the $\Delta J=1$ 246 γ from ^{169}Re , so authors expect $R \approx 1.2$ and 0.8, respectively, for stretched Q and D transitions.

[#] Multiply placed with undivided intensity.

^x γ ray not placed in level scheme.

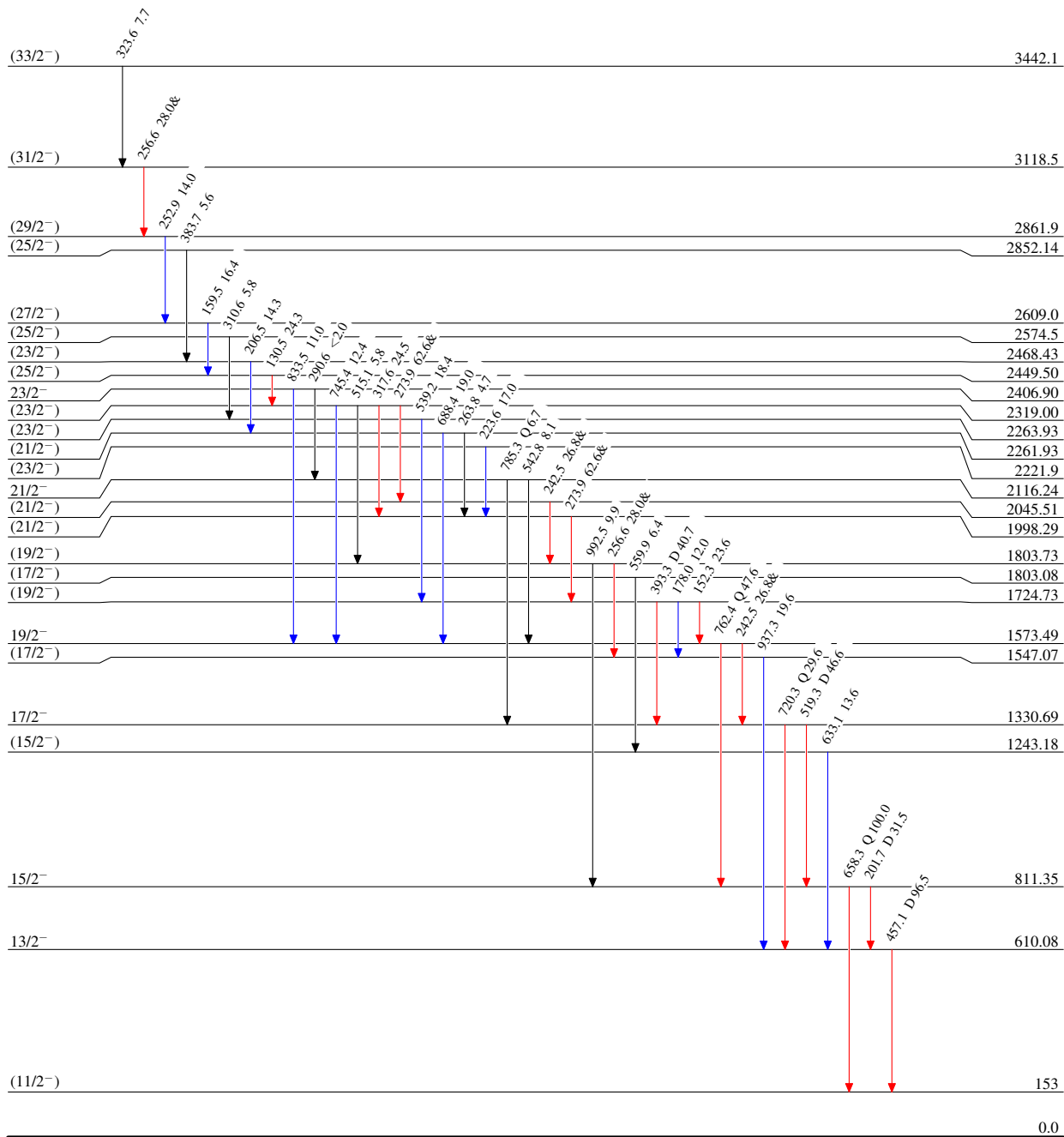
$^{112}\text{Sn}(^{60}\text{Ni}, p2n\gamma)$ 2007Sa33

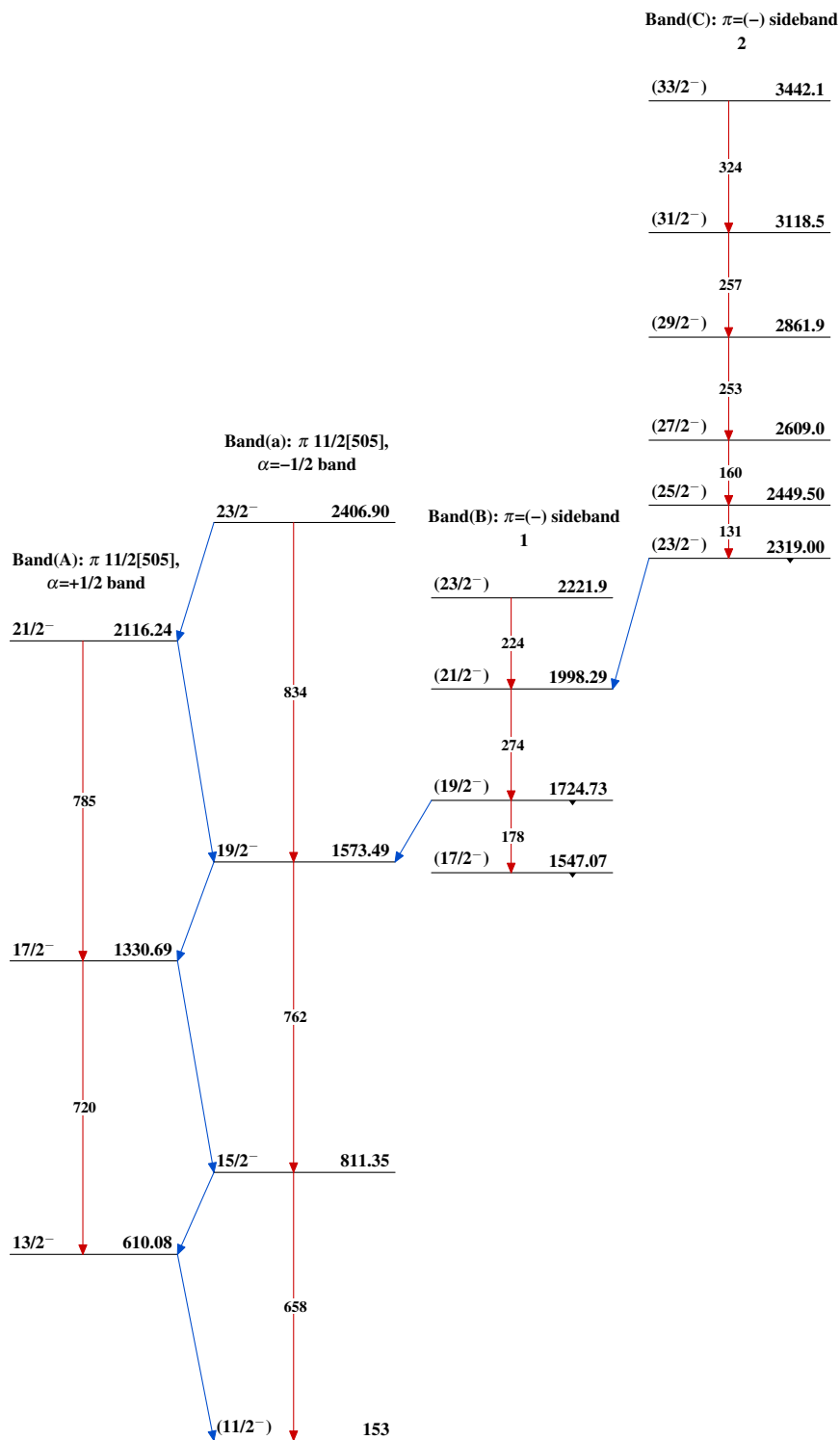
Level Scheme

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

Legend

- $I_\gamma < 2\% \times I_\gamma^{\max}$
— $I_\gamma < 10\% \times I_\gamma^{\max}$
— $I_\gamma > 10\% \times I_\gamma^{\max}$



$^{112}\text{Sn}(^{60}\text{Ni}, p2n\gamma)$ 2007Sa33

Adopted Levels, Gammas

$Q(\beta^-) = -10680$ syst; $S(n) = 9530$ syst; $S(p) = 1090$ syst; $Q(\alpha) = 6858$ 5 [2021Wa16](#)

$\Delta Q(\beta^-) = 360$, $\Delta S(n) = 250$, $\Delta S(p) = 210$ (syst, [2021Wa16](#)).

$S(2n) = 21850$ 370, $S(2p) = 540$ 220, $Q(\epsilon p) = 10240$ 200 (syst, [2021Wa16](#)).

Production: $^{112}\text{Sn}(^{68}\text{Ni}, x)$ ([1996Pa01](#)).

Identification: relationship of new α group to known transitions, as obtained through a multi-dimensional analysis correlating parent energies, daughter energies, and timing of events; production reactions were ^{58}Ni on molybdenum through tin targets and ^{107}Ag on vanadium through nickel targets ([1981Ho10](#)).

 ^{169}Pt LevelsCross Reference (XREF) Flags

A	^{173}Hg α decay	D	$^{94}\text{Mo}(^{78}\text{Kr}, 3n\gamma)$
B	^{170}Au p decay (0.29 ms)	E	$^{112}\text{Sn}(^{60}\text{Ni}, 3n\gamma)$
C	^{170}Au p decay (0.62 ms)		

<u>E(level)[†]</u>	<u>J^π[‡]</u>	<u>$T_{1/2}$</u>	<u>XREF</u>	<u>Comments</u>
0.0	(7/2 ⁻)	6.99 ms 10	ABC	$\% \alpha \approx 100$ $\% \alpha$: 1999Se14 report that number of ^{169}Pt daughter α 's correlated with ^{173}Hg decays is consistent with $\% \alpha = 100$ for ^{169}Pt . This is consistent with gross β decay theory prediction of a partial β half-life of ≈ 1 s (1973Ta30) and microscopic theory prediction of 0.33 s (2019Mo01), implying $\% \epsilon + \% \beta^+ \approx 0.7$ and 2.1, respectively. Only α decay has been observed for ^{169}Pt . J^π : unhindered α decay to (7/2 ⁻) ^{165}Os . Supported by p emission data from ^{170}Au isomers whose configurations probably include ($\nu f_{7/2}$) orbital. $T_{1/2}$: from 2009Go16 . Others: 7.0 ms 2 (2004Ke06), 13 ms +11-4 (2004Ke06 , 6693 α), 5 ms 3 (1996Pa01), 2.5 ms +25-10 (1981Ho10).
0.0+x	(13/2 ⁺)		DE	
0.0+y			D	
542.8+x 4	(17/2 ⁺)		E	
548.7+y 8			D	
1212.4+x 5			D	
1238.3+x 19			D	
1244.2+y 20			D	
1962.2+y? 24			D	

[†] From E_γ .

[‡] By analogy with heavier odd-A $^{171-175}\text{Pt}$ isotopes, except where otherwise noted.

 $\gamma(^{169}\text{Pt})$

<u>$E_i(\text{level})$</u>	<u>J^π_i</u>	<u>E_γ[†]</u>	<u>I_γ</u>	<u>E_f</u>	<u>J^π_f</u>	<u>Comments</u>
542.8+x	(17/2 ⁺)	542.8 4	100	0.0+x	(13/2 ⁺)	E_γ : other: 545 ($^{60}\text{Ni}, 3n\gamma$).
548.7+y		548.7 8	100	0.0+y		
1212.4+x		669.6 1	100	542.8+x	(17/2 ⁺)	
1238.3+x		695.5 [‡] 18	100	548.7+y		
1244.2+y		695.5 [‡] 18	100	548.7+y		
1962.2+y?		718.0 [#] 13	100	1244.2+y		

[†] From ($^{78}\text{Kr}, 3n\gamma$).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

$\gamma(^{169}\text{Pt})$ (continued)

‡ Multiply placed.
Placement of transition in the level scheme is uncertain.

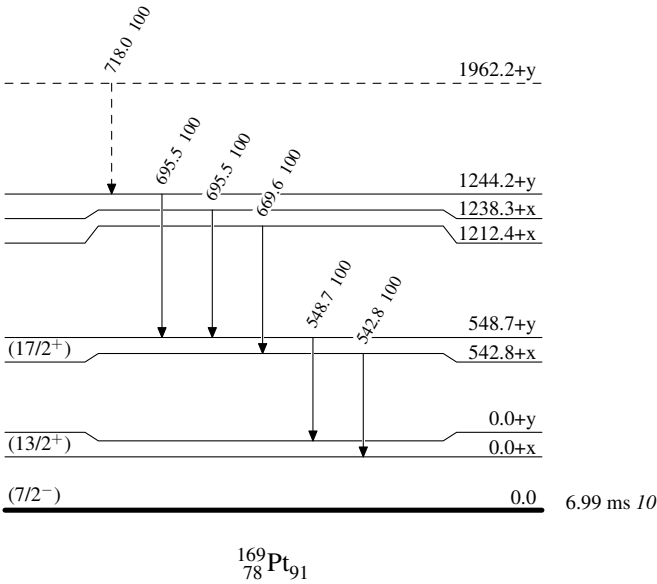
Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

-----► γ Decay (Uncertain)



^{170}Au p decay (0.29 ms) [2004Ke06](#)

Parent: ^{170}Au : $E=0.0$; $J^\pi=(2^-)$; $T_{1/2}=0.29\text{ ms } +5-4$; $Q(p)=1472\text{ }12$; %p decay= $89\text{ }10$

$^{170}\text{Au}-J^\pi, T_{1/2}$: from ^{170}Au Adopted Levels in [2018Ba41](#).

$^{170}\text{Au}-Q(p)$ from [2021Wa16](#).

$^{170}\text{Au}-\%p$ decay: from ^{170}Au Adopted Levels in [2018Ba41](#).

[2004Ke06](#) (supersedes [2002KeZZ](#), [2002LeZZ](#)): source from $^{96}\text{Ru}(^{78}\text{Kr}, p3n)$, $E(^{78}\text{Kr})=385\text{ MeV}$; tof and energy-loss gas detector and position-sensitive focal plane detector; observed correlated recoil-proton- α decay chain; measured $T_{1/2}$, $E(p)$, %p for ^{170}Au p decay.

 ^{169}Pt Levels

<u>$E(\text{level})$</u>	<u>$J^\pi^\dagger$</u>	<u>$T_{1/2}$</u>
0.0	($7/2^-$)	6.99 ms 10

† From Adopted Levels.

Protons (^{169}Pt)

<u>$E(p)$</u>	<u>$E(^{169}\text{Pt})$</u>	<u>L</u>	<u>Comments</u>
1463 12	0.0	2	$E(p)$: from 2004Ke06 . L from $d_{3/2}$ proton orbital, based on WKB calculation in 2004Ke06 . Spectroscopic factor 0.071 20 (2004Ke06).

^{170}Au p decay (0.62 ms) [2002Ma61](#),[2004Ke06](#)

Parent: ^{170}Au : $E=285$ 13; $J^\pi=(9^+)$; $T_{1/2}=0.62$ ms +5-4; $Q(p)=1472$ 12; %p decay=58 5

^{170}Au -E, J^π , $T_{1/2}$: from ^{170}Au Adopted Levels in [2018Ba41](#).

^{170}Au -Q(p) from [2021Wa16](#).

^{170}Au -%p decay: from ^{170}Au Adopted Levels in [2018Ba41](#). Same value in table III of [2004Ke06](#) (consistent with % α in table IV and %p in fig. 6); given as 59 6 in text. Other %p: 75 15 (misprinted as 0.75 15) from [2002Ma61](#); from simultaneous observation of 1735-keV proton and 7056-keV α , but that $E\alpha$ differs significantly from $E\alpha$ reported in [2004Ke06](#).

[2004Ke06](#) (supersedes [2002KeZZ](#), [2002LeZZ](#)): source from $^{96}\text{Ru}(^{78}\text{Kr},p3n)$, $E(^{78}\text{Kr})=385$ MeV; tof and energy-loss gas detector and position-sensitive focal plane detector; observed correlated recoil-proton- α decay chain; measured $T_{1/2}$, $E(p)$, %p for ^{170}Au p decay.

[2002Ma61](#): ^{170}Au source from $^{96}\text{Ru}(^{78}\text{Kr},p3n)$, $E(^{78}\text{Kr})=400$ MeV; fragment mass analyzer, gas-filled position sensitive parallel-grid counter, double-sided Si strip detector; measured $E(p)$, $E\alpha$, %p, parent $T_{1/2}$.

 ^{169}Pt Levels

<u>E(level)</u>	<u>J^π[†]</u>	<u>$T_{1/2}$</u>
0.0	(7/2 ⁻)	6.99 ms 10

[†] From Adopted Levels.

Protons (^{169}Pt)

<u>E(p)</u>	<u>E(^{169}Pt)</u>	<u>L</u>	<u>Comments</u>
1741 6	0.0	5	$E(p)$: weighted average of 1743 6 (2004Ke06) and 1735 9 (2002Ma61). L from $h_{11/2}$ proton orbital, based on WKB calculation in 2002Ma61 . Spectroscopic factor ≈ 0.21 (2002Ma61), 0.17 5 (2004Ke06).

^{173}Hg α decay 2004Ke06,1999Se14

Parent: ^{173}Hg : $E=0.0$; $J^\pi=(7/2^-)$; $T_{1/2}=0.80$ ms 8; $Q(\alpha)=7378$ 4; $\% \alpha$ decay=100.0

^{173}Hg - J^π : from ^{173}Hg Adopted Levels in ENSDF (update).

^{173}Hg - $T_{1/2}$: from ^{173}Hg Adopted Levels in ENSDF (update): 0.80 ms 8 (2012Od01 – 7208 α (t)). Others: 0.59 ms +47–18 (2004Ke06), 0.93 ms +57–26 (1999Se14).

^{173}Hg - $Q(\alpha)$: from 2021Wa16.

^{173}Hg - $\% \alpha$ decay: $\% \alpha=100$ 4 (estimated in 2012Od01). Only α decay has been observed from ^{173}Hg (1999Se14).

2004Ke06: ^{173}Hg from $^{96}\text{Ru}(^{78}\text{Kr},n)$, $E=361\text{--}391$ MeV, 96.52% ^{96}Ru target; RITU gas-filled separator with position-sensitive Si strip detector in focal plane; evaporation residues identified using method of position and time correlation with subsequent mother and daughter α decays; measured $E\alpha$, recoil- $\alpha(^{173}\text{Hg})$ - $\alpha(^{169}\text{Pt})$ time correlation, ^{173}Hg and ^{169}Pt half-life.

1999Se14: ^{173}Hg source from $^{96}\text{Ru}(^{80}\text{Kr},3n)$, $E=400$ MeV; isotopically enriched target; fragment mass analyzer with position sensitive parallel-grid avalanche counter in focal plane, double-sided Si strip detector, observed spatial and time correlations between fragment implantation and its decays; measured $E\alpha$, parent $T_{1/2}$.

 ^{169}Pt Levels

<u>E(level)</u>	<u>J^π</u>	<u>$T_{1/2}$</u>	<u>Comments</u>
0.0	(7/2 ⁻)	6.99 ms 10	$J^\pi, T_{1/2}$: from Adopted Levels.

 α radiations

<u>$E\alpha$</u>	<u>E(level)</u>	<u>$I\alpha^\ddagger$</u>	<u>HF[†]</u>	<u>Comments</u>
7207 5	0.0	100	1.21 13	$E\alpha$: weighted average of 7211 11 (1999Se14), 7192 13 (2004Ke06), and 7208 5 (2012Od01). Reduced Width=80 keV 9 (2012Od01). Correlated with known 6.7-MeV α from ^{169}Pt α decay (1999Se14).

[†] The nuclear radius parameter $r_0(^{169}\text{Pt})=1.5524$ 75 is deduced from interpolation (or unweighted average) of radius parameters of the adjacent even-even nuclides: $r_0(^{170}\text{Pt})=1.548$ 12 and $r_0(^{168}\text{Pt})=1.5567$ 40 in 2020Si16.

[‡] Absolute intensity per 100 decays.

$^{94}\text{Mo}(^{78}\text{Kr}, 3n\gamma)$ 2009Go16

Edit/Adapted the XUNDL data set compiled by B. Karamy and B. Singh (McMaster), June 18, 2009.

E=348 MeV; measured $E\gamma$, $I\gamma$, $\gamma\gamma$, (recoils) α coin, $\gamma\gamma(\text{recoil})\alpha$ $\gamma\gamma(\text{recoil})\alpha\alpha$ coin using the JUROGAM Ge-detector array, comprising of 43 escape suppressed spectrometers and the GREAT spectrometer comprised of two adjacent DSSDs, a planar Ge detector, a large-volume Ge clover detector and an array of 28 Si PIN diode detectors. Recoil- α decay tagging technique. Comparison with IBM-model calculations.

 ^{169}Pt Levels

E(level)[†]

0.0+x
0.0+y
542.8+x 4
548.7+y 8
1212.4+x 5
1238.3+x 19
1244.2+y 20
1962.2+y? 24

[†] From $E\gamma$'s.

 $\gamma(^{169}\text{Pt})$

E_γ	I_γ	$E_i(\text{level})$	E_f	Comments
^x 184.3 2	17 3			
^x 237.0 3	13 2			
542.8 4	100 19	542.8+x	0.0+x	
548.7 8	50 15	548.7+y	0.0+y	
669.6 1	69 11	1212.4+x	542.8+x	
695.5 [‡] 18	46 [‡] 8	1238.3+x	542.8+x	E_γ : other: 693 in Fig. 4.
695.5 [‡] 18	27 [‡] 5	1244.2+y	548.7+y	E_γ : other: 697 in Fig. 4.
718.0 [#] 13	12 16	1962.2+y?	1244.2+y	
^x 748.5 5	34 10			

[†] Intensity of 695.5 doublet divided on the basis of thickness arrows shown in figure 4 of 2009Go16. Total intensity=73 12.

[‡] Multiply placed with intensity suitably divided.

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

^x γ ray not placed in level scheme.

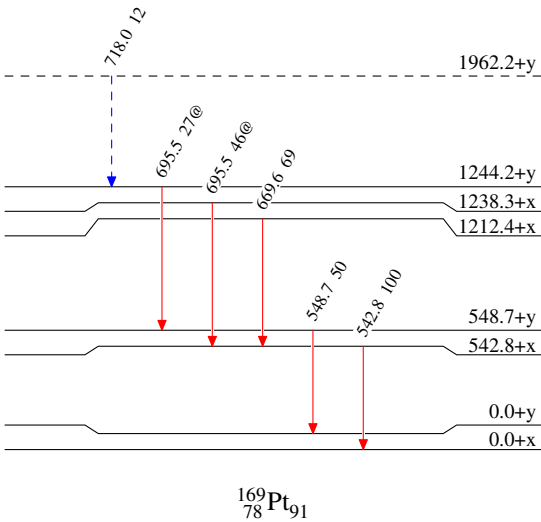
$^{94}\text{Mo}(^{78}\text{Kr},3n\gamma)$ 2009Go16

Level Scheme

Intensities: Relative I_γ
@ Multiply placed: intensity suitably divided

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{max}$
- $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{max}$
- $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{max}$
- $-----\longrightarrow$ γ Decay (Uncertain)



$^{169}_{78}\text{Pt}_{91}$

$^{112}\text{Sn}(^{60}\text{Ni}, 3n\gamma)$ 2006Jo04, 2005Jo18

2005Jo18, 2006Jo04: E=266 MeV; target enrichment 93%; JUROGAM detector array (43 EUROGAM type), escape-suppressed Ge detectors at six angles; RITU gas-filled recoil separator with GREAT spectrometer in focal plane; measured α decay correlated singles γ spectra, E γ .

 ^{169}Pt Levels

<u>E(level)[†]</u>	<u>J^π[‡]</u>
0.0+x	(13/2 ⁺)
545+x	(17/2 ⁺)

[†] From E γ .

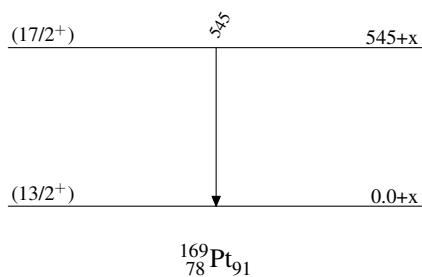
[‡] By analogy with heavier odd-A $^{171-175}\text{Pt}$ isotopes.

 $\gamma(^{169}\text{Pt})$

<u>Eγ[†]</u>	<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>
^x 184				
545	545+x	(17/2 ⁺)	0.0+x	(13/2 ⁺)

[†] From 2006Jo04.

^x γ ray not placed in level scheme.

 $^{112}\text{Sn}(^{60}\text{Ni}, 3n\gamma)$ 2006Jo04, 2005Jo18Level Scheme

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