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Nuclear Data Sheets for A=189*

T. D. Johnson and Balraj Singh

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Nuclear Data Sheets for A=189*

T.D. JOHNSON

*National Nuclear Data Center
Brookhaven National Laboratory
Upton, New York 11973, USA*

BALRAJ SINGH

*Department of Physics and Astronomy
McMaster University, Hamilton, ON L8S 4M1, Canada*

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Abstract: Evaluated experimental data are presented for 13 known mass 189 nuclides (Hf, Ta, W, Re, Os, Ir, Pt, Au, Hg, Tl, Pb, Bi, Po). Since the 2003Wu02 publication, structure and decay data from 25 new and primary publications have been incorporated in the current work, while adding a new ^{189}Hf nuclide. New data have been added for all nuclides except ^{189}Au and ^{189}Hg . Moreover, several previous datasets were modified for β -decay Q values and conversion coefficients even when no new publications appeared since 2003Wu02.

In spite of large amounts of data available for A=189 nuclides, several deficiencies remain, which are pointed out below in the hope that further experimental work may improve our knowledge of structure of these nuclides. For ^{189}Hf and ^{189}Ta , ground-state half-lives, and their decay schemes are unknown. An isomer in ^{189}Ta has recently been established but its decay characteristics are unknown, even though several gamma rays were connected with its decay. No excited states are known in ^{189}W and only one in ^{189}Po . The decay scheme of ^{189}W is known poorly with most gamma rays left as unassigned. The decay schemes of ^{189}Au and ^{189}Pb g.s. suffer from incompleteness, while those for the g.s. and isomer of ^{189}Tl are almost absent. The decay schemes of g.s. and isomer of ^{189}Hg are very complex as apparent from the study by 1996Wo04. Evaluators feel that these two decay schemes could be improved with modern gamma-ray detector arrays. While several isomers are known in many of the A=189 nuclides, there is in general lack of information of level half-lives, thus limiting the knowledge of transition probabilities. High-spin structures, including SD bands in ^{189}Hg and ^{189}Tl , are known in ^{189}Re , ^{189}Ir , ^{189}Pt , ^{189}Au , ^{189}Hg , ^{189}Tl , ^{189}Pb and ^{189}Bi . Single-particle transfer data are available for ^{189}Re , ^{189}Os , and ^{189}Pt ; and two-neutron transfer data for ^{189}Ir .

Cutoff Date: Literature available up to April 15, 2017 has been consulted based on retrieval from the Nuclear Science References (NSR) database, as described in 2011Pr03, and available on www.nndc.bnl.gov/nsr/.

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

General Comments: The statistical analysis of γ -ray data and deduced level schemes is carried out through computer codes available at NNDC, BNL website: www.nndc.bnl.gov. The direct feedings to excited states in β^- and ε decays have generally been computed from $I(\gamma+ce)$ intensity balances at each level; the associated $\log ft$ values are deduced using the LOGFT code. In cases where weighted averaging procedures have been used, the assigned uncertainty is generally not lower than the lowest uncertainty in a dataset that is being averaged.

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Skeleton Scheme for A=189

Skeleton Scheme for A=189 (continued)

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Skeleton Scheme for A=189 (continued)

Ground-State and Isomeric-Level Properties				
Nuclide	Level	J^π	$T_{1/2}$	Decay Mode
¹⁸⁹ Hf	0.0			% β^- =100
¹⁸⁹ Ta	0.0			% β^- =100
¹⁸⁹ W	0.0		11.6 min 2	% β^- =100
¹⁸⁹ Re	0.0	5/2+	24.3 h 4	% β^- =100
¹⁸⁹ Os	0.0	3/2-	stable	
¹⁸⁹ Ir	0.0	3/2+	13.2 d 1	% ϵ =100
¹⁸⁹ Pt	0.0	3/2-	10.87 h 12	% ϵ +% β^+ =100
¹⁸⁹ Au	0.0	1/2+	28.7 min 4	% ϵ +% β^+ =100 ; % α <3×10 ⁻⁵
¹⁸⁹ Hg	0.0	3/2-	7.6 min 2	% ϵ +% β^+ =100 ; % α <0.00003
¹⁸⁹ Tl	0.0	(1/2+)	2.3 min 2	% ϵ +% β^+ =100
¹⁸⁹ Pb	0.0	(3/2-)	39 s 8	% ϵ +% β^+ ≈100 ; % α ≤0.40
¹⁸⁹ Bi	0.0	(9/2-)	688 ms 5	% α ≈100
¹⁸⁹ Po	0.0	(5/2-)	3.5 ms 5	% α ≈100
¹⁹³ Bi	0.0	(9/2-)	63.6 s 30	% α =2.2 11
¹⁹³ Bi	308	(1/2+)	3.2 s 5	% α =84 16
¹⁹³ Po	0.0	(3/2-)	388 ms 40	% α ≤100
¹⁹³ Po	95	(13/2+)	245 ms 11	% α ≤100
¹⁹³ At	0.0	(1/2+)	28 ms +5-4	% α ≈100
¹⁹³ At	5	(7/2-)	21 ms 5	% α ≈100
¹⁹³ At	39	(13/2+)	27 ms +4-3	% α =24 10
¹⁹³ Rn	0.0		1.15 ms 27	% α ≈100

Adopted Levels

$Q(\beta^-)=4670$ SY; $S(n)=4360$ SY; $S(p)=10660$ SY; $Q(\alpha)=-1090$ SY [2017Wa10](#)

Estimated uncertainties ([2017Wa10](#)): 360 for $Q(\beta^-)$, 420 for $S(n)$, 590 for $S(p)$ and $Q(\alpha)$.

$S(2n)=10490$ 420 (syst,[2017Wa10](#)). $S(2p)=20220$ ([1997Mo25](#),theory).

[2009A130](#) (also [2012A105](#)): ^{189}Hf identified in $^9\text{Be}(^{208}\text{Pb},X)$ at 1 GeV/nucleon at GSI facility. Secondary fragmentation residues were separated and identified event-by-event using GSI Fragment Separator with a setting centered on ^{190}Ta or ^{192}Ta . Secondary ions were implanted into the RISING stopper with a series of double-sided silicon strip detectors (DSSSDs) to determine the position of the implanted ions correlated with β^- decays. The RISING array of Ge detectors also provided β and γ correlated events following the decay of secondary fragments. Time-of-flight and energy loss techniques provided the identification of projectile fragments. In the two-dimensional particle identification plots, ^{189}Hf is clearly identified in Fig. 3 of [2009A130](#) (also a similar plot in [2012A105](#)), as mentioned also in [2012Gr19](#), but is not discussed.

[2014Ku02](#): ^{189}Hf formed in $^9\text{Be}(^{208}\text{Pb},X)$, $E=1$ GeV/nucleon, measured production using FRS separator at GSI facility. Authors claim first experimental discovery of ^{189}Hf , but in evaluators' opinion, [2009A130](#) already had evidence for its production.

 ^{189}Hf Levels

E(level)	Comments
0	<p>$\% \beta^- = 100$</p> <p>While no decay mode has been experimentally observed, evaluators assign $\% \beta^- = 100$ by inference, as β^- is the only decay mode energetically possible.</p> <p>Production $\sigma = 3.8$ nb 8 (2014Ku02) in $^9\text{Be}(^{208}\text{Pb},X)$, $E=1$ GeV/nucleon reaction.</p> <p>E(level): the observed fragments are assumed to be in the ground state of ^{189}Hf nuclei.</p> <p>J^π: $3/2^-$ from systematic trend (2017Au03); $9/2^-$ in theoretical considerations (1997Mo25).</p> <p>$T_{1/2}$: no experimental value has been reported. A lower limit of 300 ns is implied from time of flight through the FRS separator (2008StZY). Assuming a systematic decreasing trend of half-lives in neutron-rich nuclei, as the neutron number increases, an upper limit of 3 min is suggested from the known half-lives of 4.1 h, 3.5 min and 2.6 min for ^{184}Hf, ^{185}Hf and ^{186}Hf, respectively. 2017Au03 in NUBASE list 2 s from a certain systematic trend. Theoretical values are 1.2 s (2003Mo09) and 11.7 s (2016Ma12).</p>

Adopted Levels

$Q(\beta^-)=3790$ SY; $S(n)=6290$ SY; $S(p)=8240$ SY; $Q(\alpha)=-370$ SY [2017Wa10](#)

Estimated uncertainties ([2017Wa10](#)): 200 for $Q(\beta^-)$ and $S(n)$, 360 for $S(p)$ and $Q(\alpha)$.

$S(2n)=11080$ 200, $S(2p)=18830$ 450 (syst,[2017Wa10](#)).

[1999Be63](#): ^{189}Ta produced and identified in projectile fission of ^{197}Au impinging on ^9Be target at 950 MeV/nucleon using FRS fragment separator at GSI facility. Determined production cross section to be 10 nb.

[2000PoZY](#): produced by projectile fragmentation of ^{208}Pb impinging on a 1.6 g/cm^2 ^9Be target at 1 GeV/nucleon, fragment separator FRS.

 ^{189}Ta LevelsCross Reference (XREF) Flags

A ^{189}Ta IT decay (0.58 μs)

E(level)	$T_{1/2}$	XREF	Comments
0			$\% \beta^- = 100$ While no decay mode has been experimentally observed, evaluators assign $\% \beta^- = 100$ by inference, as β^- is the only decay mode energetically possible. E(level): the observed fragments are assumed to be in the ground state of ^{189}Ta nuclei. J^π : $7/2^+$ from systematic trend (2017Au03) and theoretical considerations (1997Mo25). $T_{1/2}$: no experimental value has been reported. A lower limit of 300 ns is implied from time of flight through the FRS separator (1999Be63). Assuming a systematic decreasing trend of half-lives in neutron-rich nuclei, as the neutron number increases, an upper limit of 5 min is suggested from the known half-lives of 49.4 min, 10.5 min and 2.3 min for ^{185}Ta , ^{186}Ta and fully-stripped ^{187}Ta ion, respectively. 2017Au03 in NUBASE list 3 s from a certain systematic trend. Theoretical β^- decay half-lives: 97 s (2003Mo09) and 62.7 s (2016Ma12).
0+x	0.58 μs 22	A	$\% \text{IT} = 100$ Only the IT decay mode has been reported. The β^- decay mode is less likely in view of the short half-life. E(level): x=1600 400 suggested in 2017Au03 from systematics. According to 2011St21 , there may be another μs isomer, possibly with $T_{1/2}=1.6\text{ }\mu\text{s}$ 2 reported by 2009Al30 . $T_{1/2}$: from $\gamma(t)$ (2011St21). Other: 1.6 μs 2 (2009Al30 , $\gamma(t)$). It is suggested by 2011St21 that there may be two isomeric levels here. 153.9 $^-$, 283.7 $^-$, 342.5 $^-$, 388.7 $^-$, and 481.6-keV gamma rays deexcite this isomer (2011St21), but the decay scheme is unknown. 2009Al30 report several additional weak γ rays of 57, 83, 134, 199 and 246 keV associated with the decay of the isomer.

^{189}Ta IT decay (0.58 μs) 2011St21,2009A130

Parent: ^{189}Ta : $E=0+x$; $T_{1/2}=0.58 \mu\text{s}$ 22; %IT decay=100

^{189}Ta -%IT decay: Assumed 100% decay through isomeric transitions.

2011St21: ^{189}Ta nuclide formed by in-flight fragmentation of ^{208}Pb beam at 1 GeV/nucleon from the GSI UNILAC and SIS-18

accelerator complex. Fragments identified in flight by the FRS fragment separator operated in achromatic mode based on time of flight, $B\rho$ and energy loss. Transmitted ions slowed in Al degraders and stopped in a plastic catcher. The stopper was surrounded by the RISING γ -ray spectrometer. Measured $E\gamma$, $I\gamma$, delayed γ rays, isomer half-life. Beam was fully-stripped or mixture of H- or He-like nuclei.

2009A130: projectile fragmentation of ^{208}Pb beam at 1 GeV/nucleon with a ^9Be target at GSI facility. Fragment Recoil separator (FRS) used to identify ^{189}Ta nuclide. The secondary ions were implanted into RISING active stopper consisting of double-sided silicon strip detectors. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(t)$, correlations, and isomer half-lives using RISING array of 15 seven-element Ge cluster detectors for γ rays, two multi-wire proportional counters for position measurements, two scintillation detectors providing time-of-flight and position information, and two scintillators and an ionization chamber (MUSIC) for energy loss measurements.

 ^{189}Ta Levels

E(level)	$T_{1/2}$	Comments
0+x	0.58 μs 22	E(level): $x=1600$ 400 suggested in 2017Au03 from systematics. According to 2011St21, there may be another μs isomer, possibly with $T_{1/2}=1.6 \mu\text{s}$ 2, as reported by 2009A130. $T_{1/2}$: from $\gamma(t)$ (2011St21). Other: 1.6 μs 2 (2009A130, $\gamma(t)$). It is suggested by 2011St21 that there may be two isomeric levels here. 153.9 γ , 283.7 γ , 342.5 γ , 388.7 γ , and 481.6-keV γ rays deexcite this isomer, but the decay scheme is unknown.

 $\gamma(^{189}\text{Ta})$

$E\gamma$	$E_i(\text{level})$	$E\gamma$	$I\gamma$	$E_i(\text{level})$	$E\gamma$	$I\gamma$	$E_i(\text{level})$
$x57^{\ddagger}$		$x153.9^{\ddagger}$ 5	100 ‡ 19		$x342.5^{\ddagger}$ 5	47 ‡ 13	
$x83^{\ddagger}$		$x199^{\ddagger}$			$x388.7^{\ddagger}$ 5	80 ‡ 19	
$x99^{\S}$		$x246^{\ddagger}$			$x481.6^{\ddagger}$ 5	97 ‡ 21	
$x134^{\ddagger}$		$x283.7^{\ddagger}$ 5	73 ‡ 17				

‡ From 2011St21. Uncertainty of 0.5 keV is assigned in consultation with Zs. Podolyak. This γ is associated with the deexcitation of a 0.58- μs isomer, but the level scheme is unknown. However, the authors state that all the five γ transitions reported are in mutual coincidence. It is also suggested by 2011St21 that there may be two isomers in ^{189}Ta , one of 0.58 μs half-life in their work, and the other of 1.6 μs reported in their earlier study 2009A130. Four of these gamma rays were also observed in 2009A130, assigned to the decay of a 1.6- μs isomer, however no energy uncertainties or intensities were reported in that work.

§ From 2009A130 where they are shown in a spectrum associated with the isomeric decay in Figure 4. 2011St21 stated that these lines were only weakly observed in their spectrum and that they considered these as tentative, or possibly associated with another isomer in ^{189}Ta . The evaluators note that in the spectrum shown in Fig. 4 of 2009A130, these lines are weak relative to the other γ lines as well.

§ Questionable γ ray from 2011St21.

x γ ray not placed in level scheme.

Adopted Levels

$Q(\beta^-)=2340$ 40; $S(n)=5020$ 40; $S(p)=9290$ 70; $Q(\alpha)=280$ 80 (2017Wa10)

$S(2n)=11860$ 40, $S(2p)=17380$ 300 (syst) (2017Wa10).

Other: $Q(\beta^-)=2443$ 41 from measured mass excess(^{189}Re)= -38063 10 (2013Sh30) and mass excess(^{189}W)= -350620 40 (2017Wa10).

1963FI07: ^{189}W produced and identified in $^{192}\text{O}(n,\alpha)$, $E=14$ MeV reaction followed by chemical separation and measurement of β radiation and half-life. Later measurements: 1965Ka07, 1997Ya03, 1997Mi27, 2002Mi40 and 2009Yu11.

 ^{189}W Levels

E(level)	$T_{1/2}$	Comments
0	11.6 min 2	<p>$\% \beta^- = 100$</p> <p>$T_{1/2}$: weighted average taken by evaluators from decay curves for 22 γ rays (1997Ya03; decay curves for 11 γ rays were displayed in graphs; half-lives in minutes were reported as: 11.7 10, 11.7 17, 12.2 7, 11.5 7, 11.3 11, 11.8 4, 11.8 4, 12.2 12, 11.3 2, 12.2 6, 12.0 10, 12.1 15, 11.5 9, 11.3 11, 11.5 10, 10.7 20, 11.8 12, 11.8 12, 12.5 12, 11.3 13, 11.7 13 and 11.0 13, authors give a value of 11.7 min 5). Others: 11.2 min 17 (2009Yu11, from decay curve for 260γ); 9.1 min 4 (2002Mi40, from weighted average of 8.9 min 4 and 9.4 min 6 for decay curves for 260 and 422 γ rays, authors give an average of 9.2 min 3); 12.1 min 2 (1997Mi27, from the same group, and as referenced in 2002Mi40, weighted average of 10.6 min 13, 11.9 min 2, 9.9 min 27, 12.6 min 3 for 260 and 422 γ rays, value of 8.0 min 9 for a weak γ ray not used, 2002Mi40 give an average value of 10.8 min 2 which is close to unweighted average of all the five values). In the original 1997Mi27, 9.3 min 2 and 11.9 min 2 are reported for the 260 γ ray and 7.2 min 8 and 12.6 min 3 are reported for the 421.5 γ ray. The authors state that the results for ^{189}W are preliminary, it appears some of the results were superseded by the time 2002Mi40 was published. Other half life measurements: 11.5 min 3 (1965Ka07, from decay curves for two γ rays), and 11 min (1963FI07, from β decay curve).</p> <p>J^π: $3/2^-$ from systematics (2017Au03), $7/2^-$ from theoretical considerations (1997Mo25).</p>

Adopted Levels, Gammas

$Q(\beta^-)=1008$ 8; $S(n)=7034$ 8; $S(p)=6600$ 9; $Q(\alpha)=990$ 16 [2017Wa10](#)

$S(2n)=12905$ 8, $S(2p)=15660$ 60 ([2017Wa10](#)).

Other: $Q(\beta^-)=924$ 10 for measured mass excess(^{189}Re)= -38063 10 ([2013Sh30](#)) and mass excess(^{189}Os)= -38986.7 7 ([2017Wa10](#)).

^{189}Re activity was produced and identified by [1963Cr06](#) in $^{186}\text{W}(\alpha, p)$ and in $\text{Os}(n, p)$, $E=14$ MeV; and by [1963Fl07](#) in

$^{192}\text{Os}(d, n\alpha)$, $E=28$ MeV. Measured β and γ activities and half-life of ^{189}Re activity. Later studies of ^{189}Re decay: [1965Bl06](#), [1973Ho27](#) and [1979Sa18](#).

An activity with $T_{1/2}=4.3$ d 5 was assigned to ^{189}Re ([1969MuZP](#)) in double-neutron capture in ^{187}Re , and followed with β and γ measurements. But no other reports are published about this activity.

An activity of 140 d 20 ([1965Bl06](#), also ≈ 120 d in [1962Bl12](#)) assigned to ^{189}Re was reassigned to 169-d activity of ^{184}Re isomer by [1973Ho27](#).

Other reports of long half-lives of ≈ 150 d or >5 y ([1951Li19](#)) and ≈ 300 d ([1951Tu09](#)) have never been confirmed ([2012Ro36](#) compilation).

 ^{189}Re Levels

Band assignments are from [1977Hi06](#) and [2016Re02](#).

Cross Reference (XREF) Flags

- A $^{189}\text{W} \beta^-$ decay (11.6 min)
 B $^{187}\text{Re}(^{136}\text{Xe}, X\gamma)$
 C $^{190}\text{Os}(t, \alpha), (\text{pol } t, \alpha)$

E(level)	$J^{\pi^\dagger}$	$T_{1/2}$	XREF	Comments
$0^{\ddagger}$	$5/2^+$	24.3 h 4	A C	$\% \beta^- = 100$ $T_{1/2}$: from 1965Bl06 . Others: 23.4 h 10 (1963Cr06), 24 h (1963Fl07 , 1966BaZY).
$125^{\#} 3$	$(9/2^-)$		BC	
$146^{\ddagger} 3$	$(7/2^+)$		C	
$260.40^{\&} 20$	$3/2^+$		A C	E(level): may be doublet with $1/2^+$ member of $1/2[411]$ rotational band.
$279 3$			C	
$303^{\#} 3$	$(11/2^-)$		BC	
$471.0 3$			A	
$482.4^{\&} 4$	$(5/2\&7/2)^+$		C	E(level): doublet containing $5/2^+$ and $7/2^+$ members of the $1/2[411]$ rotational band. In the previous evaluation, based on energy summation, a 222 γ line was shown depopulating this level. The β^- measurement by 2009Yu11 could not confirm this γ transition with more reliable coincidence measurements. In $^{190}\text{Os}(t, \alpha)$ it is stated that this is level is an unresolved doublet, so this may be a combination of the 471- and 490-keV levels established in β^- decay.
$490.1 3$			A	
$501 3$	$(3/2^+)$		C	
$524.0^{\#} 2$	$(13/2^-)$		B	
$599 3$	$(3/2^+)$		C	
$640 3$	$(5/2^+, 3/2^-, 7/2^-)$		C	
$669.6^{\@} 2$	$(13/2^-)$		B	
$670 3$	$(3/2^+)$		C	
$697^a 3$	$(7/2^+)$		C	
$737.8^{\#} 2$	$(15/2^-)$		B	
$852 3$	$(5/2^+)$		C	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{189}Re Levels (continued)					
E(level)	$J^{\pi\dagger}$	$T_{1/2}$	XREF	Comments	
877 3	(9/2 ⁺ , 11/2 ⁻ , 7/2 ⁻)		C		
935.6@ 3	(15/2 ⁻)		B		
1017.7# 3	(17/2 ⁻)		B		
1097 3			C		
1149.8@ 3	(17/2 ⁻)		B		
1223 3	5/2 ⁺		C		
1247.0# 3	(19/2 ⁻)		B		
1308 3	(5/2 ⁺)		C		
1396 3	(3/2 ⁺ , 5/2 ⁻ , 1/2 ⁻)		C		
1423 3	11/2 ⁻		C	configuration: $\pi 7/2[523]$.	
1440.4@ 3	(19/2 ⁻)		B		
1502 10	(11/2 ⁻)		C		
1590.3# 4	(21/2 ⁻)		B		
1632 10			C		
1678.9@ 3	(21/2 ⁻)		B		
1692.9 5	(25/2 ⁻)	51 ns 17	B	%IT=100 $T_{1/2}$: from $\gamma\gamma(t)$ (2016Re02).	
1770.9 6	(29/2 ⁺)	223 μ s 14	B	%IT=100 $T_{1/2}$: from $\gamma(t)$ (2016Re02).	
1916 10			C		
1959 10			C		

[†] From $^{190}\text{Os}(\text{pol } t, \alpha)$ experimental analyzing power and angular distributions fit with DWBA for low-spin ($J \leq 9/2$) states. For high-spin ($J > 9/2$) states, the assignments are based on multipolarities of γ transitions from $\gamma\gamma(\theta)$ and conversion coefficients deduced from intensity balance arguments, and band structures (2016Re02).

[‡] Band(A): $\pi 5/2[402]$.

Band(B): $\pi 9/2[514]$.

@ Band(C): $\pi 9/2[514] \otimes 2^+$ of γ band.

& Band(D): $\pi 1/2[411]$.

^a Band(E): $\pi 7/2[404]$.

 $\gamma(^{189}\text{Re})$

$E_i(\text{level})$	J_i^{π}	E_{γ}	I_{γ}	E_f	J_f^{π}	Mult. [†]	$\delta^{\ddagger}$	α
260.40	3/2 ⁺	260.4 2	100	0	5/2 ⁺	[M1+E2]		0.24 11
303	(11/2 ⁻)	177.5		125	(9/2 ⁻)	(M1+E2)	0.22 8	0.988 24
471.0		210.6 2	100	260.40	3/2 ⁺			
490.1		229.7 2	100	260.40	3/2 ⁺			
524.0	(13/2 ⁻)	221.6		303	(11/2 ⁻)	(M1+E2)	0.35 8	0.511 17
		399.1		125	(9/2 ⁻)			
669.6	(13/2 ⁻)	146		524.0	(13/2 ⁻)			
		367.0		303	(11/2 ⁻)			
		544.6		125	(9/2 ⁻)			
737.8	(15/2 ⁻)	213.8		524.0	(13/2 ⁻)	(M1+E2)	0.20 10	0.589 18
		435.1		303	(11/2 ⁻)			
935.6	(15/2 ⁻)	198		737.8	(15/2 ⁻)			
		265.9		669.6	(13/2 ⁻)			
		411.6		524.0	(13/2 ⁻)			
		633		303	(11/2 ⁻)			
1017.7	(17/2 ⁻)	279.8		737.8	(15/2 ⁻)	(M1+E2)	0.3 2	0.273 22

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{189}\text{Re})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ	E_f	J_f^π	Mult. [†]	$\delta^\dagger$	α	Comments
1017.7	(17/2 ⁻)	493.7	524.0	(13/2 ⁻)				
1149.8	(17/2 ⁻)	132	1017.7	(17/2 ⁻)				
		214.2	935.6	(15/2 ⁻)				
		412.0	737.8	(15/2 ⁻)				
		480.2	669.6	(13/2 ⁻)				
		626	524.0	(13/2 ⁻)				
1247.0	(19/2 ⁻)	229.3	1017.7	(17/2 ⁻)	(M1+E2)	0.2 +2-1	0.49 3	
		509.3	737.8	(15/2 ⁻)				
1440.4	(19/2 ⁻)	194	1247.0	(19/2 ⁻)				
		290.7	1149.8	(17/2 ⁻)				
		422.7	1017.7	(17/2 ⁻)				
		504.7	935.6	(15/2 ⁻)				
		703	737.8	(15/2 ⁻)				
1590.3	(21/2 ⁻)	343.3	1247.0	(19/2 ⁻)				
		572.6	1017.7	(17/2 ⁻)				
1678.9	(21/2 ⁻)	89	1590.3	(21/2 ⁻)				
		238.5	1440.4	(19/2 ⁻)				
		431.9	1247.0	(19/2 ⁻)				
		529.1	1149.8	(17/2 ⁻)				
		661.2	1017.7	(17/2 ⁻)				
1692.9	(25/2 ⁻)	(14.0)	1678.9	(21/2 ⁻)				E_γ : from level-energy difference.
		102.6	1590.3	(21/2 ⁻)				
1770.9	(29/2 ⁺)	78.0	1692.9	(25/2 ⁻)	(M2)		118.4	B(M2)(W.u.)=0.0123 12 Mult.: from conversion coefficient deduced from K-x ray intensity and photon intensity.

[†] From $^{187}\text{Re}(^{136}\text{Xe}, X\gamma)$ and $^{192}\text{Os}(^{136}\text{Xe}, X\gamma)$ $\gamma\gamma(\theta)$ data.

Adopted Levels, Gammas

^{189}W β^- decay (11.6 min) 1997Ya03,2009Yu11

Parent: ^{189}W : $E=0$; $T_{1/2}=11.6$ min 2; $Q(\beta^-)=2360$ 40; $\% \beta^-$ decay=100

^{189}W - $Q(\beta^-)$: From 2017Wa10. Other: $Q(\beta^-)=2443$ 41 from measured mass excess(^{189}Re)= -38063 10 (2013Sh30) and mass excess(^{189}W)= -350620 40 (2017Wa10).

1997Ya03: 14.7 MeV neutrons irradiating 2-5 g of natural Os target for 20-30 minutes. Chemical separation of Re. Measured E_γ , I_γ . Determined ^{189}W half-life. HPGe detector.

1997Mi27: ^{188}W irradiated by the reactor neutrons. Measured E_γ , I_γ . Determined ^{189}W half-life. Ge(Li) detector.

2002Mi40: ^{189}W produced by $^{192}\text{Os}(n,\alpha)$ reaction. Target: 35 mg of Os metal, enriched to 99.9%. Measured E_γ , I_γ . Determined ^{189}W half-life. Ge detector.

2009Yu11: (n, α) reaction with 14-MeV neutrons from the Cockcroft-Walton accelerator at the Institute of Modern Physics, Chinese Academy of Sciences irradiated Os targets to produce ^{189}W , the decay of which was subsequently observed. The (x-ray) γ coin measurements were used to identify the 260.2 keV γ line in ^{189}Re and a lifetime measurement in agreement with previously measured half-lives of ^{189}W corroborated this identification. A clover detector consisting of four coaxial Ge crystals was used for $\gamma\gamma$ coincidences. Measured E_γ , half-life of ^{189}W decay, singles γ , (x ray) γ - and $\gamma\gamma$ coincidences.

Other: 1965Ka07.

The decay scheme is based on the γ -ray data and the reaction data of 1997Ya03, 1977Hi06 and 1976Hi08. The γ placements are based on coincidence data from 2009Yu11. In view of $Q(\beta^-)=2360$ keV and the highest populated level at 490 keV, and many unplaced γ rays, this decay scheme is considered as incomplete, thus no normalization is attempted.

 ^{189}Re Levels

<u>E(level)</u>	<u>$J^\pi^\dagger$</u>	<u>$T_{1/2}$</u>
0	$5/2^+$	24.3 h 4
260.4 2	$3/2^+$	
471.0 3		
490.1 3		

† From Adopted Levels.

 β^- radiations

<u>E(decay)</u>	<u>E(level)</u>	<u>Comments</u>
(2.36×10^3 4)	0	E(decay): measured $E\beta=2.5 \times 10^3$ keV 2; not observed in coincidence with $E_\gamma > 60$ keV, but branch is weak.

 $\gamma(^{189}\text{Re})$

<u>$E_\gamma^\dagger$</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>α</u>	<u>Comments</u>
$^{x126.2}$ 1	9.5 4							E_γ : 130 keV 2 (1997Mi27,1965Ka07).
$^{x143.8}$ ‡ 1	5.1 3							
$^{x177.8}$ ‡ 1	18.4 6							E_γ : 178 keV 2 (1965Ka07).
$^{210.6}$ § 2	8.6 4	471.0		260.4	$3/2^+$			
$^{x210.6}$ ‡ 2	8.6 4							
$^{x222.0}$ 3	6.5 8							E_γ : 222 keV 8 (1965Ka07).
$^{229.7}$ § 2	11.4 6	490.1		260.4	$3/2^+$			
260.4 2	100.0 10	260.4	$3/2^+$	0	$5/2^+$	[M1+E2]	0.24 11	E_γ : 260.2 keV 14 (2002Mi40,1997Mi27); 258 keV 3 (1965Ka07); 260.2 keV (2009Yu11).
$^{x403.9}$ ‡ 5	6.7 3							
$^{x421.4}$ 5	100.8 20							E_γ : 421.5 keV 16 (2002Mi40,1997Mi27); 417 keV 4 (1965Ka07). I_γ : 103 (1997Mi27), 77 (2002Mi40).

Continued on next page (footnotes at end of table)

^{189}W β^- decay (11.6 min) [1997Ya03,2009Yu11](#) (continued) $\gamma(^{189}\text{Re})$ (continued)

E_γ [†]	I_γ [†]	$E_i(\text{level})$	Comments
$^x547.3$ [‡] 6	27.7 11		E_γ : 545 keV 3 (2002Mi40,1997Mi27); 550 keV 10 (1965Ka07).
$^x668.6$ [‡] 5	10.9 8		
$^x750.6$ [‡] 3	6.7 4		
$^x786.3$ [‡] 2	2.7 2		
$^x847.1$ [‡] 2	4.0 3		E_γ : 855 keV 15 (1965Ka07), but could also be the 864.1 γ .
$^x864.1$ [‡] 3	12.6 9		
$^x871.7$ [‡] 4	3.2 5		
$^x957.5$ [‡] 7	8.3 6		
$^x974.3$ 7	11.3 8		E_γ : 975 keV 3 (2002Mi40,1997Mi27). I_γ : 8 (1997Mi27).
$^x1001.4$ [‡] 5	4.1 3		
$^x1185.3$ [‡] 6	4.4 5		
$^x1418.8$ [‡] 5	4.5 4		
$^x1466.2$ [‡] 7	2.3 3		

[†] From [1997Ya03](#), unless otherwise specified.

[‡] From [1997Ya03](#), however, not observed in [1997Mi27](#) or [2002Mi40](#).

[§] From [1997Ya03](#) and confirmed by coincidence measurements in [2009Yu11](#), however, not observed in [1997Mi27](#) or [2002Mi40](#).

^x γ ray not placed in level scheme.

$^{189}\text{W} \beta^- \text{ decay (11.6 min) } \quad 1997\text{Ya03,2009Yu11}$

Decay Scheme

 Intensities: Relative I_γ

$^{187}\text{Re}(^{136}\text{Xe},\text{X}\gamma)$ **2016Re02**

Includes $^{186}\text{W}(^{136}\text{Xe},\text{X}\gamma)$ and $^{192}\text{Os}(^{136}\text{Xe},\text{X}\gamma)$.

2016Re02: ^{136}Xe beam at $E \approx 6$ MeV/nucleon from ATLAS-ANL facility. Measured $E\gamma$, $I\gamma$, triple-fold $\gamma\gamma$ -coin and (x ray) γ -coin, $\gamma(t)$, $\gamma\gamma(t)$, angular correlations using Gammasphere array. In-beam and out-of-beam experiments using pulsed beam. For investigation of longer-lived isomers, chopped beam was used. Deduced high-spin levels, J , π , bands, isomers.

As stated by **2016Re02** (see reference 29 in paper), details of this work are to be published.

 ^{189}Re Levels

E(level) [†]	$J^{\pi\ddagger}$	$T_{1/2}^{\#}$	Comments
125 @ 3	(9/2 ⁻)		E(level), J^{π} : from (t, α), (pol t, α) (1976Hi08,1977Hi06).
302.6 @ 2	(11/2 ⁻)		
524.0 @ 2	13/2 ⁻		
669.6 & 2	13/2 ⁻		
737.8 @ 2	15/2 ⁻		
935.6 & 3	15/2 ⁻		
1017.7 @ 3	17/2 ⁻		
1149.8 & 3	17/2 ⁻		
1247.0 @ 3	19/2 ⁻		
1440.4 & 3	19/2 ⁻		
1590.3 @ 4	21/2 ⁻		51 ns 17 %IT=100 $T_{1/2}$: from $\gamma\gamma(t)$ (2016Re02). %IT=100 $T_{1/2}$: from $\gamma(t)$ (2016Re02).
1678.9 & 3	21/2 ⁻		
1692.9 5	25/2 ⁻		
1770.9 6	29/2 ⁺	223 μs 14	

[†] From least-squares fit to $E\gamma$ values, by keeping the energy of the 125-keV level fixed, and assuming 0.3 keV uncertainty for each γ -ray energy when stated to nearest tenth of a keV, 1 keV otherwise.

[‡] From **2016Re02**, based on multiplicities of γ transitions from $\gamma\gamma(\theta)$ and conversion coefficients deduced from intensity balance arguments, and band structures (**2016Re02**).

[#] From $\gamma(t)$ or $\gamma\gamma(t)$ (**2016Re02**).

@ Band(A): $\pi 9/2[514]$.

& Band(B): $\pi 9/2[514] \otimes 2^+$ of γ band.

 $\gamma(^{189}\text{Re})$

E_{γ}	$E_i(\text{level})$	J_i^{π}	E_f	J_f^{π}	Mult. [†]	$\delta^{\ddagger}$	α	Comments
(14.0)	1692.9	25/2 ⁻	1678.9	21/2 ⁻				E_{γ} : from level-energy difference. Mult.: from conversion coefficient deduced from K-x ray intensity and photon intensity.
78.0	1770.9	29/2 ⁺	1692.9	25/2 ⁻	(M2)		118.4	
89	1678.9	21/2 ⁻	1590.3	21/2 ⁻				
102.6	1692.9	25/2 ⁻	1590.3	21/2 ⁻				
132	1149.8	17/2 ⁻	1017.7	17/2 ⁻				
146	669.6	13/2 ⁻	524.0	13/2 ⁻				
177.5	302.6	(11/2 ⁻)	125	(9/2 ⁻)	(M1+E2)	0.22 8	0.988 24	
194	1440.4	19/2 ⁻	1247.0	19/2 ⁻				
198	935.6	15/2 ⁻	737.8	15/2 ⁻				
213.8	737.8	15/2 ⁻	524.0	13/2 ⁻	(M1+E2)	0.20 10	0.589 18	
214.2	1149.8	17/2 ⁻	935.6	15/2 ⁻				
221.6	524.0	13/2 ⁻	302.6	(11/2 ⁻)	(M1+E2)	0.35 8	0.511 17	

Continued on next page (footnotes at end of table)

$^{187}\text{Re}(^{136}\text{Xe}, X\gamma)$ **2016Re02** (continued) $\gamma(^{189}\text{Re})$ (continued)

E_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	$\delta^\dagger$	α
229.3	1247.0	19/2 ⁻	1017.7	17/2 ⁻	(M1+E2)	0.2 +2-1	0.49 3
238.5	1678.9	21/2 ⁻	1440.4	19/2 ⁻			
265.9	935.6	15/2 ⁻	669.6	13/2 ⁻			
279.8	1017.7	17/2 ⁻	737.8	15/2 ⁻	(M1+E2)	0.3 2	0.273 22
290.7	1440.4	19/2 ⁻	1149.8	17/2 ⁻			
343.3	1590.3	21/2 ⁻	1247.0	19/2 ⁻			
367.0	669.6	13/2 ⁻	302.6	(11/2 ⁻)			
399.1	524.0	13/2 ⁻	125	(9/2 ⁻)			
411.6	935.6	15/2 ⁻	524.0	13/2 ⁻			
412.0	1149.8	17/2 ⁻	737.8	15/2 ⁻			
422.7	1440.4	19/2 ⁻	1017.7	17/2 ⁻			
431.9	1678.9	21/2 ⁻	1247.0	19/2 ⁻			
435.1	737.8	15/2 ⁻	302.6	(11/2 ⁻)			
480.2	1149.8	17/2 ⁻	669.6	13/2 ⁻			
493.7	1017.7	17/2 ⁻	524.0	13/2 ⁻			
504.7	1440.4	19/2 ⁻	935.6	15/2 ⁻			
509.3	1247.0	19/2 ⁻	737.8	15/2 ⁻			
529.1	1678.9	21/2 ⁻	1149.8	17/2 ⁻			
544.6	669.6	13/2 ⁻	125	(9/2 ⁻)			
572.6	1590.3	21/2 ⁻	1017.7	17/2 ⁻			
626	1149.8	17/2 ⁻	524.0	13/2 ⁻			
633	935.6	15/2 ⁻	302.6	(11/2 ⁻)			
661.2	1678.9	21/2 ⁻	1017.7	17/2 ⁻			
703	1440.4	19/2 ⁻	737.8	15/2 ⁻			

[†] From $\gamma\gamma(\theta)$ data unless otherwise stated. Values of mixing ratios are read from plot shown in the right panel of Fig. 6 in [2016Re02](#).

$^{190}\text{Os}(t,\alpha),(\text{pol } t,\alpha)$ 1976Hi08,1977Hi06

1976Hi08: (t,α) , $E=15$ MeV beam from Los Alamos Scientific Laboratory's FN tandem Van de Graaff accelerator. The reaction products were analyzed with a Q3D magnetic spectrometer and detected with a helical-cathode position sensitive proportional counter. Measured σ . FWHM=8-12 keV.

1977Hi06: $(\text{pol } t,\alpha)$, $E=17$ MeV beam from Los Alamos polarized triton source and model FN tandem Van de Graaff accelerator with a polarization of 0.75. Target was 95.5% enriched $^{190}\text{Os} \approx 150 \mu\text{g}/\text{cm}^2$ thick deposited onto $50 \mu\text{g}/\text{cm}^2$ carbon backing. The reaction products were analyzed in a Q3D Type II magnetic spectrometer and detected with a one meter long helical-cathode position-sensitive proportional counter. Measured $\sigma(\theta)$ and analyzing powers $A_y(\theta)$ from 15° to 50° in steps of 5° . FWHM=20 keV. Relative cross sections were within $\approx 10\%$, whereas absolute cross sections were accurate to $\approx 15\%$. Comparison of $\sigma(\theta)$ and $A_y(\theta)$ data with DWBA calculations. Deduced levels, $J\pi$, hexadecapole deformation.

 ^{189}Re Levels

NSF=Nuclear structure factor.

Nuclear structure factors (NSF) from 1977Hi06 supersede those in 1976Hi08.

E(level) [†]	J^π [‡]	L [#]	$d\sigma/d\Omega$ mb/sr ^{&}	Comments
0	$5/2^+$	2	148 15	Experimental NSF=0.49; theoretical value=0.56 for $5/2$, $5/2[402]$.
125 3	$(9/2^-)$	(5)	4.7 7	J^π : $(7/2^+, 9/2^-)$ from $\sigma(\theta)$ and $A_y(\theta)$ data, $9/2^-$ supported by model interpretation.
146 3	$(7/2^+)$	(4)	5.9 9	Experimental NSF=0.05; theoretical value=0.005 for $9/2$, $9/2[514]$. J^π : $L-1/2$ from $\sigma(\theta)$ and $A_y(\theta)$ data, $7/2^+$ supported by model interpretation.
260 3	$3/2^+$	2	145 14	Experimental NSF=0.07; theoretical value=0.03 for $7/2$, $5/2[402]$.
279 3			<i>a</i>	E(level): may include $1/2^+$ member of $1/2[411]$ rotational band.
303 3	$(11/2^-)$	5	<i>a</i>	Experimental NSF<1.48; theoretical value=1.38 for $11/2$, $9/2[514]$ (1977Hi06).
481 3	$(5/2\&7/2)^+$	(2+4)	<i>b</i>	E(level), J^π : unresolved doublet with positive analyzing power. Broad peak with angular distribution consistent with states of different spin.
501 3	$(3/2^+)$	(2)	<i>b</i>	J^π : $L=(2)$ from $\sigma(\theta)$ and $L-1/2$ from $A_y(\theta)$ data.
599 3	$(3/2^+)$	(2)	13 2	Experimental NSF=0.04.
640 3	$(5/2^+, 3/2^-, 7/2^-)$	(2,1,3) [@]	13 2	
670 3	$(3/2^+)$	(2)	21 2	Experimental NSF=0.08.
697 3	$(7/2^+)$	(4)	59 6	Experimental NSF=0.72; theoretical value=0.97 for $7/2$, $7/2[404]$.
852 3	$(5/2^+)$	(2)	33 3	Experimental NSF=0.11.
877 3	$(9/2^+, 11/2^-, 7/2^-)$	(5,4,3) [@]	23 2	Experimental NSF=0.26.
1097 3				E(level): observed only in 1976Hi08.
1223 3	$5/2^+$	2	45 4	Experimental NSF=0.15.
1308 3	$(5/2^+)$	(2)	23 2	Experimental NSF=0.08.
1396 3	$(3/2^+, 5/2^-, 1/2^-)$	(2,3,1) [@]	19 2	
1423 3	$11/2^-$	5	86 9	Experimental NSF=1.10; theoretical value=0.93 for $11/2$, $7/2[523]$.
1502 10	$(11/2^-)$	(5) [@]	62 6	J^π : $(7/2^-, 9/2^+, 11/2^-)$ from $A_y(\theta)$ data, however, a tentative $(11/2^-)$ could be explained by hexadecapole deformation effects (1977Hi06).
1632 10			24 2	Experimental NSF=0.82.
1916 10				
1959 10				

[†] From 1976Hi08. The authors state that uncertainties are up to 3 keV up to 1500 keV, and estimated 10 keV above this energy.

[‡] Assigned by authors on the basis of comparison of experimental $\sigma(\theta)$ and analyzing powers ($A_y(\theta)$) data with DWBA calculations.

[#] As implied from $J\pi$ assignments in columns 2 and 3 of Table 2 in 1977Hi06 based on analysis of both the $\sigma(\theta)$ and $A_y(\theta)$ data and comparison with DWBA calculations.

$^{190}\text{Os}(\text{t},\alpha),(\text{pol t},\alpha)$ [1976Hi08,1977Hi06](#) (continued)

^{189}Re Levels (continued)

[@] From shell-model and Nilsson model predictions, L= 0, 2, 4 and 5 states should be strongly populated as compared to L=1 and 3 states in a proton pickup reaction, since there are no p- or f-states in the shell.

[&] Values are from [1977Hi06](#) at 50°. Cross sections are also given at 40° by [1976Hi08](#).

^a $d\sigma/d\Omega(279+303)=151$ mb/sr *15*.

^b $d\sigma/d\Omega(481+501)=174$ mb/sr *17*.

Adopted Levels, Gammas

$Q(\beta^-) = -537.13$; $S(n) = 5920.84$; $S(p) = 7258.95$; $Q(\alpha) = 1976.19$ (2017Wa10)

$S(2n) = 13910.45$, $S(2p) = 13660.712$ (2017Wa10).

^{189}Os isotope discovered by F.W. Aston: Nature 127, 233 (1931) from mass spectrography (see 2012Ro36 compilation).

 ^{189}Os Levels

Band assignments suggested by 1983Jh01.

Resonance levels above the neutron separation energy can be found in the $^{188}\text{Os}(n,\gamma)$:Resonances dataset (2010Fu04) and (n,γ) with $E_n = 2,24$ keV resonances (1992Br17).

Cross Reference (XREF) Flags

A	^{189}Re β^- decay (24.3 h)	F	$^{188}\text{Os}(n,\gamma)$:resonances	K	$^{189}\text{Os}(d,d')$
B	^{189}Os IT decay (5.81 h)	G	$^{188}\text{Os}(d,p)$, $^{190}\text{Os}(d,t)$	L	Coulomb excitation
C	^{189}Ir ε decay (13.2 d)	H	$^{189}\text{Os}(\gamma,\gamma)$:Mossbauer	M	$^{190}\text{Os}(^3\text{He},\alpha)$
D	$^{188}\text{Os}(n,\gamma)$ E=thermal	I	$^{189}\text{Os}(\gamma,\gamma')$		
E	$^{188}\text{Os}(n,\gamma)$ E=2,24 keV	J	$^{189}\text{Os}(e,e')$		

$E(\text{level})^\dagger$	J^π	$T_{1/2}$	XREF	Comments
0.0^a	$3/2^-$	stable	ABCDE GHIJKL	$\mu = +0.6599334$ (1954Lo36, 2014StZZ) $Q = +0.863$ (1972Wa24, 2016St14) RMS charge radius $\langle r^2 \rangle^{1/2} = 5.4016$ fm 12 (2013An02 evaluation). μ : NMR (1954Lo36, subject to correction for chemical effects). Other: $+0.65653$ (1968Sc03). Q : Mossbauer effect (1972Wa24). Other: $+0.986$ (2002Kr01) for $5d^6 6s^2$, and 0.979 for $5d^7 6s$ from laser induced fluorescence spectroscopy, $+0.82$ from optical spectroscopy includes polarization correction (1962Mu04), $+0.9110$ from optical spectroscopy (1968Hi04). J^π : spin from optical spectroscopy (1954Lo36) and NMR (1952Mu40); parity from $L(d,p)=1$ from 0^+ target.
$30.82^b 2$	$9/2^-$	5.81 h 10	ABCD G IJ L	$\%IT=100$ J^π : $M3+E4$ γ to $3/2^-$; $L=5$ in (d,p) , (d,t) . $T_{1/2}$: weighted average of 5.65 h 15 (2000Ah03), 6.0 h 1 (1963Pr12) and 5.7 h 1 (1958Sc30). Others: 5.7 h (1973Ot01), 6 h (1950Ch11).
$36.20^c 2$	$1/2^-$	0.52 ns 3	A CDE HI L	$\mu = +0.233$ (1969Wa02, 2014StZZ) μ : Mossbauer effect (1969Wa02). J^π : $M1+E2$ to $3/2^-$, $\gamma\gamma(\theta)$ isotropic. $T_{1/2}$: weighted average of 0.53 ns 3 from delayed coincidence in ^{189}Ir ε decay (1970Ma37) and 0.50 ns 3 from Mossbauer (1969Wa02).
$69.54^a 2$	$5/2^-$	1.62 ns 4	A CDE GHIJKL	$\mu = +0.9886$ (1972Wa24, 2014StZZ) $Q = -0.632$ (1972Wa24, 2016St14) J^π : $E2$ to $1/2^-$, $L=3$ in (d,p) , (d,t) . $T_{1/2}$: weighted average of delayed coincidence measurements 1.59 ns 8 (1970Ma37), 1.63 ns 4 (1969Gr10), and 1.7 ns 1 (1969An17) in ^{189}Ir ε decay. Others: Mossbauer 1.8 ns 2 (1968Pe09); Coulomb excitation 1.5 ns 3; delayed coincidence 2.12 ns 10 (1971Be71). μ : Mossbauer effect (1972Wa24, does not include polarization correction). Others: $+0.8223$ from IPAC (1968Pe09), 1971Be23. Q : Mossbauer effect (1972Wa24), deduced from the $Q_{5/2^-}/Q_{3/2^-}$ ratio of -0.735 12. Other value: -0.677 (1972Wa24, if the value for $Q_{3/2^-}$ of $+0.9110$ used in this reference is taken).
$95.27^c 1$	$3/2^-$	0.23 ns 3	A CDE GH KL	$\mu = -0.325$ (1971Be23, 2014StZZ) XREF: G(95.35). J^π : $M1+E2$ to $1/2^-$ and $5/2^-$.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{189}Os Levels (continued)

E(level) [†]	J ^π	T _{1/2}	XREF	Comments
				T _{1/2} : from delayed coincidence in ^{189}Ir ε decay (1970Ma37). Other: 0.10 ns 2 from Coulomb excitation. μ: IPAC (1971Be71).
97.35 3	11/2 ⁺		D	J ^π : E1 to 9/2 ⁻ . Not populated in ^{189}Re β ⁻ decay from 5/2 ⁺ .
216.67 ^c 2	7/2 ⁻	0.41 ns 2	A CD g I KL	J ^π : M1+E2 to 9/2 ⁻ , E2 to 3/2 ⁻ . T _{1/2} : from B(E2) in Coulomb excitation. Others: 77 ps 10 from (γ,γ') Res. Fluorescence (1995La15); <0.3 ns from delayed coincidence in ^{189}Ir ε decay (1970Ma37).
219.39 ^d 2	7/2 ⁻	0.260 ns 11	A CD g I KL	J ^π : M1+E2 to 9/2 ⁻ , E2 to 3/2 ⁻ . T _{1/2} : from B(E2) in Coulomb excitation. Other: 0.19 ns 3 from Coulomb excitation (1967Hr01); < 0.3 ns from (d,d') (1975Mo29).
233.58 ^{&} 2	5/2 ⁻	0.27 ns +7-4	A CDE KL	J ^π : M1+E2 to 3/2 ⁻ and 5/2 ⁻ , band assignment. T _{1/2} : from B(E2) in Coulomb excitation. Others: 0.28 ns 13 from Coulomb excitation; ≈0.1 ns from (d,d') (1975Mo29).
275.92 3	5/2 ⁻	0.17 ns 3	A CDE G I L	J ^π : M1+E2 to 3/2 ⁻ , M1 to 7/2 ⁻ . T _{1/2} : weighted average of 0.16 ns 4 from B(E2) in Coulomb excitation and 0.17 ns 3 from delayed coincidence in ^{189}Ir ε decay (1970Ma37).
288 3	(13/2 ⁺) [‡]		G M	J ^π : excited in Coulomb excitation, band assignment.
350.0 ^a 4	(9/2 ⁻)		KL	J ^π : L=3 in (d,p) and (d,t); band member favors 7/2.
365.78 ^{&} 3	(7/2 ⁻)		A D G KL	J ^π : E2(+M1) to 7/2 ⁻ , γ to 3/2 ⁻ and 9/2 ⁻ .
427.93 4	5/2 ⁻ , 7/2 ⁻	>4.4 ps	A I K	T _{1/2} : from (γ,γ'): Res. Fluorescence (1995La16). J ^π : L=1 in (d,p), (d,t). XREF: G(?).
438.73 3	1/2 ⁻ , 3/2 ⁻		A CDE G	J ^π : E2 γ to 11/2 ⁺ , γs to 5/2 ⁻ and 7/2 ⁻ . A 446 4 level in (d,p) with L=1 (implying J ^π =1/2 ⁻ , 3/2 ⁻) is given by 1975Mo29 but not confirmed by 1976Be50.
444.23 3	7/2 ⁺		D G	J ^π : M1 to 1/2 ⁻ . J ^π : L=1 in (d,p), (d,t).
498.79 3	1/2 ⁻ , 3/2 ⁻		A DE L	J ^π : L=3 in (d,p), (d,t), strong γ to 3/2 ⁻ .
505.86 3	1/2 ⁻ , 3/2 ⁻		DE G K	T _{1/2} : from (γ,γ'): Resonance fluorescence (1995La16).
531.55 3	5/2 ⁻	>0.26 ps	DE G I KL	J ^π : M1 to 5/2 ⁻ , fed by primary γ in (n,γ) (1976Be50). T _{1/2} : from (γ,γ'): Res. Fluorescence (1995La16).
550.04 3	3/2 ⁻	>0.039 ps	A DE I	J ^π : L=2 in (d,d'); primary γ from $^{188}\text{Os}(n,\gamma)$ E=2,24 keV res: av.
557.36 3	3/2 ⁻		DE g KL	J ^π : populated in Coulomb excitation, band assignment.
562.70 5			D	J ^π : M1 γ rays to 1/2 ⁻ and 5/2 ⁻ .
594.9 ^a 3	(11/2 ⁻)		KL	J ^π : γ rays to 1/2 ⁻ , 5/2 ⁻ and 7/2 ⁻ . However, L>3 in (d,p), (d,t) indicating J=(7/2 ⁺ , 9/2 ⁻); possibly doublet.
599.63 3	3/2 ⁻		A De g i k	J ^π : populated in Coulomb excitation, band assignment.
622.02 3	(3/2 ⁻ , 5/2 ⁻)		A D G K	J ^π : from (n,γ), E=thermal (1992Br17); L=2 in (d,d').
630.6 ^{&} 3	(9/2 ⁻)		L	J ^π : primary γ from (n,γ) E=24 keV res: av.
634.2 5			L	J ^π : γ to 7/2 ⁻ , primary γ from (n,γ) E=2,24 keV res: av.
667.4 4			L	However, L>3 in (d,p), (d,t) J ^π assignments conflict.
672.14 3	5/2 ⁻		A D K	J ^π : L=1,3 in (d,t); γs to 1/2 ⁻ and 3/2 ⁻ .
673.2 11	5/2		E	J ^π : M1 to 3/2 ⁻ , L=3 in (d,p), (d,t).
679.90 3	3/2 ⁻		DE G	J ^π : from (n,γ), E=thermal.
688.43 3	1/2 ⁻ , 3/2 ⁻ , 5/2 ⁻		DE G	
716.89 4	5/2 ⁻		A g	
717.01 4	5/2 ⁻ , 7/2 ⁻		D g	

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Adopted Levels, Gammas (continued) ^{189}Os Levels (continued)

E(level) [†]	J ^π	XREF	Comments
735.5 5	1/2 ⁻ , 3/2 ⁻	G KL	J ^π : L=1 in (d,p),(d,t).
786 3		G	
792.10 5	5/2	D k	J ^π : L>2 in (d,d'), γs to 1/2 ⁻ , 3/2 ⁻ and 7/2 ⁻ .
794.3 4		kL	
817.0 10	5/2 ⁻ , 7/2 ⁻	G KL	J ^π : L=3 in (d,p), (d,t).
849.73 6	1/2 ⁻ , 3/2 ⁻ #	DE G	
877 3	(13/2 ⁺) [‡]	G M	
898.2 18		G	
908.03 4	1/2 ⁻ , 3/2 ⁻ #	DE G	J ^π : L=1,3 in (d,p).
939.66 4	3/2 ⁺	DE	J ^π : γ to 3/2 ⁻ and 7/2 ⁺ ; primary γ from (n,γ) E=24 keV res: av.
957.3 24		G	
990.15 4	7/2 ⁺	D	J ^π : γγ(θ) in (n,γ) thermal; γ rays to 5/2 ⁻ and 11/2 ⁺ .
994.627 25	1/2 ⁻ , 3/2 ⁻	DE G	J ^π : L=1 in (d,p), (d,t); primary γ from (n,γ) E=2,24 keV res: av.
996.4 4	1/2 ⁺ , 3/2 ⁺	E	J ^π : populated by primary γ in (n,γ) E=24 keV res: av.
1019 2	(13/2 ⁺) [‡]	G M	J ^π : L=6 in (t,α).
1028 3		G	
1036.74 7	(5/2 ⁻ , 7/2, 9/2 ⁻)	D	J ^π : γ to 5/2 ⁻ and 9/2 ⁻ .
1056.02 4	(3/2 ⁻) ⁻ #	DE G	J ^π : from (n,γ) resonance, E(n)=24 keV, p-wave capture; γ to (7/2) ⁻ .
1076.92 7		D	
1107.8 18		G	
1140.0 4	1/2 ⁻ , 3/2 ⁻ #@	E	
1149.38 7	1/2 ⁺ , 3/2 ⁺ @	DE	J ^π : primary γ from (n,γ) E=24 keV res: av.
1159.94 4	3/2 ⁻	DE	J ^π : γ to 1/2, 3/2, and 7/2 ⁻ ; primary γ from (n,γ) E=2,24 keV res: av.
1163 4		G	
1188.9 18	1/2 ⁻ , 3/2 ⁻	E g	J ^π : primary γ from (n,γ) E=2,24 keV res: av.; L=1 in (d,p),(d,t).
1190.42 9	1/2 ⁻ , 3/2 ⁻	D g	J ^π : from (n,γ), E=thermal.
1196.9 9	1/2 ⁺ , 3/2 ⁺ #	E	
1206.71 7		D G	
1220.27 7	1/2 ⁻ , 3/2 ⁻ #@	DE G	
1226.35 8	1/2 ⁺ , 3/2 ⁺ #@	DE	
1235.3 2	1/2 ⁻ , 3/2 ⁻ #@	E	
1242.8 43		G	
1254.83 5	1/2 ⁻ , 3/2 ⁻ #@	DE	
1267.36 6	3/2, 1/2 ⁽⁻⁾	D	J ^π : from (n,γ), E=thermal.
1268.4 11	1/2 ⁺ , 3/2 ⁺ @	E	J ^π : primary γ from (n,γ) E=24 keV res: av.
1269 1		G	
1277.67 6		D	
1297.27 4	3/2 ⁻	DE	J ^π : γ to 1/2 ⁻ , 3/2 ⁻ and 7/2 ⁻ ; primary γ from (n,γ) E=2,24 keV res: av.
1311.73 9	1/2 ⁻ , 3/2 ⁻ #	DE	
1333.47 6	3/2 ⁺	DE	J ^π : γ to 7/2 ⁺ ; primary γ observed in (n,γ) E=2,24 keV res: av.
1361.2 3	1/2 ⁻ , 3/2 ⁻ #	E	
1370.09 5	1/2 ⁻ , 3/2 ⁻ #	DE	
1376.72 4	3/2 ⁻	DE G	J ^π : γ to 7/2 ⁻ ; primary γ observed in (n,γ) E=2,24 keV res: av.
1394.6 4	1/2 ⁻ , 3/2 ⁻ #	DE G	
1398.2 4	1/2 ⁻ , 3/2 ⁻ #	E	
1407.54 5	3/2 ⁻ #	DE	J ^π : γ to 7/2 ⁻ .
1411.3 20	1/2 ⁻ , 3/2 ⁻	G	J ^π : L=1 in (d,p).
1435.3 3	1/2 ⁻ , 3/2 ⁻ #	E	
1445.5 20	1/2 ⁻ , 3/2 ⁻	G	J ^π : L=1 in (d,p).
1451.38 8	1/2 ⁺ , 3/2 ⁺	DE	J ^π : primary γ from (n,γ) E=24 keV res: av.

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Adopted Levels, Gammas (continued) ^{189}Os Levels (continued)

E(level) [†]	J ^π	XREF	Comments
1472.27 6	1/2 ⁻ , 3/2 ⁻ [#]	DE	J ^π : from (n,γ), E=thermal; (n,γ) E=2,24 keV res: av.
1475.0 9	1/2 ⁻ , 3/2 ⁻	E G	J ^π : L=1 in (d,p).
1554.6 25	1/2 ⁻ , 3/2 ⁻	G	J ^π : L=1 in (d,p).
1633.7 23		G	
1699.6 20	(5/2 ⁻)	D G	J ^π : from (n,γ), E=thermal; L=3 in (d,p).
1724.8 21	5/2 ⁻ , 7/2 ⁻	G	J ^π : L=3 in (d,p).
1816 1	(1/2 to 7/2) ⁻	G	J ^π : L(d,p)=1,3.
1895 5	(1/2, 3/2)	D	J ^π : primary γ from 1/2 ⁺ .
1941 5	(1/2, 3/2)	D	J ^π : primary γ from 1/2 ⁺ .
(5921 1)	1/2 ⁺	D	E(level): S(n)=5920.8 4 (2017Wa10).
(5922.5 5)	1/2 ⁺	E	E(level): S(n)+E(n), where S(n)=5920.8 4 (2017Wa10), E(n)=2 keV.
(5944.5 5)	1/2, 3/2 ⁻	E	E(level): S(n)+E(n), where S(n)=5920.8 4 (2017Wa10), E(n)=2 keV.

[†] From least-squares fit to E_γ values.[‡] L=6 in (t,α) favors 13/2⁺, however, 11/2⁺ cannot be excluded.[#] Primary γ observed in (n,γ) E=2,24 keV res: av.[@] Additional support for parity assignments from intensity ratios at different neutron energies in (n,γ), E=2,24 keV using the average resonance capture (ARC) technique.[&] Band(A): ν1/2[510] band.^a Band(B): ν3/2[512] band.^b Band(C): ν9/2[505] band.^c Band(D): ν7/2[503] band.

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Os})$									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult.§	$\delta\&$	α^I	Comments
30.82	9/2 ⁻	30.81 [@] 4	100	0.0	3/2 ⁻	M3+E4	0.04 2	3.12×10 ⁵ 10	B(M3)(W.u.)=0.000356 14; B(E4)(W.u.)=0.5 +6-4
36.20	1/2 ⁻	36.17 ^d 4	100	0.0	3/2 ⁻	M1+E2	0.046 5	20.2 4	B(M1)(W.u.)=0.042 3; B(E2)(W.u.)=27 7
69.54	5/2 ⁻	33.31 ^d 4	0.19 2	36.20	1/2 ⁻	E2		723	B(E2)(W.u.)=24 3
		69.53 3	100 4	0.0	3/2 ⁻	M1+E2	+0.683 25	8.2 3	B(M1)(W.u.)=0.0026 2; B(E2)(W.u.)=100 10
95.27	3/2 ⁻	25.65 ^d 10	1.9 2	69.54	5/2 ⁻	M1+E2	0.11 +5-3	84 34	B(M1)(W.u.)=0.011 7; B(E2)(W.u.)=80 +90-40
		59.06 ^a 2	100 6	36.20	1/2 ⁻	M1+E2	0.085 10	4.82 10	B(M1)(W.u.)=0.048 8; B(E2)(W.u.)=27 16
		95.27 ^a 1	30.5 15	0.0	3/2 ⁻	M1+E2	+0.32 2	6.36	B(M1)(W.u.)=0.0032 6; B(E2)(W.u.)=14 3
97.35	11/2 ⁺	66.55 ^f 4	100	30.82	9/2 ⁻	E1		0.227	
216.67	7/2 ⁻	121.39 ^e 5	0.53 6	95.27	3/2 ⁻	[E2]		2.02	B(E2)(W.u.)=1.75 22
		147.11 ^b 4	22.3 5	69.54	5/2 ⁻	M1+E2	-1.0 +4-3	1.43 21	B(M1)(W.u.)=0.0008 4; B(E2)(W.u.)=14 6
		185.85 [#] 1	34.3 7	30.82	9/2 ⁻	M1(+E2)	<0.5	0.91 6	B(M1)(W.u.)=0.00105 17; B(E2)(W.u.)<2.2
		216.66 4	100.0 21	0.0	3/2 ⁻	E2		0.254	B(E2)(W.u.)=18.2 11
219.39	7/2 ⁻	124.18 ^b 6	0.7 4	95.27	3/2 ⁻	[E2]		1.85	B(E2)(W.u.)=5 3
		149.86 4	17.0 3	69.54	5/2 ⁻	E2		0.916	B(E2)(W.u.)=43 2
		188.55 5	10.88 21	30.82	9/2 ⁻	M1+E2	1.5 +10-4	0.57 9	B(M1)(W.u.)=0.00025 +11-14; B(E2)(W.u.)=6 +2-1
		219.39 4	100.0 19	0.0	3/2 ⁻	E2		0.244	B(E2)(W.u.)=38 2
233.58	5/2 ⁻	138.28 4	23 ^h 2	95.27	3/2 ⁻	M1+E2	-0.8 2	1.84 13	B(M1)(W.u.)=0.0012 +4-5; B(E2)(W.u.)=17 +6-7
									I _γ : Weighted average from ¹⁸⁹ Ir ε and (n,γ) thermal.
		164.02 4	22 ^h 3	69.54	5/2 ⁻	M1(+E2)	<1.7	1.1 3	B(M1)(W.u.)=0.00087 63; B(E2)(W.u.)<16
		197.36 4	80 ^h 9	36.20	1/2 ⁻	E2		0.347	B(E2)(W.u.)=25 +5-8
		233.58 4	100 ^h 4	0.0	3/2 ⁻	M1+E2	1.7 +6-3	0.28 4	B(M1)(W.u.)=0.0005 +3-4; B(E2)(W.u.)=10 +3-4
275.92	5/2 ⁻	56.50 [@] 4	1.99 18	219.39	7/2 ⁻	M1		5.17	B(M1)(W.u.)=0.0099 21
		59.1 1	≈0.8	216.67	7/2 ⁻	(M1+E2)	≈0.9	≈22.0	E _γ : γ not confirmed in (n,γ) from γγ-coin, but its presence seems established in β ⁻ and ε decays.
		180.64 [@] 7	0.51 4	95.27	3/2 ⁻	E2(+M1)	>0.2	0.75 28	B(M1)(W.u.)<7.0×10 ⁻⁵ ; B(E2)(W.u.)=0.53 50
		206.35 [@] 5	1.35 5	69.54	5/2 ⁻	M1+E2	>1.9	0.34 5	B(M1)(W.u.)<3.3×10 ⁻⁵ ; B(E2)(W.u.)=1.05 33
		239.83 ^b 16	1.3 7	36.20	1/2 ⁻	[E2]		0.183	B(E2)(W.u.)=0.6 4
									I _γ : the relative intensity of this transition varies widely in ¹⁸⁹ Re β ⁻ decay and (n,γ). The adopted intensity represents the unweighted average.
		245.09 4	100 6	30.82	9/2 ⁻	E2		0.1704	B(E2)(W.u.)=41 8
		275.85 8	8.8 3	0.0	3/2 ⁻	M1+E2	1.8 2	0.167 10	B(M1)(W.u.)=8.9×10 ⁻⁵ 23; B(E2)(W.u.)=1.5 3
350.0	(9/2 ⁻)	280.8 5	100	69.54	5/2 ⁻				

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Os})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta\&$	α^I	Comments
365.78	$(7/2)^-$	132.22 ^b 6	22 3	233.58	$5/2^-$				
		270.53 ^c 6	35 3	95.27	$3/2^-$				
		296.18 ^c 6	100 8	69.54	$5/2^-$				
		365		0.0	$3/2^-$				E_γ : only in Coulomb excitation from 1997Br18.
427.93	$5/2^-, 7/2^-$	152.03 ^e 5	25 2	275.92	$5/2^-$				
		211.26 ^e 5	13 2	216.67	$7/2^-$	E2(+M1)	>1	0.38 10	B(M1)(W.u.)<0.018; B(E2)(W.u.)<330
		397.0 ^e 1	100 10	30.82	$9/2^-$				
		428.5 ^e 5	46 10	0.0	$3/2^-$				
438.73	$1/2^-, 3/2^-$	162.74 ^f 9	1.1 3	275.92	$5/2^-$				
		343.44 ^a 6	100 5	95.27	$3/2^-$				
		402.65 ^a 8	9.6 16	36.20	$1/2^-$				
		438.5 [@] 1	6.7 17	0.0	$3/2^-$				
444.23	$7/2^+$	224.82 6	5.9 7	219.39	$7/2^-$				
		227.60 5	11.8 12	216.67	$7/2^-$				
		346.88 3	100 7	97.35	$11/2^+$	E2		0.0599	
		413.14 ^m 21	4.7 ^m 15	30.82	$9/2^-$				
498.79	$1/2^-, 3/2^-$	222.84 8	6.0 13	275.92	$5/2^-$				γ from (n, γ) E=thermal only.
		265.22 ⁱ 5	17 ^j 4	233.58	$5/2^-$				
		403.53 ⁱ 5	65 ^j 12	95.27	$3/2^-$				
		429.22 ⁱ 4	43 7	69.54	$5/2^-$				I_γ : from $^{189}\text{Re } \beta^-$. Other: 40 3 from (n, γ) E=thermal, if 498.94-keV γ ray in (n, γ) is assigned from this level.
		462.6 1	100.0 23	36.20	$1/2^-$	M1		0.0813	E_γ, I_γ : from $^{189}\text{Re } \beta^-$. Other: $E_\gamma=462.48$ 6, a strong γ ray was unplaced in (n, γ) E=thermal (1992Br17), but tentatively assigned by evaluators from the 499 level, based on results from $^{189}\text{Re } \beta^-$ data.
		498.8 1	50 5	0.0	$3/2^-$	M1		0.0667	E_γ, I_γ : from $^{189}\text{Re } \beta^-$. Other: $E_\gamma=498.94$ 4, $I_\gamma=79$ 11 relative to 100 for $E_\gamma=462.48$ 6 in (n, γ) E=thermal, both unplaced in 1992Br17, but tentatively assigned by evaluators from the 499 level, based on results from $^{189}\text{Re } \beta^-$ data.
505.86	$1/2^-, 3/2^-$	272.4 5		233.58	$5/2^-$				
		410.60 4	70 5	95.27	$3/2^-$				
		469.65 4	100 7	36.20	$1/2^-$				
		505.86 5	59 4	0.0	$3/2^-$				
531.55	$5/2^-$	297.83 ^f 9	32 6	233.58	$5/2^-$				
		312.17 ^f 4	8 3	219.39	$7/2^-$				
		314.91 ^f 4	19 1	216.67	$7/2^-$				
		531.44 ^g 10	100 10	0.0	$3/2^-$				

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Os})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	α^l	Comments
550.04	3/2 ⁻	273.6 ^e 5	5 ^e 1	275.92	5/2 ⁻	[M1]	0.332	B(M1)(W.u.)<0.79
		316.52 ^f 6	1.5 ^f 1	233.58	5/2 ⁻			
		454.75 ^b 3	100 7	95.27	3/2 ⁻			
		480.53 ^f 5	42 ^f 3	69.54	5/2 ⁻			
		550.0 ^e 3	24 ^e 2	0.0	3/2 ⁻	M1	0.0517	B(M1)(W.u.)<0.47
557.36	3/2 ⁻	281.74 ^f 16	9 ^f 3	275.92	5/2 ⁻			
		323.72 ^g 4	64 ^f 10	233.58	5/2 ⁻			
		487.87 ^f 4	55 ^f 5	69.54	5/2 ⁻			
562.70		521.20 ^f 4	100 ^f 7	36.20	1/2 ⁻			
		118.50 9	42 9	444.23	7/2 ⁺			
		465.28 18	100 27	97.35	11/2 ⁺			
594.9	(11/2 ⁻)	245.0 5	≈86	350.0	(9/2 ⁻)			
		375.3 5	100	219.39	7/2 ⁻			
		378.3 5	67	216.67	7/2 ⁻			
599.63	3/2 ⁻	101.1 ^k 5	0.7 ^k 4	498.79	1/2 ⁻ , 3/2 ⁻	M1	5.45 11	
		160.93 ^k 5	5.7 ^k 7	438.73	1/2 ⁻ , 3/2 ⁻	M1	1.451	
		323.7 ^k 1	2.0 ^k 7	275.92	5/2 ⁻	[M1]	0.211	Note that a strong 323.72 4 γ is placed from a 557 level in (n, γ) E=thermal.
		366.09 ⁱ 10	10.1 ^j 19	233.58	5/2 ⁻			
		380.0 2	4.7 4	219.39	7/2 ⁻	[E2]	0.0464	E γ unweighted average and I γ weighted average from β^- and (n, γ).
		382.95 ⁱ 8	5.5 ^j 13	216.67	7/2 ⁻	[E2]	0.0455	
		504.33 ⁱ 16	44 ^j 6	95.27	3/2 ⁻	M1	0.0648	
		530.3 ^k 3	11.7 ^k 7	69.54	5/2 ⁻	M1	0.0569	
		563.41 ⁱ 10	100 6	36.20	1/2 ⁻	M1	0.0486	
		599.62 ⁱ 4	56 ^j 5	0.0	3/2 ⁻	M1	0.0413	
622.02	(3/2 ⁻ , 5/2 ⁻)	256.22 ^b 4	96 ^f 8	365.78	(7/2 ⁻)	[M1+E2]	0.27 13	
		388.40 ^b 4	100 ^f 7	233.58	5/2 ⁻	[M1+E2]	0.09 5	
		405.5 ^f 5	58 ^f 43	216.67	7/2 ⁻			
		586.03 ^f 9	27 ^f 2	36.20	1/2 ⁻			
630.6	(9/2 ⁻)	280.8 5	≈58	350.0	(9/2 ⁻)			
		397.2 5	100	233.58	5/2 ⁻			
		410.9 5	87	219.39	7/2 ⁻			
634.2		634.2 5	100	0.0	3/2 ⁻			
667.4		597.9 5	14	69.54	5/2 ⁻			
		667.4 5	100	0.0	3/2 ⁻			
672.14	5/2 ⁻	306.37 ^b 5	13 ^f 1	365.78	(7/2 ⁻)	[M1+E2]	0.17 8	

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Os})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta\&$	α^l
672.14	$5/2^-$	438.58 ^b 3	100 ^f 8	233.58	$5/2^-$	[M1+E2]		0.06 3
		452.91 ^f 10	69 ^f 8	219.39	$7/2^-$	[M1+E2]		0.06 3
679.90	$3/2^-$	122.47 6	6.2 9	557.36	$3/2^-$			
		181.06 5	17.3 21	498.79	$1/2^-, 3/2^-$			
		241.22 6	16.7 24	438.73	$1/2^-, 3/2^-$			
		460.64 6	95 8	219.39	$7/2^-$			
		463.20 6	100 10	216.67	$7/2^-$			
		584.60 5	36 3	95.27	$3/2^-$			
		610.75 17	6.2 11	69.54	$5/2^-$			
		643.69 4	51 4	36.20	$1/2^-$			
		679.97 20	7 3	0.0	$3/2^-$			
		593.18 4	100 7	95.27	$3/2^-$			
688.43	$1/2^-, 3/2^-, 5/2^-$	652.16 5	17.8 14	36.20	$1/2^-$			
		688.50 5	68 5	0.0	$3/2^-$			
716.89	$5/2^-$	117.27 ^e 5	8 ^e 3	599.63	$3/2^-$	M1		3.56
		166.95 ^e 5	6.1 ^e 13	550.04	$3/2^-$	E2(+M1)	>2	0.69 7
		218 ^e 1	26 ^e 13	498.79	$1/2^-, 3/2^-$	[M1]		0.621 12
		351.08 ^b 10	26 ^e 13	365.78	$(7/2)^-$	[M1]		0.1692
		440.80 ^b 14	18 ^e 9	275.92	$5/2^-$			
		483.2 ^e 1	30 ^e 8	233.58	$5/2^-$	[M1]		0.0725
		497.3 ^e 1	100 ^e 26	219.39	$7/2^-$			
717.01	$5/2^-, 7/2^-$	272.77 ^m 7	36 ^m 5	444.23	$7/2^+$			
		351.06 10	7 1	365.78	$(7/2)^-$			
		440.77 14	9 2	275.92	$5/2^-$			
		621.83 5	100 7	95.27	$3/2^-$			
		647.41 10	10 1	69.54	$5/2^-$			
		717.09 8	20 2	0.0	$3/2^-$			
		735.5 5	100	0.0	$3/2^-$			
735.5	$1/2^-, 3/2^-$	293.18 11	32 5	498.79	$1/2^-, 3/2^-$			
792.10	$5/2$	572.83 10	43 7	219.39	$7/2^-$			
		575.40 6	100 8	216.67	$7/2^-$			
		163.8 5		630.6	$(9/2^-)$			
794.3		428.5 5	100	365.78	$(7/2)^-$			
		575 1	17	219.39	$7/2^-$			
		817 1	100	0.0	$3/2^-$			
817.0	$5/2^-, 7/2^-$	849.70 6	100	0.0	$3/2^-$			
849.73	$1/2^-, 3/2^-$	308.41 4	100 7	599.63	$3/2^-$			
908.03	$1/2^-, 3/2^-$	908.00 6	90 7	0.0	$3/2^-$			
		339.91 8	14.6 18	599.63	$3/2^-$			
939.66	$3/2^+$	495.49 4	100 7	444.23	$7/2^+$			

Adopted Levels, Gammas (continued)

 $\gamma(^{189}\text{Os})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π
990.15	7/2 ⁺	427.44 4	100 7	562.70	
		545.86 6	87 8	444.23	7/2 ⁺
		770.81 ^m 7	14.5 ^m 10	219.39	7/2 ⁻
		892.92 14	16 2	97.35	11/2 ⁺
		920.72 12	14 2	69.54	5/2 ⁻
		959.37 12	15 2	30.82	9/2 ⁻
994.627	1/2 ⁻ , 3/2 ⁻	277.79 15	12 4	717.01	5/2 ⁻ , 7/2 ⁻
		372.55 6	32 3	622.02	(3/2 ⁻ , 5/2 ⁻)
		394.99 5	33 3	599.63	3/2 ⁻
		444.59 5	9 1	550.04	3/2 ⁻
		761.08 5	100 7	233.58	5/2 ⁻
		899.39 5	57 4	95.27	3/2 ⁻
1036.74	(5/2 ⁻ , 7/2, 9/2 ⁻)	817.59 16	85 14	219.39	7/2 ⁻
		819.82 14	100 15	216.67	7/2 ⁻
		967.17 9	26 4	69.54	5/2 ⁻
		1006.11 15	25 3	30.82	9/2 ⁻
1056.02	(3/2 ⁻)	550.11 4	100 7	505.86	1/2 ⁻ , 3/2 ⁻
		690.30 8	20.1 18	365.78	(7/2 ⁻)
		1019.98 8	15.0 12	36.20	1/2 ⁻
1076.92		801.00 6	100	275.92	5/2 ⁻
1149.38	1/2 ⁺ , 3/2 ⁺	710.62 6	100 9	438.73	1/2 ⁻ , 3/2 ⁻
		1054.36 18	26 4	95.27	3/2 ⁻
1159.94	3/2 ⁻	602.64 8	100 11	557.36	3/2 ⁻
		721.16 8	39 4	438.73	1/2 ⁻ , 3/2 ⁻
		795.0 ^m 4	6 ^m 2	365.78	(7/2 ⁻)
		940.41 11	24 3	219.39	7/2 ⁻
		943.25 16	14 2	216.67	7/2 ⁻
		1064.74 7	29 3	95.27	3/2 ⁻
1190.42	1/2 ⁻ , 3/2 ⁻	751.69 8	100	438.73	1/2 ⁻ , 3/2 ⁻
1206.71		930.78 7	100 8	275.92	5/2 ⁻
		1109.38 13	29 4	97.35	11/2 ⁺
1220.27	1/2 ⁻ , 3/2 ⁻	280.71 9	100 16	939.66	3/2 ⁺
		663.03 15	49 7	557.36	3/2 ⁻
		781.39 9	40 3	438.73	1/2 ⁻ , 3/2 ⁻
1226.35	1/2 ⁺ , 3/2 ⁺	727.55 7	100	498.79	1/2 ⁻ , 3/2 ⁻
1254.83	1/2 ⁻ , 3/2 ⁻	582.97 9	45 4	672.14	5/2 ⁻
		704.66 6	100 8	550.04	3/2 ⁻
		756.05 12	23 8	498.79	1/2 ⁻ , 3/2 ⁻
1267.36	3/2, 1/2 ⁽⁻⁾	272.77 ^m 7	207 ^m 29	994.627	1/2 ⁻ , 3/2 ⁻
		735.78 7	100 9	531.55	5/2 ⁻
1277.67		678.33 21	60 11	599.63	3/2 ⁻

Adopted Levels, Gammas (continued)

 $\gamma(^{189}\text{Os})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π
1277.67		838.92 5	100 8	438.73	$1/2^-, 3/2^-$
1297.27	$3/2^-$	608.84 10	56 7	688.43	$1/2^-, 3/2^-, 5/2^-$
		739.99 7	73 7	557.36	$3/2^-$
		791.38 16	29 4	505.86	$1/2^-, 3/2^-$
		1078.03 13	43 4	219.39	$7/2^-$
		1080.50 6	100 7	216.67	$7/2^-$
1311.73	$1/2^-, 3/2^-$	873.00 8	100	438.73	$1/2^-, 3/2^-$
1333.47	$3/2^+$	770.81 ^m 7	38 ^m 3	562.70	
		827.58 8	100 13	505.86	$1/2^-, 3/2^-$
		889.19 11	35 8	444.23	$7/2^+$
1370.09	$1/2^-, 3/2^-$	812.74 5	100 8	557.36	$3/2^-$
		864.13 12	15 2	505.86	$1/2^-, 3/2^-$
1376.72	$3/2^-$	696.66 10	24 3	679.90	$3/2^-$
		871.02 6	100 8	505.86	$1/2^-, 3/2^-$
		937.99 5	49 4	438.73	$1/2^-, 3/2^-$
		1010.96 7	24 5	365.78	$(7/2)^-$
		1100.71 12	67 6	275.92	$5/2^-$
		1156.95 11	50 5	219.39	$7/2^-$
1394.6	$1/2^-, 3/2^-$	795.0 ^m 4	100 ^m	599.63	$3/2^-$
1407.54	$3/2^-$	413.14 ^m 21	81 ^m 26	994.627	$1/2^-, 3/2^-$
		719.11 9	79 7	688.43	$1/2^-, 3/2^-, 5/2^-$
		901.64 7	100 8	505.86	$1/2^-, 3/2^-$
		1131.52 7	60 9	275.92	$5/2^-$
		1191.14 12	96 12	216.67	$7/2^-$
1451.38	$1/2^+, 3/2^+$	291.83 20	16 4	1159.94	$3/2^-$
		659.24 6	100 8	792.10	$5/2$
1472.27	$1/2^-, 3/2^-$	532.65 16	70 13	939.66	$3/2^+$
		914.90 5	100 7	557.36	$3/2^-$
(5921)	$1/2^+$	3980 4	13 6	1941	$(1/2, 3/2)$
		4026 4	12 6	1895	$(1/2, 3/2)$
		4221 3	45 12	1699.6	$(5/2^-)$
		4449 4	11 6	1472.27	$1/2^-, 3/2^-$
		4527 3	18 6	1394.6	$1/2^-, 3/2^-$
		4546 3	38 8	1376.72	$3/2^-$
		4928 3	37 13	994.627	$1/2^-, 3/2^-$
		5363 3	10 4	557.36	$3/2^-$
		5370 3	31 7	550.04	$3/2^-$
		5415 2	100 21	505.86	$1/2^-, 3/2^-$
		5482 2	38 9	438.73	$1/2^-, 3/2^-$
		5884 2	44 9	36.20	$1/2^-$
(5922.5)	$1/2^+$	4447.5 9	34 14	1475.0	$1/2^-, 3/2^-$

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Os})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π
(5922.5)	$1/2^+$	4450.8 4	76 14	1472.27	$1/2^-, 3/2^-$
		4471.7 9	15 4	1451.38	$1/2^+, 3/2^+$
		4487.3 3	57 7	1435.3	$1/2^-, 3/2^-$
		4515.0 4	39 6	1407.54	$3/2^-$
		4524.4 3	77 9	1398.2	$1/2^-, 3/2^-$
		4528.7 5	39 8	1394.6	$1/2^-, 3/2^-$
		4546.1 4	63 7	1376.72	$3/2^-$
		4552.8 4	38 6	1370.09	$1/2^-, 3/2^-$
		4561.4 3	73 7	1361.2	$1/2^-, 3/2^-$
		4589.3 7	15 4	1333.47	$3/2^+$
		4610.4 3	63 6	1311.73	$1/2^-, 3/2^-$
		4625.4 3	49 5	1297.27	$3/2^-$
		4667.9 4	23 4	1254.83	$1/2^-, 3/2^-$
		4687.4 2	77 6	1235.3	$1/2^-, 3/2^-$
		4696.2 8	14 3	1226.35	$1/2^+, 3/2^+$
		4702.8 4	31 5	1220.27	$1/2^-, 3/2^-$
		4725.7 9	10 3	1196.9	$1/2^+, 3/2^+$
		4733.7 4	35 4	1188.9	$1/2^-, 3/2^-$
		4763.1 3	36 5	1159.94	$3/2^-$
		4772.9 5	10 3	1149.38	$1/2^+, 3/2^+$
		4782.5 3	55 5	1140.0	$1/2^-, 3/2^-$
		4865.9 3	35 5	1056.02	$(3/2)^-$
		4928.2 3	73 5	994.627	$1/2^-, 3/2^-$
		5014.6 3	42 4	908.03	$1/2^-, 3/2^-$
		5073.6 3	74 5	849.73	$1/2^-, 3/2^-$
		5234.1 3	52 4	688.43	$1/2^-, 3/2^-, 5/2^-$
		5243.0 3	56 4	679.90	$3/2^-$
		5323.0 3	63 4	599.63	$3/2^-$
		5365.6 3	86 6	557.36	$3/2^-$
		5372.7 3	43 4	550.04	$3/2^-$
		5416.9 3	88 5	505.86	$1/2^-, 3/2^-$
		5423.9 3	29 3	498.79	$1/2^-, 3/2^-$
		5483.7 3	53 4	438.73	$1/2^-, 3/2^-$
		5827.4 2	152 8	95.27	$3/2^-$
		5886.4 2	100 5	36.20	$1/2^-$
		5922.3 3	34 3	0.0	$3/2^-$
(5944.5)	$1/2, 3/2^-$	4469.6	259 41	1475.0	$1/2^-, 3/2^-$
		4472.9	93 39	1472.27	$1/2^-, 3/2^-$
		4493.7	84 12	1451.38	$1/2^+, 3/2^+$
		4509.3	94 13	1435.3	$1/2^-, 3/2^-$
		4537.0	36 12	1407.54	$3/2^-$
		4546.4	118 16	1398.2	$1/2^-, 3/2^-$

$^{189}\text{Os}_{113}^{-11}$

NUCLEAR DATA SHEETS

$^{189}\text{Os}_{113}^{-11}$

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Os})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π
(5944.5)	1/2, 3/2 ⁻	4550.8	122 17	1394.6	1/2 ⁻ , 3/2 ⁻
		4568.2	36 14	1376.72	3/2 ⁻
		4574.9	70 13	1370.09	1/2 ⁻ , 3/2 ⁻
		4583.4	123 13	1361.2	1/2 ⁻ , 3/2 ⁻
		4611.3	73 12	1333.47	3/2 ⁺
		4632.5	119 13	1311.73	1/2 ⁻ , 3/2 ⁻
		4647.5	53 11	1297.27	3/2 ⁻
		4676.3	53 10	1268.4	1/2 ⁺ , 3/2 ⁺
		4690.0	69 13	1254.83	1/2 ⁻ , 3/2 ⁻
		4709.4	68 9	1235.3	1/2 ⁻ , 3/2 ⁻
		4718.2	74 9	1226.35	1/2 ⁺ , 3/2 ⁺
		4724.6	83 9	1220.27	1/2 ⁻ , 3/2 ⁻
		4747.7	75 10	1196.9	1/2 ⁺ , 3/2 ⁺
		4755.7	51 9	1188.9	1/2 ⁻ , 3/2 ⁻
		4785.2	72 9	1159.94	3/2 ⁻
		4795.0	83 8	1149.38	1/2 ⁺ , 3/2 ⁺
		4804.6	87 9	1140.0	1/2 ⁻ , 3/2 ⁻
		4888.0	71 8	1056.02	(3/2) ⁻
		4948.2	124 14	996.4	1/2 ⁺ , 3/2 ⁺
		4950.3	131 14	994.627	1/2 ⁻ , 3/2 ⁻
		5004.8	66 8	939.66	3/2 ⁺
		5036.7	97 8	908.03	1/2 ⁻ , 3/2 ⁻
		5095.7	140 10	849.73	1/2 ⁻ , 3/2 ⁻
		5256.2	144 9	688.43	1/2 ⁻ , 3/2 ⁻ , 5/2 ⁻
		5265.0	84 7	679.90	3/2 ⁻
		5271.5	33 5	673.2	5/2
		5345.1	106 7	599.63	3/2 ⁻
		5387.6	160 10	557.36	3/2 ⁻
		5394.7	160 10	550.04	3/2 ⁻
		5412.0	24 5	531.55	5/2 ⁻
		5439.0	116 8	505.86	1/2 ⁻ , 3/2 ⁻
		5446.0	98 8	498.79	1/2 ⁻ , 3/2 ⁻
		5505.8	141 8	438.73	1/2 ⁻ , 3/2 ⁻
		5669.3	16 3	275.92	5/2 ⁻
		5709.8	16 3	233.58	5/2 ⁻
		5849.4	219 12	95.27	3/2 ⁻
		5875.0	15 3	69.54	5/2 ⁻
		5908.4	100 6	36.20	1/2 ⁻
		5944.4	93 6	0.0	3/2 ⁻

[†] Weighted average of γ -ray energies from ^{189}Re β^- decay, ^{189}Ir ε decay, Coulomb excitation, and (n, γ), E=thermal, when possible. Exceptions are noted. For levels 849 keV and higher γ energies are from (n, γ), E=thermal.

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Os})$ (continued)

- [‡] Weighted average of branching ratios from $^{189}\text{Re } \beta^-$ decay, $^{189}\text{Ir } \varepsilon$ decay, Coulomb excitation, and (n, γ), E=thermal.
- [§] From conversion electron measurements in $^{189}\text{Re } \beta^-$ decay ([1970Ma37](#)), $^{189}\text{Ir } \varepsilon$ decay ([1973Ho27](#)) and (n, γ) E=thermal.
- [&] Sign from $\gamma\gamma(\theta)$ in $^{189}\text{Ir } \varepsilon$ decay. Magnitude from weighted average of values from $^{189}\text{Re } \beta^-$ decay, $^{189}\text{Ir } \varepsilon$ decay and (n, γ) E=thermal, when values of comparable precision are available from more than one dataset. For 69.5 γ from a 69.5 level, $\delta(\text{E2/M1})$ from (γ,γ):Mossbauer is also included in the averaging.
- [@] Weighted average from $^{189}\text{Re } \beta^-$ decay and $^{189}\text{Ir } \varepsilon$ decay.
- [#] Weighted average from $^{189}\text{Re } \beta^-$ decay, $^{189}\text{Ir } \varepsilon$ decay, and Coulomb excitation.
- ^a Weighted average from $^{189}\text{Re } \beta^-$ decay, $^{189}\text{Ir } \varepsilon$ decay, and (n, γ), E=thermal.
- ^b Weighted average from $^{189}\text{Re } \beta^-$ decay and (n, γ), E=thermal.
- ^c Weighted average from $^{189}\text{Re } \beta^-$ decay, Coulomb excitation and (n, γ) E=thermal.
- ^d From $^{189}\text{Ir } \varepsilon$ decay.
- ^e From $^{189}\text{Re } \beta^-$ decay.
- ^f From (n, γ) E=thermal.
- ^g Weighted average from (n, γ) and Coulomb excitation.
- ^h Weighted average from $^{189}\text{Ir } \varepsilon$ decay and (n, γ) E=thermal, since the value for the strongest transition depopulating the 233.57 level in $^{189}\text{Re } \beta^-$ decay is not in agreement with that in $^{189}\text{Ir } \varepsilon$ decay or (n, γ). Note that I γ for the 197.36 γ is an unweighted average.
- ⁱ From weighted average of values in $^{189}\text{Re } \beta^-$ and (n, γ) E=thermal.
- ^j From unweighted average of values from $^{189}\text{Re } \beta^-$ and (n, γ) E=thermal, normalized to the intensity of the 429 γ , which is reported in both the experiments.
- ^k γ only from $^{189}\text{Re } \beta^-$ decay.
- ^l From BrIcc v2.3b (16-Dec-2014) [2008Ki07](#), "Frozen Orbitals" appr.
- ^m Multiply placed with undivided intensity.

Adopted Levels, Gammas

 $^{189}_{76}\text{Os}_{113}$

$^{189}\text{Re} \beta^-$ decay (24.3 h) [1973Ho27,1979Sa18](#)

Parent: ^{189}Re : $E=0.0$; $J^\pi=5/2^+$; $T_{1/2}=24.3$ h 4; $Q(\beta^-)=1008$ 8; $\% \beta^-$ decay=100

$^{189}\text{Re}-J^\pi, T_{1/2}$: From ^{189}Re Adopted Levels.

$^{189}\text{Re}-Q(\beta^-)$: From [2017Wa10](#). Other: $Q(\beta^-)=924$ 10 for measured mass excess(^{189}Re)= -38063 10 ([2013Sh30](#)) and mass excess(^{189}Os)= -38986.7 7 ([2017Wa10](#)).

[1973Ho27](#): measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin.

[1979Sa18](#): measured $E\gamma$, $I\gamma$, $I(\text{ce})$, $\gamma\gamma$ -coin, $\beta\gamma$ -coin.

Others: [1965BI06](#), [1963Cr06](#).

 ^{189}Os Levels

E(level)	J^π	$T_{1/2}$	E(level)	J^π	E(level)	J^π
0.0	$3/2^-$	5.81 h 10	219.399 25	$7/2^-$	498.78 5	$1/2^-, 3/2^-$
30.82 4	$9/2^-$		233.54 3	$5/2^-$	549.89 6	$3/2^-$
36.21 3	$1/2^-$		275.90 3	$5/2^-$	599.57 4	$3/2^-$
69.551 22	$5/2^-$		365.77 5	$7/2^-$	621.97 11	$(3/2^-, 5/2^-)$
95.269 10	$3/2^-$		427.93 4	$5/2^-, 7/2^-$	672.18 8	$5/2^-$
216.68 3	$7/2^-$		438.67 6	$1/2^-, 3/2^-$	716.82 5	$5/2^-$

 β^- radiations

E(decay)	E(level)	$I\beta^-$ [†]	Log ft	Comments
(291 8)	716.82	0.32 8	7.6 1	
(336 8)	672.18	0.045 13	8.7 1	
(386 8)	621.97	0.016 5	9.3 2	
(408 8)	599.57	1.3 2	7.5 1	
(458 8)	549.89	0.24 5	8.4 1	
(509 8)	498.78	0.32 6	8.4 1	
(580 8)	427.93	0.20 4	8.8 1	
(642 [‡] 8)	365.77	<0.03	>9.8	
(732 8)	275.90	5.6 10	7.6 1	E(decay): 725 30 from 1963Cr06 .
(774 8)	233.54	0.21 4	9.2 1	
(789 8)	219.399	7.4 13	7.7 1	E(decay): see comment on β to 217 level.
(791 8)	216.68	13 2	7.4 1	E(decay): $E\beta=800$ 20 (1965BI06), $E\beta=780$ 20 (1963Cr06) to the 217+219 levels.
(913 [‡] 8)	95.269	<5	>8.1	
(938 [‡] 8)	69.551	<4	>8.2	
(972 8)	36.21	2.6 16	8.9 3	
(977 8)	30.82	3.9 23	8.8 3	$I\beta^-$: from the intensity balance through the 30.8 level assuming no direct β feeding. Note that for $\log f^{1u}t > 8.5$, $I\beta^- < 6\%$.
(1008 8)	0.0	62 7	7.1 1	$I\beta^-$: other measured values: 60 20 (1965BI06), 58 25 (1963Cr06). E(decay): 1015 20 from 1965BI06 , other value: 1000 50 (1963Cr06).

[†] Absolute intensity per 100 decays.

[‡] Existence of this branch is questionable.

γ(¹⁸⁹Os)

Experimental conversion coefficients from [1963Cr06](#), [1965BI06](#), and [1979Sa18](#) assuming $\alpha(K)\exp(185.9\gamma)=0.49$.

I_γ normalization: From weighted average of I_γ(186γ+189γ)=0.025 10, I_γ(217γ+219γ)=0.11 3, and I_γ(245γ)=0.04 2 for γ-ray singles per ¹⁸⁹Re β⁻; and

I_γ(217γ+219γ)=0.09 3 from βγ coincidences ([1963Cr06](#)).

E_γ [†]	I_γ ^{†c}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [‡]	δ [‡]	α ^b	$I_{(\gamma+ce)}$ ^c	Comments
25.65 10	0.035 [@] 13	95.269	3/2 ⁻	69.551	5/2 ⁻	M1+E2	0.11 +5-3	1.3×10 ³ 13		E_γ : from ¹⁸⁹ Ir ε decay (1970Ma37). Included here for completeness.
30.82 5		30.82	9/2 ⁻	0.0	3/2 ⁻	M3+E4	0.04 2	3.12×10 ⁵ 10	227 39	M1/M3=0.32 5 (1963Cr06) E_γ : weighted average of values from β-decay (1962Cr02) by measurement of the conversion electrons. $I_{(\gamma+ce)}$: from ce(M3)(30.8γ)/ce(L3)(69.5γ)=550 60/465 10 measured in equilibrium. The indirect feeding into the 30.8 level is $I(\gamma+ce)=5.6$ 4. δ : <0.09 from M1/M3 in β ⁻ decay.
33.31 4	0.027 [@] 3	69.551	5/2 ⁻	36.21	1/2 ⁻	E2		723		I_γ : referred from ε decay, the ratio of 0.113:59 (in ε) or 0.027:14.0 (in β ⁻ decay). E_γ : From ¹⁸⁹ Ir ε decay (1970Ma37). Included here for completeness.
36.17 [§] 5	4.3 13	36.21	1/2 ⁻	0.0	3/2 ⁻	M1+E2	0.046 5	20.2 4		$\alpha(L1)\exp=13.8 +67-44$ (1973Ho27) δ : other: <0.8 from ce data in β ⁻ .
56.50 ^{&} 4	1.23 12	275.90	5/2 ⁻	219.399	7/2 ⁻	M1		5.17		
59.1 [§] 1	1.7 [#] 6	95.269	3/2 ⁻	36.21	1/2 ⁻	M1+E2	0.085 10	4.81 10		
59.1 1	≈0.5 [#]	275.90	5/2 ⁻	216.68	7/2 ⁻	(M1+E2)	≈0.9	≈22.0		L1/L2≈5 (1962Ha24) E_γ : note that this transition is not confirmed in (n,γ), γγ coin measurements.
69.54 4	14.0 5	69.551	5/2 ⁻	0.0	3/2 ⁻	M1+E2	+0.683 25	8.2 3		$\alpha(L2)\exp=2.55 +26-24$ (1973Ho27) L1:L2:L3:M1:M2:M3=367 20:470 20:465 10:52 20:108 15:115 15. δ : other: +0.62 +11-9 in β ⁻ decay.
^x 90.0 ^{&} 1	0.31 12									
95.27 1	0.55 6	95.269	3/2 ⁻	0.0	3/2 ⁻	M1+E2	+0.32 2	6.36		L12:L3=63 30:32 24 (1963Cr06); $\alpha(K)\exp=6.5$ 25 (1979Sa18) $\alpha(L1)\exp=0.82 +145-53$ (1973Ho27) δ : other: +0.3 +5-1 from β ⁻ decay.
101.1 ^{&} 5	0.06 ^a 3	599.57	3/2 ⁻	498.78	1/2 ⁻ , 3/2 ⁻	M1		5.45 11		$\alpha(K)\exp=5.7$ 18 (1979Sa18)

γ(¹⁸⁹Os) (continued)

E _γ [†]	I _γ ^{†c}	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. [‡]	δ [‡]	α ^b	Comments
117.27 ^{& 5}	0.18 6	716.82	5/2 ⁻	599.57	3/2 ⁻	M1		3.56	α(K)exp=4.5 13 (1979Sa18)
^x 118.60 ^{& 5}	0.12 6								
121.39 ^{& 5}	0.53 6	216.68	7/2 ⁻	95.269	3/2 ⁻	[E2]		2.02	
124.14 ^{& 5}	0.53 6	219.399	7/2 ⁻	95.269	3/2 ⁻	[E2]		1.85	
132.28 ^{& 5}	0.086 25	365.77	7/2 ⁻	233.54	5/2 ⁻	[M1]		2.53	
138.24 ^{& 5}	0.45 4	233.54	5/2 ⁻	95.269	3/2 ⁻	M1+E2	-0.8 2	1.84 13	
147.09 ^{& 5}	22.6 6	216.68	7/2 ⁻	69.551	5/2 ⁻	M1+E2	-1.0 +4-3	1.43 21	α(K)exp=0.94 20 (1973Ho27)
149.84 5	14.3 3	219.399	7/2 ⁻	69.551	5/2 ⁻	E2		0.917	α(K)exp=0.75 32 (1973Ho27)
152.03 ^{& 5}	0.47 4	427.93	5/2 ⁻ , 7/2 ⁻	275.90	5/2 ⁻				
160.93 ^{& 5}	0.51 6	599.57	3/2 ⁻	438.67	1/2 ⁻ , 3/2 ⁻	M1		1.451	α(K)exp=1.9 3 (1979Sa18)
164.02 ^{& 5}	0.38 4	233.54	5/2 ⁻	69.551	5/2 ⁻	M1+E2	<1.7	1.1 3	
166.95 ^{& 5}	0.14 3	716.82	5/2 ⁻	549.89	3/2 ⁻	E2(+M1)	>2	0.69 7	α(K)exp=0.35 14 (1979Sa18)
^x 175.1 ^{e 5}	0.5 2								E _γ : observed only by 1973Ho27. Inspection of the spectrum indicates that this transition may be the same as one identified at 180.7 in 1979Sa18.
180.67 ^{& 5}	0.35 4	275.90	5/2 ⁻	95.269	3/2 ⁻	M1+E2	>0.2	0.75 28	E _γ : see comment on 175.1γ.
185.89 5	34.3 7	216.68	7/2 ⁻	30.82	9/2 ⁻	M1+E2	<0.5	0.91 6	K:L1:L3=194 25:37 13:14 12 (1963Cr06,1965Bl06)
									α(K)exp=0.83 11 (1973Ho27)
188.53 9	9.06 18	219.399	7/2 ⁻	30.82	9/2 ⁻	M1+E2	1.5 +10-4	0.57 9	α(K)exp=1.0 3 (1973Ho27)
									δ: other: <0.6 from β ⁻ decay.
197.33 5	1.97 6	233.54	5/2 ⁻	36.21	1/2 ⁻	E2		0.347	
206.36 5	1.21 16	275.90	5/2 ⁻	69.551	5/2 ⁻	M1+E2	>1.9	0.34 5	
211.26 ^{& 5}	0.25 4	427.93	5/2 ⁻ , 7/2 ⁻	216.68	7/2 ⁻	E2(+M1)	>1	0.38 10	K/(L1+L2)≈2.4 (1965Bl06).
216.69 7	100.0 25	216.68	7/2 ⁻	0.0	3/2 ⁻	E2		0.254	α(L1)exp=0.047 25 (1973Ho27)
218 ^{& 1}	0.6 ^a 3	716.82	5/2 ⁻	498.78	1/2 ⁻ , 3/2 ⁻	[M1]		0.621 12	
219.40 5	82.5 18	219.399	7/2 ⁻	0.0	3/2 ⁻	E2		0.244	α(K)exp=0.127 33 (1973Ho27)
(222.84 8)	0.14 3	498.78	1/2 ⁻ , 3/2 ⁻	275.90	5/2 ⁻				E _γ , I _γ : from Adopted Gammas, based on (n,γ) E=thermal data. It is possible that an unplaced E _γ =223.80 5 with I _γ =0.37 12 corresponds to the γ ray seen in (n,γ), although energy deviation of ≈1 keV seems quite large in view of quoted low uncertainties.
^x 223.80 ^{& 5}	0.37 12								
233.6 1	1.29 6	233.54	5/2 ⁻	0.0	3/2 ⁻	M1+E2	1.7 +6-3	0.28 4	
239.7 ^{& 1}	0.25 6	275.90	5/2 ⁻	36.21	1/2 ⁻	[E2]		0.183	
245.09 ^{& 10}	64 8	275.90	5/2 ⁻	30.82	9/2 ⁻	E2		0.1704	α(K)exp=0.137 63 (1973Ho27)
256.2 ^{& 1}	0.12 3	621.97	(3/2 ⁻ , 5/2 ⁻)	365.77	7/2 ⁻	[M1+E2]		0.27 13	

$\gamma(^{189}\text{Os})$ (continued)

E_γ [†]	I_γ ^{†c}	E_i (level)	J_i^π	E_f	J_f^π	Mult. [‡]	δ [‡]	α ^b	Comments
265.2 & 1	0.33 5	498.78	1/2 ⁻ , 3/2 ⁻	233.54	5/2 ⁻				
270.6 & 1	0.172 18	365.77	7/2 ⁻	95.269	3/2 ⁻	[E2]		0.1249	
273.6 & 5	0.15 3	549.89	3/2 ⁻	275.90	5/2 ⁻	[M1]		0.332	E_γ : ¹⁹⁷³ Ho27 report a 275.8 8 which may be this transition, although the large mismatch makes this unlikely.
275.9 1	5.6 3	275.90	5/2 ⁻	0.0	3/2 ⁻	M1+E2	1.8 2	0.167 10	
296.0 & 1	0.49 12	365.77	7/2 ⁻	69.551	5/2 ⁻	[M1]		0.268	
306.6 & 5	0.12 ^a 6	672.18	5/2 ⁻	365.77	7/2 ⁻	[M1+E2]		0.165 80	
323.7 & 1	0.18 6	599.57	3/2 ⁻	275.90	5/2 ⁻	[M1]		0.211	
^x 332.9 & 1	0.31 12								
343.5 & 1	0.80 12	438.67	1/2 ⁻ , 3/2 ⁻	95.269	3/2 ⁻				
351.1 & 1	0.6 3	716.82	5/2 ⁻	365.77	7/2 ⁻	[M1]		0.1692	
366.1 1	0.74 6	599.57	3/2 ⁻	233.54	5/2 ⁻				
380.2 & 1	0.43 12	599.57	3/2 ⁻	219.399	7/2 ⁻	[E2]		0.0464	
382.8 & 1	0.61 12	599.57	3/2 ⁻	216.68	7/2 ⁻	[E2]		0.0456	
388.3 & 4	0.12 6	621.97	(3/2 ⁻ , 5/2 ⁻)	233.54	5/2 ⁻	[M1+E2]		0.087 43	
397.0 1	1.88 18	427.93	5/2 ⁻ , 7/2 ⁻	30.82	9/2 ⁻				
402.6 & 3	0.12 6	438.67	1/2 ⁻ , 3/2 ⁻	36.21	1/2 ⁻				
403.6 1	1.35 12	498.78	1/2 ⁻ , 3/2 ⁻	95.269	3/2 ⁻				
428.8 5	0.86 18	427.93	5/2 ⁻ , 7/2 ⁻	0.0	3/2 ⁻				
428.8 5	1.11 18	498.78	1/2 ⁻ , 3/2 ⁻	69.551	5/2 ⁻				
^x 432.0 & 8	0.19 12								
438.50 ^d & 10	0.38 ^d 12	672.18	5/2 ⁻	233.54	5/2 ⁻	[M1+E2]		0.063 31	
438.8 ^d & 8	0.055 ^d @ 20	438.67	1/2 ⁻ , 3/2 ⁻	0.0	3/2 ⁻				
441.2 5	0.12 6	716.82	5/2 ⁻	275.90	5/2 ⁻				I_γ : from ¹⁹⁷⁹ Sa18. Other value: 2.4 3 from ¹⁹⁷³ Ho27 is inconsistent with the spectrum of ¹⁹⁷⁹ Sa18 and presumably includes an impurity.
(452.91 10)	0.26 9	672.18	5/2 ⁻	219.399	7/2 ⁻	[M1+E2]		0.058 29	
454.7 2	2.8 5	549.89	3/2 ⁻	95.269	3/2 ⁻	M1		0.0851	α (K)exp=0.09 4 (¹⁹⁷⁹ Sa18)
462.6 & 1	2.58 6	498.78	1/2 ⁻ , 3/2 ⁻	36.21	1/2 ⁻	M1		0.0813	α (K)exp=0.08 3 (¹⁹⁷⁹ Sa18)
480.4 & 1	0.55 18	549.89	3/2 ⁻	69.551	5/2 ⁻	M1		0.0736	α (K)exp=0.055 25 (¹⁹⁷⁹ Sa18)
483.2 & 1	0.68 18	716.82	5/2 ⁻	233.54	5/2 ⁻	[M1]		0.0725	
497.3 1	2.3 6	716.82	5/2 ⁻	219.399	7/2 ⁻				
498.8 & 1	1.29 12	498.78	1/2 ⁻ , 3/2 ⁻	0.0	3/2 ⁻	M1		0.0667	α (K)exp=0.095 35 (¹⁹⁷⁹ Sa18) E_γ : ¹⁹⁷³ Ho27 report a γ of 496.8 keV 8 which may correspond to this transition, although a large mismatch makes this unlikely.
504.1 1	4.5 4	599.57	3/2 ⁻	95.269	3/2 ⁻	M1		0.0649	α (K)exp=0.050 18 (¹⁹⁷⁹ Sa18)

γ(¹⁸⁹Os) (continued)

<u>E_γ[†]</u>	<u>I_γ^{†c}</u>	<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.[‡]</u>	<u>α^b</u>	Comments
530.3 3	1.05 6	599.57	3/2 ⁻	69.551	5/2 ⁻	M1	0.0569	α(K)exp=0.058 40 (1979Sa18)
550.0& 3	0.68 6	549.89	3/2 ⁻	0.0	3/2 ⁻	M1	0.0517	α(K)exp=0.058 40 (1979Sa18)
563.4 1	9.0 5	599.57	3/2 ⁻	36.21	1/2 ⁻	M1	0.0486	α(K)exp=0.032 10 (1979Sa18)
599.6 1	5.1 4	599.57	3/2 ⁻	0.0	3/2 ⁻	M1	0.0413	α(K)exp=0.034 10 (1979Sa18)

[†] Weighted average of values from 1973Ho27 and 1979Sa18, unless otherwise noted.

[‡] From Adopted Gammas.

[§] Weighted average of 1963Cr06 (electron measurements) and 1979Sa18.

[&] From 1979Sa18.

[@] From adopted gammas branching ratios, I_γ(59.0γ+59.3γ)=2.0 5.

[#] From I_γ(59.0γ+59.3γ)=21 2 in ¹⁸⁹Ir ε decay, I_γ(59.0γ+59.3γ)=2.2 5 ¹⁸⁹Re β⁻ decay, and relative intensities deexciting the 95 and 276 levels.

^a Deduced from coincidence data in 1979Sa18.

^b From BrIcc v2.3b (16-Dec-2014) 2008Ki07, "Frozen Orbitals" appr.

^c For absolute intensity per 100 decays, multiply by 0.055 9.

^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.

$^{189}\text{Re} \beta^-$ decay (24.3 h) $^{1973}\text{Ho}27,1979\text{Sa}18$

Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiplied placed: intensity suitably divided

Legend

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

$^{189}\text{Re} \beta^-$ decay (24.3 h) $^{1973}\text{Ho}27,1979\text{Sa}18$

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
@ Multiply placed: intensity suitably divided

Legend

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

^{189}Os IT decay (5.81 h) [1960Ne04](#)

Parent: ^{189}Os : E=30.81 4; $J^\pi=9/2^-$; $T_{1/2}=5.81$ h 10; %IT decay=100

^{189}Os -%IT decay: %IT=100.

 ^{189}Os Levels

<u>E(level)</u>	<u>J^π[†]</u>	<u>$T_{1/2}$[†]</u>
0.0	$3/2^-$	
30.81 4	$9/2^-$	5.81 h 10

[†] From Adopted Levels.

 $\gamma(^{189}\text{Os})$

I(γ +ce) normalization: I(γ +ce)(30.8 γ)=100.

<u>E_γ[‡]</u>	<u>$E_i(\text{level})$</u>	<u>J^π_i</u>	<u>E_f</u>	<u>J^π_f</u>	<u>Mult.</u>	<u>δ</u>	<u>α[†]</u>	<u>$I_{(\gamma+ce)}$</u>	<u>Comments</u>
30.81 4	30.81	$9/2^-$	0.0	$3/2^-$	M3+E4	0.04 2	3.12×10^5 10	100	L1:L2:L3:M1:M3:N1:N3:O3=30:2:100:7:33:3:12:3. Mult.: deduced by the evaluators assuming 50% uncertainty for the conversion electron intensities. In 1960Ne04 , the authors state the uncertainties are large due to a steep efficiency curve, but do not give the values. δ : from Adopted Gammas. Other: >0.46 from subshell ratios in 1960Ne04 .

[†] From BrIcc v2.3b (16-Dec-2014) [2008Ki07](#), "Frozen Orbitals" appr.

[‡] Weighted average of values from β -decay ([1962Cr02](#)), IT decay ([1960Ne04](#)) and ^{189}Ir ε decay ([1970Ma37](#)).

^{189}Os IT decay (5.81 h) 1960Ne04

Decay Scheme

^{189}Ir ε decay (13.2 d) [1970Ma37,1969Gr10,1962Ha24](#)

Parent: ^{189}Ir : $E=0.0$; $J^\pi=3/2^+$; $T_{1/2}=13.2$ d I ; $Q(\varepsilon)=537$ $I3$; $\% \varepsilon + \% \beta^+$ decay=100

^{189}Ir - J^π , $T_{1/2}$: From ^{189}Ir Adopted Levels.

^{189}Ir - $Q(\varepsilon)$: From [2017Wa10](#).

[1970Ma37](#): measured $E\gamma$, $I\gamma$, $E(\text{ce})$, $I(\text{ce})$, $(\text{ce})\text{ce}(\text{t})$.

[1969Gr10](#): measured $E\gamma$, $I\gamma$, $(\text{x ray})(\text{ce})(\text{t})$.

Others: [1971Be71](#) ($\gamma\gamma(\theta)$), [1966Sy01](#), [1963Cr06](#).

 ^{189}Os Levels

E(level)	$J^\pi^\dagger$	$T_{1/2}^\ddagger$	Comments
0.0	$3/2^-$		
30.79 4	$9/2^-$	5.81 h 10	
36.173 25	$1/2^-$	0.53 ns 3	
69.512 24	$5/2^-$	1.62 ns 4	$T_{1/2}$: weighted average of delayed coincidence measurements 1.59 ns 8 (1970Ma37), 1.63 ns 4 (1969Gr10), and 1.7 ns 1 (1969An17) in ^{189}Ir ε decay.
95.23 3	$3/2^-$	0.23 ns 3	$T_{1/2}$: other: <0.3 ns (1969Gr10).
216.64 4	$7/2^-$		
219.36 5	$7/2^-$		
233.53 6	$5/2^-$		
275.84 5	$5/2^-$	0.17 ns 3	J^π : 3/2, 5/2 from $\gamma\gamma(\theta)$ in 1971Be71 .
438.64 6	$1/2^-, 3/2^-$		

† From Adopted Levels.

‡ From [1970Ma37](#), except where noted otherwise, based on $\gamma\gamma(\text{t})$.

 ε radiations

E(decay)	E(level)	$I\varepsilon^\dagger$	$\text{Log } ft$	$I(\varepsilon + \beta^+)^\dagger$
(98 13)	438.64	0.076 9	7.8 3	0.076 9
(261 13)	275.84	10.1 11	7.0 1	10.1 11
(303 13)	233.53	1.09 12	8.1 1	1.09 12
(442 13)	95.23	11.6 17	7.5 1	11.6 17
(467 13)	69.512	35 5	7.1 1	35 5
(501 13)	36.173	2.0 17	8.4 4	2.0 17
(537 13)	0.0	40 7	7.2 1	40 7

† Absolute intensity per 100 decays.

γ(¹⁸⁹Os)

γγ(θ) angular correlations (1971Be71). NaI(Tl), resolving time of 50 ns, chemical separation of sources. Assignments below were made by evaluators assuming Jπ(0)=3/2⁻, Jπ(69)=5/2⁻, and Jπ(95)=3/2⁻ from Adopted Levels. All parities are from Adopted Levels.

Experimental conversion coefficients from 1970Ma37, 1962Ha24. Other: 1966Sy01. Normalized assuming α(K)exp(245γ)=0.101.

Iγ normalization: From I(K x ray)=1270 70 (1970Ma37) and corrections for fluorescence yield, internal conversion, and I(K x ray)/Iε.

E_γ †	I_γ & a	E_i (level)	J_i^π	E_f	J_f^π	Mult. @	δ @	α #	$I_{(\gamma+ce)}$ a	Comments
25.65 ‡ 10	0.40 5	95.23	3/2 ⁻	69.512	5/2 ⁻	M1+E2	0.11 +5-3	84 34		α(L1)exp=55 18; L1:L2:L3=22 7:12.5 38:4.2 +70-42
30.80 ‡ 4		30.79	9/2 ⁻	0.0	3/2 ⁻	M3+E4	0.04 2	3.13×10 ⁵ 10	124 4	L1:L2:L3:M1:M3=17.4 10:1.8 30:90 6:6.0 15: 26 8. Others: 1962Ha24, 1966Sy01. I _(γ+ce) : from intensity balance assuming no direct ε feeding. Other: I(γ+ce)=153 10 from ce(L3)(30.8γ)/Iγ(69.5γ)=90 5/59 6.
33.31 ‡ 4	0.113 14	69.512	5/2 ⁻	36.173	1/2 ⁻	E2		723		L2/L3=0.94 8 (1970Ma37) Iγ: from ce(L3)(33γ)/Iγ(69.6)=33 2/59 6.
36.17 ‡ 4	11.2 10	36.173	1/2 ⁻	0.0	3/2 ⁻	M1+E2	0.046 5	20.2 4		α(L1)exp=12 1; L1:L2:L3=135 6:21.3 6:4.4 20 L1:L2:L3:M:N=360:50:13:140:45 (1962Ha24).
56.50 ‡ 4	2.5 5	275.84	5/2 ⁻	219.36	7/2 ⁻	M1		5.17		α(L1)exp=3.5 (1962Ha24); L1:L2:M=39:5:10 (56γ)(219γ)(θ): A ₂ =-0.075 25, A ₄ =+0.031 30; J(276)=3/2,7/2 and J(219)=5/2; sign of δ(56) not determined; or J(276)=5/2 and J(219)=7/2 ⁻ , δ(56)=-0.09 4.
59.05 ^b ‡ 2	20 ^b 2	95.23	3/2 ⁻	36.173	1/2 ⁻	M1+E2	0.085 10	4.83 10		α(L1)exp=3.6 4; L1:L2:L3:M1=75 8:8.8 10:3.0 30:25 19 δ: other: 0.06 4 from ε decay. Iγ: Iγ(59.0γ+59.3γ)=21 2. See comment on 59.3γ.
59.05 ^b 2	≈1 ^b	275.84	5/2 ⁻	216.64	7/2 ⁻	(M1+E2)	≈0.9	≈22.1		L1/L2≈5 (1962Ha24) L1 not completely resolved. Iγ: from ce(L3)(59.3γ)/Iγ(245γ)≈0.03. δ: estimated from intensity balance through 216.7 level assuming no feeding to that level. Eγ: note that this transition is not confirmed in (n,γ) γγ coin measurements.
69.52 ‡ 3	59 6	69.512	5/2 ⁻	0.0	3/2 ⁻	M1+E2	+0.683 25	8.3 3		α(L2)exp=3.0 3 L1:L2:L3=100 5:180 5:169 5 L1:L2:L3:M:N=490:830:780:570:180

$\gamma(^{189}\text{Os})$ (continued)

E_γ †	I_γ &a	E_i (level)	J_i^π	E_f	J_f^π	Mult. @	δ @	$\alpha^\#$	Comments
95.23‡ 4	6.4 5	95.23	3/2 ⁻	0.0	3/2 ⁻	M1+E2	+0.32 2	6.37	(1962Ha24). δ : other: 0.70 3 from ce data in ε decay. Sign from 1968Ku17, 1968Pe09, 1972Wa24. $\alpha(\text{K})_{\text{exp}}=5.3$ 6 δ : other: 0.29 4 from ε decay. K:L1:L2:L3=33.8 8:4.8 8:1.35 15:0.97 20.
^x 97.8 138.3 1	<0.01 1.14 13	233.53	5/2 ⁻	95.23	3/2 ⁻	M1+E2	-0.8 2	1.84 13	$\alpha(\text{K})_{\text{exp}}=0.22$; K:L12:L3=16 8:2.0 10:0.8 (138 γ)(95 γ)(θ): $A_2=-0.123$ 19, $A_4=-0.004$ 9; for $\delta(95)=+0.32$: J(233)=1/2, $\delta(138)=+0.19$; J(233)=3/2, $\delta(138)=-0.37$; J(233)=5/2, $\delta(138)=+0.043$. K,L12 from 1966Sy01 and L3 from 1962Ha24. From 1962Ha24 K=13, and L1,L2 were reported as a composite of 2 different lines and M was observed but not completely resolved. $\alpha(\text{K})_{\text{exp}}$ calculated using intensities from 1962Ha24.
147.1 1	1.80 14	216.64	7/2 ⁻	69.512	5/2 ⁻	M1+E2	-1.0 +4-3	1.43 21	$\alpha(\text{K})_{\text{exp}}=0.73$ (147 γ)(69 γ)(θ): $A_2=-0.184$ 34, $A_4=+0.049$ 19; J(217)=7/2. K:L1:L2:L3=130:~25:~20:~15. Intensities obtained by multiplying by a factor of 10 to compare with γ intensity from 1970Ma37.
149.9 1	1.41 10	219.36	7/2 ⁻	69.512	5/2 ⁻	E2		0.915	δ : other: -1.2 +34-4 from ε decay. $\alpha(\text{K})_{\text{exp}}=0.43$ (1962Ha24) K:L2:L3:M:N=6:3.5:2.4:2.2:6.3. L2 not completely resolved.
164.0 1	1.23 6	233.53	5/2 ⁻	69.512	5/2 ⁻	M1+E2	<1.7	1.1 3	K/L1=7.3; $\alpha(\text{K})_{\text{exp}}=1.1$ (1962Ha24)
180.5 1	0.49 5	275.84	5/2 ⁻	95.23	3/2 ⁻	M1+E2	>0.2	0.75 28	δ : deduced assuming 50% uncertainty for $\alpha(\text{K})_{\text{exp}}$ and K/L1. $\alpha(\text{K})_{\text{exp}}=0.86$ (1966Sy01) (180 γ)(95 γ)(θ): $A_2=-0.087$ 15, $A_4=+0.066$ 63; J(276)=1/2,3/2,5/2; $\delta(95\gamma)=+0.32$. K/L=3.0 15/2.8 10.
185.85 1	3.0 3	216.64	7/2 ⁻	30.79	9/2 ⁻	M1+E2	<0.5	0.91 6	$\alpha(\text{K})_{\text{exp}}$ is calculated using intensities from 1962Ha24 where K=3.2. K/L1 $\approx$ 7.2; $\alpha(\text{K})_{\text{exp}}=0.82$ (1962Ha24)
188.6 1	0.86 7	219.36	7/2 ⁻	30.79	9/2 ⁻	M1+E2	1.5 +10-4	0.57 9	δ : deduced assuming 50% uncertainty for $\alpha(\text{K})_{\text{exp}}$ and K/L1. K/L3 $\approx$ 10; $\alpha(\text{K})_{\text{exp}}=0.39$ (1962Ha24)
197.4 1	4.4 2	233.53	5/2 ⁻	36.173	1/2 ⁻	E2		0.347	δ : deduced assuming $\alpha(\text{K})_{\text{exp}}$ and K/L3 uncertainties are 50%. K/L2 $\approx$ 5.3; $\alpha(\text{K})_{\text{exp}}=0.40$ (1962Ha24) (197 γ)(36 γ)(θ): isotropic; J(36 level)=1/2. L2 was not completely resolved.
206.3 1	1.33 5	275.84	5/2 ⁻	69.512	5/2 ⁻	M1+E2	>1.9	0.35 5	K/L $\approx$ 2.6; $\alpha(\text{K})_{\text{exp}}=0.15$ (1962Ha24) (206 γ)(69 γ)(θ): $A_2=-0.100$ 20, $A_4=+0.058$ 38; J(276)=3/2,5/2,7/2. δ : deduced assuming uncertainties for $\alpha(\text{K})_{\text{exp}}$ and K/L to be 50% percent.

$\gamma(^{189}\text{Os})$ (continued)

E_γ [†]	I_γ ^{&a}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [@]	δ [@]	α [#]	Comments
216.7 <i>I</i>	8.6 <i>4</i>	216.64	7/2 ⁻	0.0	3/2 ⁻	E2		0.254	$\alpha(\text{K})\text{exp}=0.14$ (1962Ha24) K:L2:L3:M=15:4.5:3.1:2; L2 not completely resolved.
219.4 <i>I</i>	8.8 <i>4</i>	219.36	7/2 ⁻	0.0	3/2 ⁻	E2		0.244	$\alpha(\text{K})\text{exp}=0.93$ (1962Ha24) K:L1:L2:L3:M=13: $\approx$ 1.5:4.5:2.4:2.1. L2 was not completely resolved.
233.5 <i>I</i>	5.0 <i>2</i>	233.53	5/2 ⁻	0.0	3/2 ⁻	M1+E2	1.7 +6-3	0.28 <i>4</i>	K/L3=16; $\alpha(\text{K})\text{exp}=0.22$ (1962Ha24) δ : other: 1.4 +10-4 from ϵ decay.
245.1 <i>I</i>	100	275.84	5/2 ⁻	30.79	9/2 ⁻	E2		0.1703	$\alpha(\text{K})\text{exp}=0.59$ (1962Ha24) K:L1:L2:L3:M:N=100: $\approx$ 15:25:18:14:4. 1962Ha24 note this a recurring transition listed twice.
275.8 <i>I</i>	9.0 <i>5</i>	275.84	5/2 ⁻	0.0	3/2 ⁻	M1+E2	1.8 <i>2</i>	0.167 <i>10</i>	$\alpha(\text{K})\text{exp}=0.2$ K:L1:L2:L3:M1=14:2.7: $\approx$ 1.3:0.8:1. δ : deduced assuming 50 percent uncertainty for $\alpha(\text{K})\text{exp}$ and all ratios.
343.2 [§] <i>I</i> ^x 369.1	0.91 <i>6</i> <0.01	438.64	1/2 ⁻ , 3/2 ⁻	95.23	3/2 ⁻	[M1]		0.180	
402.8 [§] <i>I</i>	0.11 <i>I</i>	438.64	1/2 ⁻ , 3/2 ⁻	36.173	1/2 ⁻	[M1]		0.1173	E_γ : somewhat poor fit, level-energy difference=402.46.
438.5 [§] <i>I</i>	0.06 <i>2</i>	438.64	1/2 ⁻ , 3/2 ⁻	0.0	3/2 ⁻	[M1]		0.0936	

[†] Weighted average of 1963Cr06 and 1970Ma37 (from ¹⁸⁹Ir ϵ decay), and 1973Ho27 and 1979Sa18 (from ¹⁸⁹Re β^- decay), unless otherwise noted. Uncertainty of 0.1 keV assumed when not available.

[‡] From electron measurements in 1970Ma37.

[§] Only in 1970Ma37.

[&] From 1970Ma37.

[@] From Adopted Gammas.

[#] From BrIcc v2.3b (16-Dec-2014) 2008Ki07, "Frozen Orbitals" appr.

^a For absolute intensity per 100 decays, multiply by 0.060 δ .

^b Multiply placed with intensity suitably divided.

^x γ ray not placed in level scheme.

^{189}Ir ε decay (13.2 d) 1970Ma37,1969Gr10,1962Ha24**Decay Scheme**

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiply placed: intensity suitably divided

Legend

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

$^{188}\text{Os}(\text{n},\gamma)$ E=thermal [1992Br17](#)

[1992Br17](#): $^{188}\text{Os}(\text{n},\gamma)$, E=thermal; 94.5% enriched ^{188}Os target; LEPS for $E_\gamma \leq 200$ keV, Ge detectors for other γ rays. Measured E_γ , I_γ , $\gamma\gamma(\theta)$. For conversion electron measurements, 86.67% enriched ^{188}Os target was used, and electrons detected by high-resolution beta-ray spectrometer (BILL). Deduced multiplicity of γ -transitions.

[1976Be50](#): E=thermal; ^{188}Os target of 15 to 40 $\mu\text{g}/\text{cm}^2$ thickness; Measured with pair spectrometer. Resolution of Ge(Li) was 6-7 keV FWHM for high-energy γ rays. Low-energy γ ray (100-1500 keV) measured in anti-coincidence mode with 3-keV FWHM resolution. Under 100 keV measured with Si(Li) detector of 0.5 $^\circ$ to 0.9-keV FWHM resolution.

 ^{189}Os Levels

E(level) [†]	J^π [‡]	Comments
0.0	$3/2^-$	
30.83 4	$9/2^-$	
36.17 2	$1/2^-$	
69.53 3	$5/2^-$	
95.25 2	$3/2^-$	
97.36 4	$11/2^+$	
216.66 3	$5/2^-$	
219.38 3	$7/2^-$	
233.58 2	$5/2^-$	
275.96 4	$5/2^-$	
365.76 3	$7/2^-$	J^π : From Adopted Levels.
438.74 3	$1/2^-, 3/2^-$ #	
444.22 3	$7/2^+$	
498.79 3	$1/2^-, 3/2^-$	
505.85 3	$1/2^-, 3/2^-$	
531.54 3	$5/2^-$	
550.06 3	$3/2^-, (1/2^-)$	
557.35 3	$3/2^-$ #	
562.70 5		
599.64 3	$3/2^-$	J^π : 1/2 is less likely for γ to $7/2^-$.
622.02 3	$(3/2^-, 5/2^-)$	
672.13 4	$5/2^-$	
679.90 3	$3/2^-$	
688.42 3	$1/2^-, 3/2^-$	
717.00 4	$5/2^-, 7/2^-$	
792.10 5	$5/2^-$	
849.73 6	$1/2^-, 3/2^-$	
908.04 4	$1/2^-, 3/2^-$	
939.66 4	$3/2^+$ #	
990.15 4	$7/2^+$ #	
994.63 3	$1/2^-, 3/2^-$	
1036.74 7	$(5/2^-, 7/2^-, 9/2^-)$	
1056.01 4	$(3/2^-)$	J^π : γ to $7/2^-$ makes 1/2 less likely.
1076.96 7		
1149.39 7	$1/2^+, 3/2^+$	
1159.93 5	$3/2^-$	
1190.43 9	$1/2^-, 3/2^-$	
1206.74 7		
1220.27 7	$1/2^-, 3/2^-$	
1226.34 8	$1/2^+, 3/2^+$	
1254.84 6	$1/2^-, 3/2^-$	
1267.36 6	$3/2, 1/2^{(-)}$	J^π : assigned as $3/2^+$ in 1992Br17 , but not reported in ARC measurements, and with γ transitions to $1/2^-, 3/2^-$ and $5/2^-$, but no multipolarity is available, thus a more definite assignment can not be made.
1277.68 6		

Continued on next page (footnotes at end of table)

$^{188}\text{Os}(\text{n},\gamma)$ E=thermal [1992Br17](#) (continued) ^{189}Os Levels (continued)

E(level) [†]	J ^π [‡]	Comments
1297.26 5	3/2 ⁻	
1311.74 9	1/2 ⁻ , 3/2 ⁻	
1333.47 6	3/2 ⁺	
1370.08 6	1/2 ⁻ , 3/2 ⁻	
1376.72 4	3/2 ⁻	
1394.6 4	1/2 ⁻ , 3/2 ⁻	
1407.54 5	3/2 ⁻	
1451.37 8	1/2 ⁺ , 3/2 ⁺	
1472.26 6	1/2 ⁻ , 3/2 ⁻	
1700 ^a 4	(5/2 ⁻)	
1895 ^a 4	(1/2, 3/2) ^{&}	
1941 ^a 4	(1/2, 3/2) ^{&}	
(5921 ^a 1)	1/2 ⁺ [@]	E(level): S(n)=5920.8 4 (2017Wa10).

[†] Deduced from a least-square fit to E_γ values, except where noted.

[‡] From ARC measurements and/or from the assumption of M1, E1 or E2 transitions from the capture state ([1992Br17](#)), except as noted.

From $\gamma\gamma(\theta)$ ([1992Br17](#)).

@ s-wave capture ([1976Be50](#)).

& E1 transition from the s-wave captured state ([1976Be50](#)).

^a From [1976Be50](#).

$\gamma(^{189}\text{Os})$

Energies and relative intensities of x-ray (1976Be50)

E(x ray)	I(x ray)#	Assignment
61.55 7	587	Os K α_2 x-ray
63.03 7	796	Os K α_1 x-ray
71.3 1	297	Os K β_1 x-ray
73.2 4	193	Os K β_2 x-ray+Pb K α_2 x-ray

#Values are on the same scale as the γ -ray intensities

E_γ [†]	I_γ [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [‡]	δ [‡]	α^d	Comments
36.14 4	105 8	36.17	1/2 ⁻	0.0	3/2 ⁻				
59.08 3	146 11	95.25	3/2 ⁻	36.17	1/2 ⁻	M1+E2	0.087 10	4.83 10	
^x 64.96 7	13 3								
66.55 4	83 7	97.36	11/2 ⁺	30.83	9/2 ⁻	E1		0.227	$\delta^2(\text{M2/E1}) \leq 0.0003$ (1992Br17). Assigned as 505.8 to 438.8 transition in 1976Be50.
69.55 6	65 12	69.53	5/2 ⁻	0.0	3/2 ⁻	M1+E2	0.67 3	8.1 4	
95.27 4	42 3	95.25	3/2 ⁻	0.0	3/2 ⁻	M1+E2	0.33 2	6.35	
118.50 9	3.1 7	562.70		444.22	7/2 ⁺				
122.47 7	2.9 4	679.90	3/2 ⁻	557.35	3/2 ⁻				
124.25 6	3.3 4	219.38	7/2 ⁻	95.25	3/2 ⁻				
^x 129.42 4	19.1 16					M1+E2	0.84 19	2.23 14	
132.16 5	9.2 10	365.76	7/2 ⁻	233.58	5/2 ⁻				
138.30 4	20.1 15	233.58	5/2 ⁻	95.25	3/2 ⁻				
147.12 4	21.2 16	216.66	5/2 ⁻	69.53	5/2 ⁻				
149.86 4	17.1 14	219.38	7/2 ⁻	69.53	5/2 ⁻				
162.74 9	3.2 8	438.74	1/2 ⁻ , 3/2 ⁻	275.96	5/2 ⁻				Also assigned as 233.6 to 69.5 transition in 1976Be50.
164.03 4	17.8 14	233.58	5/2 ⁻	69.53	5/2 ⁻				
^x 175.62 7	9.6 14								
181.06 6	8.1 10	679.90	3/2 ⁻	498.79	1/2 ⁻ , 3/2 ⁻				
188.55 5	12.0 13	219.38	7/2 ⁻	30.83	9/2 ⁻				
197.37 4	62 ^b 6	233.58	5/2 ⁻	36.17	1/2 ⁻				
^x 198.29 4	40 3								
216.65 4	100 7	216.66	5/2 ⁻	0.0	3/2 ⁻	E2		0.254	$\delta^2(\text{E2/M1}) = 6.0 +47-19$ (1992Br17).
219.39 4	115 8	219.38	7/2 ⁻	0.0	3/2 ⁻	E2		0.244	$\delta^2(\text{E2/M1}) \geq 73$ (1992Br17). Also assigned as 438.8 to 219.4 transition in 1976Be50.
222.84 8	6.0 9	498.79	1/2 ⁻ , 3/2 ⁻	275.96	5/2 ⁻				
224.82 6	8.7 11	444.22	7/2 ⁺	219.38	7/2 ⁻				
227.60 5	17.4 18	444.22	7/2 ⁺	216.66	5/2 ⁻				
233.59 4	87 6	233.58	5/2 ⁻	0.0	3/2 ⁻	M1+E2	1.8 +6-3	0.27 3	
^x 235.14 6	9.5 12								
240.02 12	3.6 9	275.96	5/2 ⁻	36.17	1/2 ⁻				

$\gamma(^{189}\text{Os})$ (continued)

E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.‡	α^d	Comments
241.22 7	7.8 11	679.90	3/2 ⁻	438.74	1/2 ⁻ , 3/2 ⁻			
245.09 4	158 11	275.96	5/2 ⁻	30.83	9/2 ⁻	E2	0.1704	$\delta^2(E2/M1) \geq 15.6$ (1992Br17).
256.23 4	23.3 20	622.02	(3/2 ⁻ , 5/2 ⁻)	365.76	7/2 ⁻			
265.22 5	14.3 14	498.79	1/2 ⁻ , 3/2 ⁻	233.58	5/2 ⁻			
270.50 6	13.6 18	365.76	7/2 ⁻	95.25	3/2 ⁻			
272.4 @ 5		505.85	1/2 ⁻ , 3/2 ⁻	233.58	5/2 ⁻			
272.77 ^e 7	12.0 ^e 17	717.00	5/2 ⁻ , 7/2 ⁻	444.22	7/2 ⁺			
272.77 ^e 7	12.0 ^e 17	1267.36	3/2, 1/2 ⁽⁻⁾	994.63	1/2 ⁻ , 3/2 ⁻			
^x 274.97 9	11.2 18							
275.85 8	13.5 19	275.96	5/2 ⁻	0.0	3/2 ⁻			
277.79 15	4.6 15	994.63	1/2 ⁻ , 3/2 ⁻	717.00	5/2 ⁻ , 7/2 ⁻			
280.71 9	8.6 14	1220.27	1/2 ⁻ , 3/2 ⁻	939.66	3/2 ⁺			
281.74 16	4.1 13	557.35	3/2 ⁻	275.96	5/2 ⁻			
291.83 20	2.0 5	1451.37	1/2 ⁺ , 3/2 ⁺	1159.93	3/2 ⁻			
293.18 11	3.9 6	792.10	5/2	498.79	1/2 ⁻ , 3/2 ⁻			
296.21 4	38 3	365.76	7/2 ⁻	69.53	5/2 ⁻			
297.83 9	8.0 15	531.54	5/2 ⁻	233.58	5/2 ⁻			
^x 304.58 7	3.1 3							
306.37 5	5.0 4	672.13	5/2 ⁻	365.76	7/2 ⁻			
308.41 4	11.3 8	908.04	1/2 ⁻ , 3/2 ⁻	599.64	3/2 ⁻			
312.17 4	2.0 ^{bc} 7	531.54	5/2 ⁻	219.38	7/2 ⁻			
314.91 4	4.7 3	531.54	5/2 ⁻	216.66	5/2 ⁻			
316.52 6	2.4 2	550.06	3/2 ⁻ , (1/2 ⁻)	233.58	5/2 ⁻			
323.72 4	29 ^c 5	557.35	3/2 ⁻	233.58	5/2 ⁻			
^x 326.02 28	5.2 22							
^x 332.72 5	1.8 ^c 4							
339.91 8	9.8 12	939.66	3/2 ⁺	599.64	3/2 ⁻			
343.47 4	298 21	438.74	1/2 ⁻ , 3/2 ⁻	95.25	3/2 ⁻	M1	0.179	$\delta^2(E2/M1) \leq 0.08$ (1992Br17).
346.88 4	148 11	444.22	7/2 ⁺	97.36	11/2 ⁺	E2	0.0599	$\delta^2(E2/M1) \geq 7.8$ (1992Br17).
351.06 10	2.4 3	717.00	5/2 ⁻ , 7/2 ⁻	365.76	7/2 ⁻			
366.05 5	10.2 9	599.64	3/2 ⁻	233.58	5/2 ⁻			
372.55 6	12.4 11	994.63	1/2 ⁻ , 3/2 ⁻	622.02	(3/2 ⁻ , 5/2 ⁻)			
379.84 5	4.0 3	599.64	3/2 ⁻	219.38	7/2 ⁻			This γ ray is unplaced in 1992Br17. Evaluators assign this γ ray from 599 level, based on results from ^{189}Re β^- decay. Moreover, its coincidence with a 219 γ from 219 level in (n, γ) (1992Br17) supports this placement.
382.99 5	3.6 ^c 3	599.64	3/2 ⁻	216.66	5/2 ⁻			
388.40 4	24.2 17	622.02	(3/2 ⁻ , 5/2 ⁻)	233.58	5/2 ⁻			
^x 390.11 10	3.9 ^c 7							
394.99 5	12.8 10	994.63	1/2 ⁻ , 3/2 ⁻	599.64	3/2 ⁻			

γ(¹⁸⁹Os) (continued)

E_γ †	I_γ †	E_i (level)	J_i^π	E_f	J_f^π	Comments
^x 397.13 4	27 ^b 3					
402.58 7	22 3	438.74	1/2 ⁻ , 3/2 ⁻	36.17	1/2 ⁻	
403.51 5	54 4	498.79	1/2 ⁻ , 3/2 ⁻	95.25	3/2 ⁻	
405.5 ^s 5	14 ^s 11	622.02	(3/2 ⁻ , 5/2 ⁻)	216.66	5/2 ⁻	
410.60 4	163 12	505.85	1/2 ⁻ , 3/2 ⁻	95.25	3/2 ⁻	
413.14 ^e 21	6.9 ^e 22	444.22	7/2 ⁺	30.83	9/2 ⁻	
413.14 ^e 21	6.9 ^e 22	1407.54	3/2 ⁻	994.63	1/2 ⁻ , 3/2 ⁻	
^x 423.10 5	9.0 7					
427.44 4	20.0 14	990.15	7/2 ⁺	562.70		
429.22 4	30.1 21	498.79	1/2 ⁻ , 3/2 ⁻	69.53	5/2 ⁻	
^x 436.43 4	41 3					
438.58 4	38 3	672.13	5/2 ⁻	233.58	5/2 ⁻	
440.77 14	3.2 6	717.00	5/2 ⁻ , 7/2 ⁻	275.96	5/2 ⁻	
444.59 5	3.6 3	994.63	1/2 ⁻ , 3/2 ⁻	550.06	3/2 ⁻ , (1/2 ⁻)	
452.91 ^s 10	26 ^s 3	672.13	5/2 ⁻	219.38	7/2 ⁻	
454.76 4	163 12	550.06	3/2 ⁻ , (1/2 ⁻)	95.25	3/2 ⁻	
^x 455.82 ^{&} 20						
460.64 6	45 4	679.90	3/2 ⁻	219.38	7/2 ⁻	
^x 461.75 ^s 7	39 ^s 4					
462.48 ^{#f} 6	74.7 48	498.79	1/2 ⁻ , 3/2 ⁻	36.17	1/2 ⁻	E _γ : assigned from 557.4 level to 95.3 level in 1976Be50.
463.20 7	47 5	679.90	3/2 ⁻	216.66	5/2 ⁻	
465.28 18	7.4 20	562.70		97.36	11/2 ⁺	
469.65 4	233 17	505.85	1/2 ⁻ , 3/2 ⁻	36.17	1/2 ⁻	
^x 474.7 [@] 10						
480.53 5	69 6	550.06	3/2 ⁻ , (1/2 ⁻)	69.53	5/2 ⁻	
^x 483.11 7	33 3					
487.87 4	25.0 ^c 24	557.35	3/2 ⁻	69.53	5/2 ⁻	
^x 491.34 10	1.3 1					
495.49 4	67 5	939.66	3/2 ⁺	444.22	7/2 ⁺	
498.94 ^{#f} 4	59.2 5	498.79	1/2 ⁻ , 3/2 ⁻	0.0	3/2 ⁻	
504.44 7	32 4	599.64	3/2 ⁻	95.25	3/2 ⁻	
505.86 5	137 10	505.85	1/2 ⁻ , 3/2 ⁻	0.0	3/2 ⁻	
521.20 4	46 3	557.35	3/2 ⁻	36.17	1/2 ⁻	
^x 527.18 5	30.1 23					
531.43 7	25 3	531.54	5/2 ⁻	0.0	3/2 ⁻	
532.65 16	10.3 19	1472.26	1/2 ⁻ , 3/2 ⁻	939.66	3/2 ⁺	
^x 538.44 6	13.4 12					
545.86 6	17.4 15	990.15	7/2 ⁺	444.22	7/2 ⁺	
550.11 4	66 5	1056.01	(3/2) ⁻	505.85	1/2 ⁻ , 3/2 ⁻	

$\gamma(^{189}\text{Os})$ (continued)

E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
$^{x551.94\& 52}$						
$^{x554.46\& 14}$						
$^{x556.63 8}$	50 5					
$^{x557.91 4}$	$69^b 19$					Assigned as 557.4 to 0.0 transition in 1976Be50.
$563.67 4$	85 6	599.64	$3/2^-$	36.17	$1/2^-$	This γ ray is unplaced in 1992Br17. Evaluators assign this γ ray from 599 level, based on results from ^{189}Re β^- decay, where it is reported as the strongest transition from this level. Moreover, its coincidence with a 308 γ from a 908 level in (n, γ) (1992Br17) supports this placement.
$^{x563.67 4}$	85 6					E_γ : This is likely the strong γ transition from the 599.64 keV as observed in ^{189}Re β^- decay. The 308 keV γ also supports this.
$^{x564.80\& 9}$						
$572.83 10$	5.2 8	792.10	$5/2$	219.38	$7/2^-$	
$575.40 6$	12.1 10	792.10	$5/2$	216.66	$5/2^-$	
$^{x581.06\& 8}$						
$582.97 9$	5.4 5	1254.84	$1/2^-, 3/2^-$	672.13	$5/2^-$	
$584.60 6$	16.9 12	679.90	$3/2^-$	95.25	$3/2^-$	
$586.03 9$	6.5 6	622.02	$(3/2^-, 5/2^-)$	36.17	$1/2^-$	
$593.18 5$	59 4	688.42	$1/2^-, 3/2^-$	95.25	$3/2^-$	
$^{x594.9@ 8}$						
$599.62 5$	47 4	599.64	$3/2^-$	0.0	$3/2^-$	
$602.64 8$	16.0 17	1159.93	$3/2^-$	557.35	$3/2^-$	
$608.84 10$	5.0 6	1297.26	$3/2^-$	688.42	$1/2^-, 3/2^-$	
$610.75 17$	2.9 5	679.90	$3/2^-$	69.53	$5/2^-$	
$^{x615.20 8}$	2.2 2					
$^{x619.12 11}$	5.5 8					
$621.83 5$	33.8 25	717.00	$5/2^-, 7/2^-$	95.25	$3/2^-$	
$^{x633.13 5}$	$39^c 11$					
$^{x634.60 6}$	$37^c 8$					
$^{x637.11\& 10}$						
$^{x641.51\& 10}$						
$643.69 4$	23.6 17	679.90	$3/2^-$	36.17	$1/2^-$	
$647.41 10$	3.3 4	717.00	$5/2^-, 7/2^-$	69.53	$5/2^-$	
$652.16 5$	10.5 8	688.42	$1/2^-, 3/2^-$	36.17	$1/2^-$	
$659.24 6$	12.5 10	1451.37	$1/2^+, 3/2^+$	792.10	$5/2$	
$663.03 15$	4.2 6	1220.27	$1/2^-, 3/2^-$	557.35	$3/2^-$	
$^{x665.00 11}$	5.8 7					
$^{x672.26 5}$	38 3					
$^{x673.54\& 6}$						
$^{x676.26 25}$	4.1 10					

γ(¹⁸⁹Os) (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>
678.33 21	7.1 13	1277.68		599.64	3/2 ⁻
679.97 20	3.5 ^b 14	679.90	3/2 ⁻	0.0	3/2 ⁻
^x 681.69 ^{&} 11					
^x 686.88 11	9.9 11				
688.50 5	40 3	688.42	1/2 ⁻ ,3/2 ⁻	0.0	3/2 ⁻
690.30 8	13.3 12	1056.01	(3/2) ⁻	365.76	7/2 ⁻
^x 691.69 ^{&} 11					
696.66 10	6.6 8	1376.72	3/2 ⁻	679.90	3/2 ⁻
704.66 6	12.0 9	1254.84	1/2 ⁻ ,3/2 ⁻	550.06	3/2 ⁻ ,(1/2 ⁻)
710.62 6	10.4 9	1149.39	1/2 ⁺ ,3/2 ⁺	438.74	1/2 ⁻ ,3/2 ⁻
^x 715.42 ^{&} 22					
717.09 8	6.6 6	717.00	5/2 ⁻ ,7/2 ⁻	0.0	3/2 ⁻
719.11 9	6.7 6	1407.54	3/2 ⁻	688.42	1/2 ⁻ ,3/2 ⁻
721.16 8	6.3 6	1159.93	3/2 ⁻	438.74	1/2 ⁻ ,3/2 ⁻
727.55 7	7.0 6	1226.34	1/2 ⁺ ,3/2 ⁺	498.79	1/2 ⁻ ,3/2 ⁻
^x 730.8 3	1.1 5				
735.78 7	5.8 5	1267.36	3/2,1/2 ⁽⁻⁾	531.54	5/2 ⁻
739.99 7	6.5 6	1297.26	3/2 ⁻	557.35	3/2 ⁻
^x 742.60 22	1.6 5				
^x 748.38 9	8.1 8				
751.69 ^s 8	6.2 ^s 6	1190.43	1/2 ⁻ ,3/2 ⁻	438.74	1/2 ⁻ ,3/2 ⁻
^x 753.81 5	26.4 ^b 21				
756.05 12	2.7 ^b 9	1254.84	1/2 ⁻ ,3/2 ⁻	498.79	1/2 ⁻ ,3/2 ⁻
761.08 5	39 3	994.63	1/2 ⁻ ,3/2 ⁻	233.58	5/2 ⁻
770.81 ^e 7	2.9 ^e 2	990.15	7/2 ⁺	219.38	7/2 ⁻
770.81 ^e 7	2.9 ^e 2	1333.47	3/2 ⁺	562.70	
^x 779.48 8	4.1 3				
781.39 9	3.4 3	1220.27	1/2 ⁻ ,3/2 ⁻	438.74	1/2 ⁻ ,3/2 ⁻
791.38 16	2.6 4	1297.26	3/2 ⁻	505.85	1/2 ⁻ ,3/2 ⁻
795.0 ^e 4	0.9 ^e 3	1159.93	3/2 ⁻	365.76	7/2 ⁻
795.0 ^e 4	0.9 ^e 3	1394.6	1/2 ⁻ ,3/2 ⁻	599.64	3/2 ⁻
801.00 6	9.9 8	1076.96		275.96	5/2 ⁻
^x 806.63 24	0.8 2				
812.74 5	46 ^b 4	1370.08	1/2 ⁻ ,3/2 ⁻	557.35	3/2 ⁻
817.59 16	6.2 10	1036.74	(5/2 ⁻ ,7/2,9/2 ⁻)	219.38	7/2 ⁻
819.82 14	7.3 11	1036.74	(5/2 ⁻ ,7/2,9/2 ⁻)	216.66	5/2 ⁻
^x 823.82 11	4.1 4				
^x 825.81 18	3.6 5				
827.58 8	7.7 ^c 10	1333.47	3/2 ⁺	505.85	1/2 ⁻ ,3/2 ⁻

$\gamma(^{189}\text{Os})$ (continued)

E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π
838.92 5	11.8 9	1277.68		438.74	$1/2^-, 3/2^-$
^x 844.81 5	11.9 8				
^x 846.67 14	2.4 3				
849.73 6	6.0 5	849.73	$1/2^-, 3/2^-$	0.0	$3/2^-$
^x 858.36 9	2.5 2				
864.13 12	7.0 10	1370.08	$1/2^-, 3/2^-$	505.85	$1/2^-, 3/2^-$
^x 868.39 8	14.9 13				
871.02 6	27.0 21	1376.72	$3/2^-$	505.85	$1/2^-, 3/2^-$
873.00 8	18.2 16	1311.74	$1/2^-, 3/2^-$	438.74	$1/2^-, 3/2^-$
^x 876.20 & 21					
^x 877.70 7	10.8 ^b 15				
^x 879.93 & 9					
889.19 ^s 11	2.7 ^s 6	1333.47	$3/2^+$	444.22	$7/2^+$
892.92 14	3.1 4	990.15	$7/2^+$	97.36	$11/2^+$
^x 896.26 7	7.6 6				
899.39 5	22.1 16	994.63	$1/2^-, 3/2^-$	95.25	$3/2^-$
901.64 7	8.5 7	1407.54	$3/2^-$	505.85	$1/2^-, 3/2^-$
908.00 6	10.2 8	908.04	$1/2^-, 3/2^-$	0.0	$3/2^-$
914.90 5	14.7 10	1472.26	$1/2^-, 3/2^-$	557.35	$3/2^-$
920.72 12	2.7 3	990.15	$7/2^+$	69.53	$5/2^-$
930.78 7	12.7 10	1206.74		275.96	$5/2^-$
937.99 5	13.3 10	1376.72	$3/2^-$	438.74	$1/2^-, 3/2^-$
940.41 11	3.8 4	1159.93	$3/2^-$	219.38	$7/2^-$
943.24 16	2.2 3	1159.93	$3/2^-$	216.66	$5/2^-$
^x 951.46 5	7.8 ^{bc} 9				
959.37 12	3.0 3	990.15	$7/2^+$	30.83	$9/2^-$
^x 961.62 5	12.6 9				
967.17 9	1.9 ^c 3	1036.74	$(5/2^-, 7/2, 9/2^-)$	69.53	$5/2^-$
^x 970.36 19	0.9 1				
^x 974.37 20	0.8 1				
^x 980.68 10	2.4 2				
^x 994.24 6	8.2 6				
^x 996.78 7	5.9 4				
^x 1002.22 7	4.5 3				
1006.11 15	1.8 2	1036.74	$(5/2^-, 7/2, 9/2^-)$	30.83	$9/2^-$
^x 1009.42 10	6.2 6				
1010.96 7	6.4 ^b 14	1376.72	$3/2^-$	365.76	$7/2^-$
1019.98 8	9.9 8	1056.01	$(3/2)^-$	36.17	$1/2^-$
^x 1022.59 8	9.2 8				
^x 1027.25 19	3.0 5				
^x 1030.85 9	7.7 7				

$\gamma(^{189}\text{Os})$ (continued)

E_γ †	I_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π
$^{x1035.05}$ 22	2.6 5				
$^{x1045.36}$ 10	3.7 4				
$^{x1051.33}$ 14	2.6 3				
1054.36 18	2.7 4	1149.39	$1/2^+, 3/2^+$	95.25	$3/2^-$
$^{x1056.43}$ 12	4.2 ^c 5				
$^{x1061.72}$ 10	2.8 3				
1064.74 7	4.6 4	1159.93	$3/2^-$	95.25	$3/2^-$
$^{x1069.11}$ 8	3.7 3				
$^{x1075.62}$ 12	3.3 3				
1078.03 13	3.8 4	1297.26	$3/2^-$	219.38	$7/2^-$
1080.50 6	8.9 6	1297.26	$3/2^-$	216.66	$5/2^-$
$^{x1092.96}$ 14	3.4 5				
$^{x1096.41}$ 9	5.3 ^c 9				
$^{x1098.94}$ 12	11.3 12				
1100.71 12	18.2 15	1376.72	$3/2^-$	275.96	$5/2^-$
$^{x1102.47}$ 9	22.2 18				
$^{x1104.56}$ 12	7.3 7				
1109.38 13	3.7 5	1206.74		97.36	$11/2^+$
$^{x1115.17}$ 7	6.0 5				
$^{x1124.41}$ 8	5.0 4				
1131.52 7	5.1 ^b 8	1407.54	$3/2^-$	275.96	$5/2^-$
$^{x1140.02}$ 8	18.1 15				
$^{x1141.84}$ 7	20.0 ^b 18				
$^{x1152.14}$ 10	17.1 16				
1156.95 11	13.5 13	1376.72	$3/2^-$	219.38	$7/2^-$
$^{x1159.42}$ 16	13.2 15				
$^{x1161.42}$ 18	9.8 14				
1191.14 12	8.2 10	1407.54	$3/2^-$	216.66	$5/2^-$
$^{x1196.68}$ 10	14.3 13				
$^{x1199.41}$ 9	36 3				
3980@ 4	40 ^a 20	(5921)	$1/2^+$	1941	($1/2, 3/2$)
4026@ 4	37 ^a 19	(5921)	$1/2^+$	1895	($1/2, 3/2$)
4221@ 3	140 ^a 36	(5921)	$1/2^+$	1700	($5/2^-$)
4449@ 4	35 ^a 18	(5921)	$1/2^+$	1472.26	$1/2^-, 3/2^-$
4527@ 3	56 ^a 18	(5921)	$1/2^+$	1394.6	$1/2^-, 3/2^-$
4546@ 3	118 ^a 26	(5921)	$1/2^+$	1376.72	$3/2^-$
4928@ 3	116 ^a 42	(5921)	$1/2^+$	994.63	$1/2^-, 3/2^-$
5363@ 3	31 ^a 12	(5921)	$1/2^+$	557.35	$3/2^-$
5370@ 3	97 ^a 23	(5921)	$1/2^+$	550.06	$3/2^-, (1/2^-)$

$\gamma(^{189}\text{Os})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π
5415@ 2	311 ^a 65	(5921)	1/2 ⁺	505.85	1/2 ⁻ , 3/2 ⁻
5482@ 2	119 ^a 27	(5921)	1/2 ⁺	438.74	1/2 ⁻ , 3/2 ⁻
5884@ 2	136 ^a 29	(5921)	1/2 ⁺	36.17	1/2 ⁻

[†] From 1992Br17, except as noted.

[‡] From conversion electron data (1992Br17), but the conversion coefficients or subshell ratios are not provided in the paper.

[§] Energy and intensity from coincidence measurement.

[&] Energy from coincidence measurement.

@ E γ observed in 1976Be50 only.

Strong γ rays of 462.48 6 and 498.94 4 were unplaced in 1992Br17. However, comparison with data from ^{189}Re β^- suggests that both the γ rays can deexcite the 499 level which in 1992Br17 is depopulated by 429.22, 403.51 and 265.22 γ rays, whose energies and branching ratios match closely with those from ^{189}Re β^- decay data. A weak 222.84 γ assigned from this level by 1992Br17 is not reported in β^- decay, probably because of its low intensity. Evaluators assign here 462.48 and 498.94 gamma rays, tentatively, from the 499 level.

^a Partial cross sections in mb from 1976Be50.

^b Intensity from $^{189}\text{Os}(\text{n},\gamma)$ has been corrected.

^c Intensity from $^{187}\text{Os}(\text{n},\gamma)$ has been corrected.

^d From BrIcc v2.3b (16-Dec-2014) 2008Ki07, "Frozen Orbitals" appr.

^e Multiply placed with undivided intensity.

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

^x γ ray not placed in level scheme.

$^{188}\text{Os}(\text{n},\gamma) \text{E}=2,24 \text{ keV}$ [1992Br17](#)

[1992Br17](#): E=2 keV, 24 keV; FWHM $\approx$ 900 eV; 94.5% enriched ^{188}Os target; three crystal pair spectrometer; resolution $\approx$ 6 keV at 7.5 MeV; measured γ , $I\gamma$; $J\pi$ determined from $I\gamma(2 \text{ keV})/I\gamma(24 \text{ keV})$.

 ^{189}Os Levels

E(level) [†]	$J\pi^{\#}$	Comments
0.0	$1/2^{-}, 3/2^{-}$	
36.2 3	$1/2^{-}, 3/2^{-}$	
69.6 [‡] 5	$5/2$	
95.2 3	$1/2^{-}, 3/2^{-}$	
234.8 [‡] 6	$5/2$	
275.3 [‡] 5	$5/2$	
438.8 3	$1/2^{-}, 3/2^{-}$	
498.6 5	$1/2^{-}, 3/2^{-}$	
505.6 4	$1/2^{-}, 3/2^{-}$	
532.6 [‡] 6	$5/2$	
549.9 5	$1/2^{-}, 3/2^{-}$	
557.0 4	$1/2^{-}, 3/2^{-}$	
599.5 4	$1/2^{-}, 3/2^{-}$	
673.1 [‡] 5	$5/2$	
679.6 4	$1/2^{-}, 3/2^{-}$	
688.4 4	$1/2^{-}, 3/2^{-}$	
848.9 4	$1/2^{-}, 3/2^{-}$	
907.9 5	$1/2^{-}, 3/2^{-}$	
939.8 [‡] 4	$1/2^{+}, 3/2^{+}$	
994.3 4	$1/2^{-}, 3/2^{-}$	
996.4 [‡] 4	$1/2^{+}, 3/2^{+}$	
1056.6 4	$1/2^{-}, 3/2^{-}$	
1140.0 4	$1/2^{-}, 3/2^{-}$	
1149.6 6	$1/2^{+}, 3/2^{+}$	
1159.4 4	$1/2^{-}, 3/2^{-}$	
1188.9 4	$1/2^{-}, 3/2^{-}$	
1196.9 9	$1/2^{+}, 3/2^{+}$	
1220.0 4	$1/2^{-}, 3/2^{-}$	
1226.4 8	$1/2^{+}, 3/2^{+}$	
1235.2 3	$1/2^{-}, 3/2^{-}$	
1254.6 4	$1/2^{-}, 3/2^{-}$	
1268.3 [‡] 5	$1/2^{+}, 3/2^{+}$	
1297.1 4	$1/2^{-}, 3/2^{-}$	
1312.1 3	$1/2^{-}, 3/2^{-}$	
1333.3 7	$1/2^{+}, 3/2^{+}$	
1361.2 3	$1/2^{-}, 3/2^{-}$	
1369.7 5	$1/2^{-}, 3/2^{-}$	
1376.4 4	$1/2^{-}, 3/2^{-}$	
1393.8 6	$1/2^{-}, 3/2^{-}$	
1398.2 4	$1/2^{-}, 3/2^{-}$	
1407.6 4	$1/2^{-}, 3/2^{-}$	
1435.3 3	$1/2^{-}, 3/2^{-}$	
1450.9 9	$1/2^{+}, 3/2^{+}$	
1471.7 5	$1/2^{-}, 3/2^{-}$	
1475.0 9	$1/2^{-}, 3/2^{-}$	
5922.5 5	$1/2^{+}$	E(level): S(n)+E(n), where S(n)=5920.8 4 (2017Wa10), E(n)=2 keV. J^{π} : s-wave capture.
(5944.5 5)	$1/2, 3/2^{-}$	E(level): S(n)+E(n), where S(n)=5920.8 4 (2017Wa10), E(n)=24 keV. J^{π} : s- and p-wave capture.

Continued on next page (footnotes at end of table)

$^{188}\text{Os}(\text{n},\gamma)$ E=2,24 keV **1992Br17** (continued) ^{189}Os Levels (continued)

[†] From E=2, 24 keV, except as noted.

[‡] From E=24 keV spectrum.

Levels of low $J\pi$'s are populated from neutron capture resonances by E1 or M1 primary γ -transitions. At 2-keV resonances, s-wave neutron capture is dominant, so that the spins and parities of capture resonance states are $J\pi=1/2^+$. For 24-keV resonances p-wave neutron capture into $J\pi=1/2^-$ or $3/2^-$ levels is significant. States of $J\pi=1/2^-$ or $3/2^-$ are populated by E1 primary γ -transitions from the 2-keV resonances. States of $J\pi=1/2^+$ or $3/2^+$ are populated by M1 primary γ -transitions from the 2-keV resonances, or E1 primary γ -transitions from the 24-keV resonances. States of $1/2^+$, $3/2^+$ or $5/2^+$ are populated by E1 primary γ -transitions from the 24-keV resonances. See **1970Bo29** for a detailed description of this technique.

 $\gamma(^{189}\text{Os})$

E_γ	$I_\gamma/E_\gamma^{5^\dagger}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π
4447.5 [‡] 9	34 [‡] 14	5922.5	1/2 ⁺	1475.0	1/2 ⁻ , 3/2 ⁻
4450.8 [‡] 4	76 [‡] 14	5922.5	1/2 ⁺	1471.7	1/2 ⁻ , 3/2 ⁻
4469.6 [§]	259 ^{&} 41	(5944.5)	1/2, 3/2 ⁻	1475.0	1/2 ⁻ , 3/2 ⁻
4471.7 [‡] 9	15 [‡] 4	5922.5	1/2 ⁺	1450.9	1/2 ⁺ , 3/2 ⁺
4472.9 [§]	93 ^{&} 39	(5944.5)	1/2, 3/2 ⁻	1471.7	1/2 ⁻ , 3/2 ⁻
4487.3 [‡] 3	57 [‡] 7	5922.5	1/2 ⁺	1435.3	1/2 ⁻ , 3/2 ⁻
4493.7 [§]	84 ^{&} 12	(5944.5)	1/2, 3/2 ⁻	1450.9	1/2 ⁺ , 3/2 ⁺
4509.3 [§]	94 ^{&} 13	(5944.5)	1/2, 3/2 ⁻	1435.3	1/2 ⁻ , 3/2 ⁻
4515.0 [‡] 4	39 [‡] 6	5922.5	1/2 ⁺	1407.6	1/2 ⁻ , 3/2 ⁻
4524.4 [‡] 3	77 [‡] 9	5922.5	1/2 ⁺	1398.2	1/2 ⁻ , 3/2 ⁻
4528.7 [‡] 5	39 [‡] 8	5922.5	1/2 ⁺	1393.8	1/2 ⁻ , 3/2 ⁻
4537.0 [§]	36 ^{&} 12	(5944.5)	1/2, 3/2 ⁻	1407.6	1/2 ⁻ , 3/2 ⁻
4546.1 [‡] 4	63 [‡] 7	5922.5	1/2 ⁺	1376.4	1/2 ⁻ , 3/2 ⁻
4546.4 [§]	118 ^{&} 16	(5944.5)	1/2, 3/2 ⁻	1398.2	1/2 ⁻ , 3/2 ⁻
4550.8 [§]	122 ^{&} 17	(5944.5)	1/2, 3/2 ⁻	1393.8	1/2 ⁻ , 3/2 ⁻
4552.8 [‡] 4	38 [‡] 6	5922.5	1/2 ⁺	1369.7	1/2 ⁻ , 3/2 ⁻
4561.4 [‡] 3	73 [‡] 7	5922.5	1/2 ⁺	1361.2	1/2 ⁻ , 3/2 ⁻
4568.2 [§]	36 ^{&} 14	(5944.5)	1/2, 3/2 ⁻	1376.4	1/2 ⁻ , 3/2 ⁻
4574.9 [§]	70 ^{&} 13	(5944.5)	1/2, 3/2 ⁻	1369.7	1/2 ⁻ , 3/2 ⁻
4583.4 [§]	123 ^{&} 13	(5944.5)	1/2, 3/2 ⁻	1361.2	1/2 ⁻ , 3/2 ⁻
4589.3 [‡] 7	15 [‡] 4	5922.5	1/2 ⁺	1333.3	1/2 ⁺ , 3/2 ⁺
4610.4 [‡] 3	63 [‡] 6	5922.5	1/2 ⁺	1312.1	1/2 ⁻ , 3/2 ⁻
4611.3 [§]	73 ^{&} 12	(5944.5)	1/2, 3/2 ⁻	1333.3	1/2 ⁺ , 3/2 ⁺
4625.4 [‡] 3	49 [‡] 5	5922.5	1/2 ⁺	1297.1	1/2 ⁻ , 3/2 ⁻
4632.5 [§]	119 ^{&} 13	(5944.5)	1/2, 3/2 ⁻	1312.1	1/2 ⁻ , 3/2 ⁻
4647.5 [§]	53 ^{&} 11	(5944.5)	1/2, 3/2 ⁻	1297.1	1/2 ⁻ , 3/2 ⁻
4667.9 [‡] 4	23 [‡] 4	5922.5	1/2 ⁺	1254.6	1/2 ⁻ , 3/2 ⁻
4676.3 [§]	53 ^{&} 10	(5944.5)	1/2, 3/2 ⁻	1268.3	1/2 ⁺ , 3/2 ⁺
4687.4 [‡] 2	77 [‡] 6	5922.5	1/2 ⁺	1235.2	1/2 ⁻ , 3/2 ⁻
4690.0 [§]	69 ^{&#} 13	(5944.5)	1/2, 3/2 ⁻	1254.6	1/2 ⁻ , 3/2 ⁻
4696.2 [‡] 8	14 [‡] 3	5922.5	1/2 ⁺	1226.4	1/2 ⁺ , 3/2 ⁺
4702.8 [‡] 4	31 [‡] 5	5922.5	1/2 ⁺	1220.0	1/2 ⁻ , 3/2 ⁻
4709.4 [§]	68 ^{&} 9	(5944.5)	1/2, 3/2 ⁻	1235.2	1/2 ⁻ , 3/2 ⁻
4718.2 [§]	74 ^{&} 9	(5944.5)	1/2, 3/2 ⁻	1226.4	1/2 ⁺ , 3/2 ⁺

Continued on next page (footnotes at end of table)

$^{188}\text{Os}(n,\gamma) E=2,24 \text{ keV}$ 1992Br17 (continued) $\gamma(^{189}\text{Os})$ (continued)

E_γ	$I_\gamma/E_\gamma^{5^\dagger}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π
4724.6 $\frac{8}{2}$	83 $\frac{8}{2}$ 9	(5944.5)	1/2,3/2 $^-$	1220.0	1/2 $^-$,3/2 $^-$
4725.7 $\frac{7}{2}$ 9	10 $\frac{7}{2}$ 3	5922.5	1/2 $^+$	1196.9	1/2 $^+$,3/2 $^+$
4733.7 $\frac{7}{2}$ 4	35 $\frac{7}{2}$ 4	5922.5	1/2 $^+$	1188.9	1/2 $^-$,3/2 $^-$
4747.7 $\frac{8}{2}$	75 $\frac{8}{2}$ 10	(5944.5)	1/2,3/2 $^-$	1196.9	1/2 $^+$,3/2 $^+$
4755.7 $\frac{8}{2}$	51 $\frac{8}{2}$ 9	(5944.5)	1/2,3/2 $^-$	1188.9	1/2 $^-$,3/2 $^-$
4763.1 $\frac{7}{2}$ 3	36 $\frac{7}{2}$ 5	5922.5	1/2 $^+$	1159.4	1/2 $^-$,3/2 $^-$
4772.9 $\frac{7}{2}$ 5	10 $\frac{7}{2}$ 3	5922.5	1/2 $^+$	1149.6	1/2 $^+$,3/2 $^+$
4782.5 $\frac{7}{2}$ 3	55 $\frac{7}{2}$ 5	5922.5	1/2 $^+$	1140.0	1/2 $^-$,3/2 $^-$
4785.2 $\frac{8}{2}$	72 $\frac{8}{2}$ 9	(5944.5)	1/2,3/2 $^-$	1159.4	1/2 $^-$,3/2 $^-$
4795.0 $\frac{8}{2}$	83 $\frac{8}{2}$ 8	(5944.5)	1/2,3/2 $^-$	1149.6	1/2 $^+$,3/2 $^+$
4804.6 $\frac{8}{2}$	87 $\frac{8}{2}$ 9	(5944.5)	1/2,3/2 $^-$	1140.0	1/2 $^-$,3/2 $^-$
4865.9 $\frac{7}{2}$ 3	35 $\frac{7}{2}$ 5	5922.5	1/2 $^+$	1056.6	1/2 $^-$,3/2 $^-$
4888.0 $\frac{8}{2}$	71 $\frac{8}{2}$ 8	(5944.5)	1/2,3/2 $^-$	1056.6	1/2 $^-$,3/2 $^-$
4928.2 $\frac{7}{2}$ 3	73 $\frac{7}{2}$ 5	5922.5	1/2 $^+$	994.3	1/2 $^-$,3/2 $^-$
4948.2 $\frac{8}{2}$	124 $\frac{8}{2}$ 14	(5944.5)	1/2,3/2 $^-$	996.4	1/2 $^+$,3/2 $^+$
4950.3 $\frac{8}{2}$	131 $\frac{8}{2}$ 14	(5944.5)	1/2,3/2 $^-$	994.3	1/2 $^-$,3/2 $^-$
5004.8 $\frac{8}{2}$	66 $\frac{8}{2}$ 8	(5944.5)	1/2,3/2 $^-$	939.8	1/2 $^+$,3/2 $^+$
5014.6 $\frac{7}{2}$ 3	42 $\frac{7}{2}$ 4	5922.5	1/2 $^+$	907.9	1/2 $^-$,3/2 $^-$
5036.7 $\frac{8}{2}$	97 $\frac{8}{2}$ 8	(5944.5)	1/2,3/2 $^-$	907.9	1/2 $^-$,3/2 $^-$
5073.6 $\frac{7}{2}$ 3	74 $\frac{7}{2}$ 5	5922.5	1/2 $^+$	848.9	1/2 $^-$,3/2 $^-$
5095.7 $\frac{8}{2}$	140 $\frac{8}{2}$ 10	(5944.5)	1/2,3/2 $^-$	848.9	1/2 $^-$,3/2 $^-$
5234.1 $\frac{7}{2}$ 3	52 $\frac{7}{2}$ 4	5922.5	1/2 $^+$	688.4	1/2 $^-$,3/2 $^-$
5243.0 $\frac{7}{2}$ 3	56 $\frac{7}{2}$ 4	5922.5	1/2 $^+$	679.6	1/2 $^-$,3/2 $^-$
5256.2 $\frac{8}{2}$	144 $\frac{8}{2}$ 9	(5944.5)	1/2,3/2 $^-$	688.4	1/2 $^-$,3/2 $^-$
5265.0 $\frac{8}{2}$	84 $\frac{8}{2}$ 7	(5944.5)	1/2,3/2 $^-$	679.6	1/2 $^-$,3/2 $^-$
5271.5 $\frac{8}{2}$	33 $\frac{8}{2}$ 5	(5944.5)	1/2,3/2 $^-$	673.1	5/2
5323.0 $\frac{7}{2}$ 3	63 $\frac{7}{2}$ 4	5922.5	1/2 $^+$	599.5	1/2 $^-$,3/2 $^-$
5345.1 $\frac{8}{2}$	106 $\frac{8}{2}$ 7	(5944.5)	1/2,3/2 $^-$	599.5	1/2 $^-$,3/2 $^-$
5365.6 $\frac{7}{2}$ 3	86 $\frac{7}{2}$ 6	5922.5	1/2 $^+$	557.0	1/2 $^-$,3/2 $^-$
5372.7 $\frac{7}{2}$ 3	43 $\frac{7}{2}$ 4	5922.5	1/2 $^+$	549.9	1/2 $^-$,3/2 $^-$
5387.6 $\frac{8}{2}$	160 $\frac{8}{2}$ 10	(5944.5)	1/2,3/2 $^-$	557.0	1/2 $^-$,3/2 $^-$
5394.7 $\frac{8}{2}$	160 $\frac{8}{2}$ 10	(5944.5)	1/2,3/2 $^-$	549.9	1/2 $^-$,3/2 $^-$
5412.0 $\frac{8}{2}$	24 $\frac{8}{2}$ 5	(5944.5)	1/2,3/2 $^-$	532.6	5/2
5416.9 $\frac{7}{2}$ 3	88 $\frac{7}{2}$ 5	5922.5	1/2 $^+$	505.6	1/2 $^-$,3/2 $^-$
5423.9 $\frac{7}{2}$ 3	29 $\frac{7}{2}$ 3	5922.5	1/2 $^+$	498.6	1/2 $^-$,3/2 $^-$
5439.0 $\frac{8}{2}$	116 $\frac{8}{2}$ 8	(5944.5)	1/2,3/2 $^-$	505.6	1/2 $^-$,3/2 $^-$
5446.0 $\frac{8}{2}$	98 $\frac{8}{2}$ 8	(5944.5)	1/2,3/2 $^-$	498.6	1/2 $^-$,3/2 $^-$
5483.7 $\frac{7}{2}$ 3	53 $\frac{7}{2}$ 4	5922.5	1/2 $^+$	438.8	1/2 $^-$,3/2 $^-$
5505.8 $\frac{8}{2}$	141 $\frac{8}{2}$ 8	(5944.5)	1/2,3/2 $^-$	438.8	1/2 $^-$,3/2 $^-$
5669.3 $\frac{8}{2}$	16 $\frac{8}{2}$ 3	(5944.5)	1/2,3/2 $^-$	275.3	5/2
5709.8 $\frac{8}{2}$	16 $\frac{8}{2}$ 3	(5944.5)	1/2,3/2 $^-$	234.8	5/2
5827.4 $\frac{7}{2}$ 2	152 $\frac{7}{2}$ 8	5922.5	1/2 $^+$	95.2	1/2 $^-$,3/2 $^-$
5849.4 $\frac{8}{2}$	219 $\frac{8}{2}$ 12	(5944.5)	1/2,3/2 $^-$	95.2	1/2 $^-$,3/2 $^-$
5875.0 $\frac{8}{2}$	15 $\frac{8}{2}$ 3	(5944.5)	1/2,3/2 $^-$	69.6	5/2
5886.4 $\frac{7}{2}$ 2	100 $\frac{7}{2}$ 5	5922.5	1/2 $^+$	36.2	1/2 $^-$,3/2 $^-$

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$^{188}\text{Os}(\text{n},\gamma)$ E=2,24 keV **1992Br17** (continued) $\gamma(^{189}\text{Os})$ (continued)

E_γ	I_γ/E_γ^5 [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π
5908.4 [§]	100 ^{&} 6	(5944.5)	1/2,3/2 ⁻	36.2	1/2 ⁻ ,3/2 ⁻
5922.3 [‡] 3	34 ^{‡@} 3	5922.5	1/2 ⁺	0.0	1/2 ⁻ ,3/2 ⁻
5944.4 [§]	93 ^{&} 6	(5944.5)	1/2,3/2 ⁻	0.0	1/2 ⁻ ,3/2 ⁻

[†] Reduced average γ -ray intensity.[‡] From 2-keV neutrons.[§] From 24-keV neutrons, deduced by evaluators from S(n)=5920.8 4 (**2017Wa10**).[&] From 24-keV neutrons.[@] Contribution from Fe has been corrected.[#] Contribution from Al has been corrected.

$^{188}\text{Os}(\text{n},\gamma)\text{:resonances}$ 2010Fu04

See also companion papers: [2010Mo15](#), [2010Mo16](#) and [2010Co02](#).

Neutrons from 1 eV to 1 MeV produced in bombardment of 20 GeV/c protons on a massive Pb target. Measured neutron spectra by time-of-flight method. Resonance parameters extracted using SAMMY code for a full R-matrix fit of the capture yields. Average resonance parameters were derived by a statistical analysis to provide a comprehensive experimental basis for modeling stellar neutron capture rates of these isotopes in terms of the Hauser-Feshbach statistical model. Discussed consequences for s-process component of the ^{187}Os abundance and evaluation of time duration of galactic nucleosynthesis via Re/Os cosmochronometer.

Experiment conducted at n.TOF facility at CERN.

See also [2006MuZX](#) evaluation of neutron resonances.

Values with no uncertainty listed in the data field or comments were kept fixed during the fitting procedures.

 ^{189}Os Levels

E(level) [†]	$J^{\pi\ddagger}$	L	$g\Gamma_{\gamma}\Gamma_n/\Gamma$ (meV) [#]	Comments
S(n)+0.03868	1/2 ⁺	0	22.1	
S(n)+0.07874	1/2 ⁺	0	32.5 4	E(n)=0.078739 2. Γ_{γ} =35.6 meV 5, $g\Gamma_n$ =377.9 meV.
S(n)+0.15007	1/2 ⁺	0	30.3 3	E(n)=0.150066 3. Γ_{γ} =37.4 meV 2, $g\Gamma_n$ =159.8 meV 10.
S(n)+0.19192	1/2 ⁺	0	27.7 3	E(n)=0.191922 3. Γ_{γ} =36.1 meV 3, $g\Gamma_n$ =120.0 meV 10.
S(n)+0.25421	1/2 ⁺	0	31.1 4	E(n)=0.254208 3.
S(n)+0.28244	1/2 ⁺	0	9.95 12	E(n)=0.282441 3. Γ_{γ} =52.0 meV, $g\Gamma_n$ =12.3 meV 1.
S(n)+0.31723	1/2 ⁺	0	54.3 4	Γ_{γ} =57.5 meV 5, $g\Gamma_n$ =960.8 meV.
S(n)+0.38837 2	1/2 ⁺	0	41.5 5	Γ_{γ} =43.8 meV 5, $g\Gamma_n$ =812.2 meV.
S(n)+0.47892 2	1/2 ⁺	0	40.0 5	Γ_{γ} =43.5 meV 5, $g\Gamma_n$ =490.1 meV.
S(n)+0.52877	1/2 ⁺	0	37.7 8	E(n)=0.528774 5.
S(n)+0.53697 1	1/2 ⁺	0	36.8 8	
S(n)+0.62055 1	1/2 ⁺	0	40.6 9	
S(n)+0.64955 1	1/2 ⁺	0	37.1 12	
S(n)+0.70599 1	1/2 ⁺	0	38.0 13	
S(n)+0.74570 2	1/2 ⁺	0	42.1 6	Γ_{γ} =48.6 meV 7, $g\Gamma_n$ =313 meV.
S(n)+0.78151 5	1/2 ⁺	0	42.9 9	Γ_{γ} =44.6 meV 10, $g\Gamma_n$ =1.125 eV.
S(n)+0.81995 1	1/2 ⁺	0	28.7 15	
S(n)+0.84441 6	1/2 ⁺	0	43.5 9	Γ_{γ} =44.6 meV 10, $g\Gamma_n$ =1.880 eV.
S(n)+0.86311 1	1/2 ⁺	0	39.5 8	Γ_{γ} =44.0 meV 8, $g\Gamma_n$ =380 meV.
S(n)+0.90027 2	1/2 ⁺	0	2.8 5	Γ_{γ} =52.0 meV, $g\Gamma_n$ =2.9 meV 5.
S(n)+0.98003 1	1/2 ⁺	0	34.9 7	Γ_{γ} =46.5 meV 9, $g\Gamma_n$ =140.0 meV.
S(n)+1.00152	1/2 ⁺	0	22.9	E(n)=1.001523 3. Γ_{γ} =52.0 meV, $g\Gamma_n$ =41.0 meV.
S(n)+1.04215 2	1/2 ⁺	0	44.0 7	Γ_{γ} =48.0 meV 7, $g\Gamma_n$ =529 meV.
S(n)+1.07976 1	1/2 ⁺	0	14.5 4	Γ_{γ} =52.0 meV, $g\Gamma_n$ =20.2 meV 5.
S(n)+1.10778 4	1/2 ⁺	0	49.9 8	Γ_{γ} =51.9 meV 8, $g\Gamma_n$ =1.280 eV.
S(n)+1.18274 1	1/2 ⁺	0	23.5	Γ_{γ} =52.0 meV, $g\Gamma_n$ =43.0 meV.
S(n)+1.21667 1	1/2 ⁺	0	47.5 30	
S(n)+1.29322 2	1/2 ⁺	0	32.4	Γ_{γ} =52.0 meV, $g\Gamma_n$ =86.0 meV.
S(n)+1.31653 3	1/2 ⁺	0	49.3 9	Γ_{γ} =52.1 meV 10, $g\Gamma_n$ =936 meV.
S(n)+1.34789 2	1/2 ⁺	0	41.0 14	Γ_{γ} =54.1 meV 18, $g\Gamma_n$ =170.0 meV.
S(n)+1.41327 5	1/2 ⁺	0	57.0 11	Γ_{γ} =59.5 meV 12, $g\Gamma_n$ =1.330 eV.
S(n)+1.48560 2	1/2 ⁺	0	38 6	
S(n)+1.52035 2	1/2 ⁺	0	34.5 10	Γ_{γ} =48.1 meV 13, $g\Gamma_n$ =122.0 meV.
S(n)+1.54493	1/2 ⁺	0	26.0	E(n)=1.544931 4. Γ_{γ} =52.0 meV, $g\Gamma_n$ =52.0 meV.
S(n)+1.59814 7	1/2 ⁺	0	49.9 11	Γ_{γ} =51.4 meV 11, $g\Gamma_n$ =1.730 eV.
S(n)+1.62526 1	1/2 ⁺	0	2.9 6	Γ_{γ} =52.0 meV, $g\Gamma_n$ =3.1 meV 6.
S(n)+1.67373 4	1/2 ⁺	0	44.1 9	Γ_{γ} =47.1 meV 10, $g\Gamma_n$ =678.1 meV.

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$^{188}\text{Os}(n,\gamma)$:resonances 2010Fu04 (continued) ^{189}Os Levels (continued)

E(level) [†]	J ^π [‡]	L	$g\Gamma_\gamma\Gamma_n/\Gamma$ (meV) [#]	Comments
S(n)+1.71994 2	1/2 ⁺	0	36.7 10	$\Gamma_\gamma=54.3$ meV 14, $g\Gamma_n=113.0$ meV.
S(n)+1.76443 1	1/2 ⁺	0	4.6 9	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=5.0$ meV 10.
S(n)+1.77950 3	1/2 ⁺	0	28.49	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=63.0$ meV.
S(n)+1.80343 2	1/2 ⁺	0	44.9 11	$\Gamma_\gamma=57.8$ meV 14, $g\Gamma_n=202.0$ meV.
S(n)+1.87687 6	1/2 ⁺	0	43.3 11	$\Gamma_\gamma=45.2$ meV 11, $g\Gamma_n=1.020$ meV.
S(n)+1.90575	1/2 ⁺	0	23.2	E(n)=1.905748 3. $\Gamma_\gamma=52.0$ meV, $g\Gamma_n=42.0$ meV.
S(n)+1.96762 1	1/2 ⁺	0	35.6	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=113.0$ meV.
S(n)+1.97165 3	1/2 ⁺	0	41.0 11	$\Gamma_\gamma=47.3$ meV 13, $g\Gamma_n=303.9$ meV.
S(n)+2.01789 3	1/2 ⁺	0	32.2 24	
S(n)+2.04907 9	1/2 ⁺	0	5.3 4	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=5.9$ meV 4.
S(n)+2.09224 3	1/2 ⁺	0	44.0 12	$\Gamma_\gamma=55.0$ meV 15, $g\Gamma_n=219.0$ meV.
S(n)+2.13805 3	1/2 ⁺	0	47.6 14	$\Gamma_\gamma=56.3$ meV 16, $g\Gamma_n=306.0$ meV.
S(n)+2.17942 2	1/2 ⁺	0	15 3	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=21$ meV 4.
S(n)+2.19159 5	1/2 ⁺	0	44.2 15	$\Gamma_\gamma=50.6$ meV 17, $g\Gamma_n=351.1$ meV.
S(n)+2.25779 1	1/2 ⁺	0	4.6 9	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=5.0$ meV 10.
S(n)+2.27438 5	1/2 ⁺	0	44.1 12	$\Gamma_\gamma=48.0$ meV 13, $g\Gamma_n=540.9$ meV.
S(n)+2.29898 8	1/2 ⁺	0	48.3 14	$\Gamma_\gamma=50.1$ meV 15, $g\Gamma_n=1.360$ eV.
S(n)+2.38682 1	1/2 ⁺	0	33 6	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=93$ meV 17.
S(n)+2.41206 7	1/2 ⁺	0	44.4 14	$\Gamma_\gamma=47.1$ meV 15, $g\Gamma_n=762$ meV.
S(n)+2.43833 4	1/2 ⁺	0	42.9 14	$\Gamma_\gamma=52.6$ meV 17, $g\Gamma_n=233$ meV.
S(n)+2.50093 7	1/2 ⁺	0	42.6 13	$\Gamma_\gamma=45.3$ meV 14, $g\Gamma_n=715$ meV.
S(n)+2.50478 3	1/2 ⁺	0	2.7 5	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=2.8$ meV 6.
S(n)+2.54505 1	1/2 ⁺	0	26 5	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=53$ meV 10.
S(n)+2.57083 2	1/2 ⁺	0	39.8 13	$\Gamma_\gamma=46.8$ meV 16, $g\Gamma_n=267.0$ meV.
S(n)+2.61322 15	1/2 ⁺	0	5.1 6	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=5.7$ meV 6.
S(n)+2.61976 1	1/2 ⁺	0	3.7 7	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=4.0$ meV 8.
S(n)+2.62682 4	1/2 ⁺	0	45.5 18	$\Gamma_\gamma=55.5$ meV 22, $g\Gamma_n=253.0$ meV.
S(n)+2.72912 12	1/2 ⁺	0	8.1 6	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=9.6$ meV 7.
S(n)+2.76844 1	1/2 ⁺	0	19 4	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=30$ meV 6.
S(n)+2.79950 11	1/2 ⁺	0	9.52 7	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=11.6$ meV 8.
S(n)+2.81579 6	1/2 ⁺	0	41	
S(n)+2.86400 6	1/2 ⁺	0	36 4	
S(n)+2.92414 2	1/2 ⁺	0	8.4 17	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=10$ meV 2.
S(n)+2.96798 8	1/2 ⁺	0	4.7 9	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=5.2$ meV 10.
S(n)+2.97572 13	1/2 ⁺	0	46.0 18	$\Gamma_\gamma=47.3$ meV 19, $g\Gamma_n=1.670$ eV.
S(n)+2.98842 6	1/2 ⁺	0	39 5	
S(n)+3.03660 7	1/2 ⁺	0	53.2 17	$\Gamma_\gamma=58.4$ meV 18, $g\Gamma_n=600$ meV.
S(n)+3.05603 8	1/2 ⁺	0	57.7 19	$\Gamma_\gamma=62.7$ meV 20, $g\Gamma_n=730$ meV.
S(n)+3.11330 8	1/2 ⁺	0	48.3 17	$\Gamma_\gamma=54.8$ meV 20, $g\Gamma_n=403$ meV.
S(n)+3.12895 8	1/2 ⁺	0	45.6 18	$\Gamma_\gamma=58.3$ meV 22, $g\Gamma_n=210$ meV.
S(n)+3.18954 12	1/2 ⁺	0	55.0 24	$\Gamma_\gamma=55.7$ meV 24, $g\Gamma_n=4.390$ eV.
S(n)+3.20881 8	1/2 ⁺	0	49.6 19	$\Gamma_\gamma=55.9$ meV 22, $g\Gamma_n=437$ meV.
S(n)+3.26943 9	1/2 ⁺	0	25.2 22	
S(n)+3.28427 7	1/2 ⁺	0	46.1 16	$\Gamma_\gamma=51.4$ meV 18, $g\Gamma_n=448$ meV.
S(n)+3.35503 6	1/2 ⁺	0	48.6 19	$\Gamma_\gamma=61.1$ meV 24, $g\Gamma_n=237$ meV.
S(n)+3.41795 8	1/2 ⁺	0	49.1 19	$\Gamma_\gamma=56.9$ meV 21, $g\Gamma_n=360$ meV.
S(n)+3.43886 8	1/2 ⁺	0	45.5 17	$\Gamma_\gamma=49.8$ meV 19, $g\Gamma_n=528$ meV.
S(n)+3.48612 8	1/2 ⁺	0	27.8 23	
S(n)+3.51756 1	1/2 ⁺	0	6.2 12	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=7.0$ meV 14.
S(n)+3.60022 10	1/2 ⁺	0	55.5 21	$\Gamma_\gamma=59.7$ meV 22, $g\Gamma_n=786$ meV.
S(n)+3.63202 1	1/2 ⁺	0	8.4 17	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=10$ meV 2.
S(n)+3.66031 1	1/2 ⁺	0	11.7 23	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=15$ meV 3.
S(n)+3.66831 2	1/2 ⁺	0	15 3	$\Gamma_\gamma=52.0$ meV, $g\Gamma_n=20$ meV 4.

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$^{188}\text{Os}(n,\gamma)$:resonances 2010Fu04 (continued) ^{189}Os Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	L	$g\Gamma_{\gamma}\Gamma_n/\Gamma$ (meV) [#]	Comments
S(n)+3.69502 20	1/2 ⁺	0	43.8 24	$\Gamma_{\gamma}=44.9$ meV 24, $g\Gamma_n=1.790$ eV.
S(n)+3.7064 5	1/2 ⁺	0	35 3	$\Gamma_{\gamma}=35.2$ meV 3, $g\Gamma_n=4.590$ eV.
S(n)+3.71978 11	1/2 ⁺	0	52.0 23	$\Gamma_{\gamma}=55.9$ meV 25, $g\Gamma_n=763$ meV.
S(n)+3.73294 2	1/2 ⁺	0	7.9 15	$\Gamma_{\gamma}=52.0$ meV, $g\Gamma_n=9.3$ meV 18.
S(n)+3.77265 13	1/2 ⁺	0	22.9 22	
S(n)+3.88398 10	1/2 ⁺	0	57.1 22	$\Gamma_{\gamma}=62.1$ meV 24, $g\Gamma_n=703$ meV.
S(n)+3.92904 1	1/2 ⁺	0	15 3	$\Gamma_{\gamma}=52.0$ meV, $g\Gamma_n=20$ meV 4.
S(n)+3.93148 1	1/2 ⁺	0	33.2	$\Gamma_{\gamma}=52.0$ meV, $g\Gamma_n=92.0$ meV.
S(n)+3.94753 10	1/2 ⁺	0	39.6 22	$\Gamma_{\gamma}=56$ meV 3, $g\Gamma_n=134.0$ meV.
S(n)+3.96666 10	1/2 ⁺	0	38.5 24	$\Gamma_{\gamma}=59$ meV 4, $g\Gamma_n=111.0$ meV.
S(n)+3.98207 3	1/2 ⁺	0	15 3	$\Gamma_{\gamma}=52.0$ meV, $g\Gamma_n=20$ meV 4.
S(n)+3.98738 12	1/2 ⁺	0	35.2	$\Gamma_{\gamma}=52.0$ meV, $g\Gamma_n=109.0$ meV.
S(n)+4.10633 12	1/2 ⁺	0	41 7	$\Gamma_{\gamma}=52.0$ meV, $g\Gamma_n=196$ meV 35.
S(n)+4.13473 1	1/2 ⁺	0	34 6	
S(n)+4.21540 10	1/2 ⁺	0	49.6 25	$\Gamma_{\gamma}=65$ meV 3, $g\Gamma_n=208$ meV.
S(n)+4.23628 17	1/2 ⁺	0	53.8 24	$\Gamma_{\gamma}=55.9$ meV 24, $g\Gamma_n=1.451$ eV.
S(n)+4.26821 19	1/2 ⁺	0	45.4 23	$\Gamma_{\gamma}=46.7$ meV 24, $g\Gamma_n=1.600$ eV.
S(n)+4.31322 12	1/2 ⁺	0	34 4	
S(n)+4.34127 14	1/2 ⁺	0	24.4 23	
S(n)+4.43427 6	1/2 ⁺	0	48 8	$\Gamma_{\gamma}=58$ meV 10, $g\Gamma_n=263.0$ meV.
S(n)+4.45093 16	1/2 ⁺	0	53.7 25	$\Gamma_{\gamma}=56$ meV 3, $g\Gamma_n=1.310$ eV.
S(n)+4.48301 16	1/2 ⁺	0	28.9	$\Gamma_{\gamma}=52.0$ meV, $g\Gamma_n=65.0$ meV.
S(n)+4.57992 12	1/2 ⁺	0	41 9	$\Gamma_{\gamma}=61$ meV 6, $g\Gamma_n=130$ meV 23.
S(n)+4.60379 6	1/2 ⁺	0	25 5	
S(n)+4.62801 2	1/2 ⁺	0	8.4 17	$\Gamma_{\gamma}=52.0$ meV, $g\Gamma_n=10$ meV 2.
S(n)+4.64147 25	1/2 ⁺	0	49 3	$\Gamma_{\gamma}=51$ meV 3, $g\Gamma_n=2.150$ eV.
S(n)+4.72268 15	1/2 ⁺	0	40.4 24	$\Gamma_{\gamma}=51$ meV 3, $g\Gamma_n=198$ meV.
S(n)+4.74696 14	1/2 ⁺	0	46 3	$\Gamma_{\gamma}=56$ meV 3, $g\Gamma_n=242$ meV.
S(n)+4.81755 11	1/2 ⁺	0	41 6	$\Gamma_{\gamma}=54$ meV 8, $g\Gamma_n=160$ meV.
S(n)+4.85249 20	1/2 ⁺	0	43 3	$\Gamma_{\gamma}=50$ meV 3, $g\Gamma_n=300$ meV.
S(n)+4.88195 20	1/2 ⁺	0	48 3	$\Gamma_{\gamma}=50$ meV 3, $g\Gamma_n=950$ meV.
S(n)+4.89385 15	1/2 ⁺	0	47 3	$\Gamma_{\gamma}=57$ meV 4, $g\Gamma_n=269$ meV.
S(n)+4.93339 16	1/2 ⁺	0	32 6	
S(n)+4.95980 8	1/2 ⁺	0	38 6	$\Gamma_{\gamma}=48$ meV 8, $g\Gamma_n=194$ meV.
S(n)+4.98975 8	1/2 ⁺	0	37 6	
S(n)+5.05483 17	1/2 ⁺	0	44 8	
S(n)+5.09482 4	1/2 ⁺	0	11.8 23	
S(n)+5.10232 7	1/2 ⁺	0	48 7	
S(n)+5.16311 17	1/2 ⁺	0	50.3	
S(n)+5.20425 3	1/2 ⁺	0	23 5	
S(n)+5.21134 2	1/2 ⁺	0	29 6	
S(n)+5.24654 20	1/2 ⁺	0	41 7	
S(n)+5.27356 3	1/2 ⁺	0	37 7	
S(n)+5.33724 2	1/2 ⁺	0	13 3	
S(n)+5.35027 2	1/2 ⁺	0	41 8	
S(n)+5.38397 1	1/2 ⁺	0	25 5	
S(n)+5.40193 18	1/2 ⁺	0	46 9	
S(n)+5.43743 19	1/2 ⁺	0	47 9	
S(n)+5.45592 19	1/2 ⁺	0	38 6	
S(n)+5.52535 25	1/2 ⁺	0	48 9	
S(n)+5.5626 3	1/2 ⁺	0	50 7	
S(n)+5.61352 3	1/2 ⁺	0	38 7	
S(n)+5.63456 1	1/2 ⁺	0	26 5	
S(n)+5.66613 19	1/2 ⁺	0	42 7	

Continued on next page (footnotes at end of table)

$^{188}\text{Os}(\text{n},\gamma)$:resonances **2010Fu04** (continued) ^{189}Os Levels (continued)

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	L	$g\Gamma_\gamma\Gamma_n/\Gamma$ (meV) $^\#$	$E(\text{level})^\dagger$	$J^\pi^\ddagger$	L	$g\Gamma_\gamma\Gamma_n/\Gamma$ (meV) $^\#$
S(n)+5.73431 23	1/2 ⁺	0	48 7	S(n)+6.89958 4	1/2 ⁺	0	45 9
S(n)+5.78524 2	1/2 ⁺	0	45 8	S(n)+6.94311 2	1/2 ⁺	0	43 8
S(n)+5.82958 25	1/2 ⁺	0	47 9	S(n)+6.9591 3	1/2 ⁺	0	43 8
S(n)+5.89021 23	1/2 ⁺	0	42 8	S(n)+6.99397 1	1/2 ⁺	0	21 4
S(n)+5.9077 3	1/2 ⁺	0	50.3	S(n)+7.0218 3	1/2 ⁺	0	46 9
S(n)+5.9711 3	1/2 ⁺	0	47 9	S(n)+7.06764 1	1/2 ⁺	0	35 7
S(n)+5.9961 3	1/2 ⁺	0	47 9	S(n)+7.12346 5	1/2 ⁺	0	45 9
S(n)+6.04467 11	1/2 ⁺	0	42 8	S(n)+7.16165 1	1/2 ⁺	0	30 6
S(n)+6.10495 4	1/2 ⁺	0	34 7	S(n)+7.19370 3	1/2 ⁺	0	43 8
S(n)+6.13069 1	1/2 ⁺	0	14 3	S(n)+7.2333 3	1/2 ⁺	0	43. 8
S(n)+6.1837 3	1/2 ⁺	0	46 9	S(n)+7.2603 3	1/2 ⁺	0	47 9
S(n)+6.2010 4	1/2 ⁺	0	51 8	S(n)+7.2795 3	1/2 ⁺	0	45 8
S(n)+6.2503 3	1/2 ⁺	0	48 9	S(n)+7.3257 3	1/2 ⁺	0	45 9
S(n)+6.28738 25	1/2 ⁺	0	25 4	S(n)+7.37249 5	1/2 ⁺	0	33 7
S(n)+6.3351 4	1/2 ⁺	0	47 8	S(n)+7.38421 2	1/2 ⁺	0	43 8
S(n)+6.37645 24	1/2 ⁺	0	42 7	S(n)+7.4432 4	1/2 ⁺	0	42 8
S(n)+6.42643 22	1/2 ⁺	0	47 9	S(n)+7.47532 3	1/2 ⁺	0	42 8
S(n)+6.45835 4	1/2 ⁺	0	32 6	S(n)+7.50136 8	1/2 ⁺	0	35 7
S(n)+6.48552 25	1/2 ⁺	0	43 8	S(n)+7.54629 1	1/2 ⁺	0	30 6
S(n)+6.5319 5	1/2 ⁺	0	46 9	S(n)+7.58596 2	1/2 ⁺	0	39 8
S(n)+6.5367 3	1/2 ⁺	0	37 7	S(n)+7.6412 4	1/2 ⁺	0	42 7
S(n)+6.5529 4	1/2 ⁺	0	11.6 20	S(n)+7.70073 3	1/2 ⁺	0	30 6
S(n)+6.60559 10	1/2 ⁺	0	39 7	S(n)+7.7335 4	1/2 ⁺	0	42 8
S(n)+6.64015 1	1/2 ⁺	0	38 7	S(n)+7.77948 3	1/2 ⁺	0	41 8
S(n)+6.68960 12	1/2 ⁺	0	34 7	S(n)+7.8773 5	1/2 ⁺	0	38 7
S(n)+6.7110 3	1/2 ⁺	0	47 9	S(n)+7.89127 1	1/2 ⁺	0	28 6
S(n)+6.77633 2	1/2 ⁺	0	39 8	S(n)+7.9603 4	1/2 ⁺	0	35 5
S(n)+6.8152 3	1/2 ⁺	0	44 8				

† S(n)(^{189}Os)+E(n)(c.m.), where S(n)=5920.8 4 (**2017Wa10**) E(n)=neutron resonance energy. E(n)(lab) values are shown in the comments. Recoil correction is 0.20 eV to 42 eV over the range of 38 eV to 8.0 keV.

‡ All spins are defined as s-wave, target spin=0.

$^\#$ g=statistical weight factor=(2J+1)/[(2s+1)(2I+1)], where J=spin of the compound state, I=spin of the target g.s., which is 0 for ^{188}Os , s=spin of the incident neutron=1/2.

$^{188}\text{Os}(\text{d,p}), ^{190}\text{Os}(\text{d,t})$ **1976Be50,1975Mo29**

1976Be50: $^{188}\text{Os}(\text{d,p})$; $E(\text{d})=12$ MeV; FWHM=10-17 keV; measured $\sigma(\text{Ep},\theta)$. $^{190}\text{Os}(\text{d,t})$; $E(\text{d})=12$ MeV; FWHM=14-21 keV; measured $\sigma(\text{Et},\theta)$. DWBA, ^{189}Os deduced levels, $J\pi$. Nilsson model.

1975Mo29: $^{188}\text{Os}(\text{d,p}), ^{190}\text{Os}(\text{d,t})$, $E=12.1$ MeV; measured $\sigma(\theta)$; deduced levels, $J\pi$. Enriched targets, magnetic spectrograph.

 ^{189}Os Levels

$E(\text{level})^{\ddagger}$	$L^{\dagger}$	$d\sigma/d\Omega$ mb/sr ^c	Comments
0.0 ^d	1	6 1	$L=1$ (1975Mo29,1976Be50). $d\sigma/d\Omega(90^\circ)(\text{d,t})=10$ mb/sr 1.
31 1	5	9 1	Configuration=9/2[505]. $E(\text{level})$: from 1975Mo29, 1976Be50 list 30.81 from compilations. $L=\text{high}$ (1975Mo29). $d\sigma/d\Omega(90^\circ)(\text{d,t})=19$ mb/sr 2.
69.60 ^{&d} 7	3	147 12	$E(\text{level})$: 70 2 (1975Mo29). $L=3$ (1975Mo29,1976Be50). $d\sigma/d\Omega(90^\circ)(\text{d,t})=245$ mb/sr 7.
95.35 ^{&e} 6	1	233 16	$E(\text{level})$: 95 1 (1975Mo29). $L=1$ (1975Mo29,1976Be50). $d\sigma/d\Omega(90^\circ)(\text{d,t})=451$ mb/sr 10.
217 ^d 2	3	84 6	$E(\text{level})$: from 1975Mo29, 1976Be50 list 216.8 from compilations. $L=3$ (1975Mo29,1976Be50). $d\sigma/d\Omega(90^\circ)(\text{d,t})=252$ mb/sr 7.
275	3	≈ 48	$E(\text{level})$: from 1975Mo29, 1976Be50 list 275.8 from compilations. $L=3$ (1975Mo29,1976Be50). $d\sigma/d\Omega(90^\circ)(\text{d,t})=24$ mb/sr 2.
290.5 ^a 47	6	≈ 20	$E(\text{level})$: 286 (1975Mo29). $L=\text{high}$ (1975Mo29). $d\sigma/d\Omega(90^\circ)(\text{d,t})=58$ mb/sr 3.
365.7 ^{ae} 9	3	64 5	$E(\text{level})$: 365 3 (1975Mo29). $L=3$ (1975Mo29,1976Be50). $d\sigma/d\Omega(90^\circ)(\text{d,t})=82$ mb/sr 4.
439.1 ^{&} 4	1	≈ 100	$E(\text{level})$: doublet at 436 2 and 446 4, each with $L=1$, reported by 1975Mo29 but not confirmed by 1976Be50 . $L=1$ (1975Mo29,1976Be50). $d\sigma/d\Omega(90^\circ)(\text{d,t})=147$ mb/sr 5 for 439 level.
446 4	1	60 5	$E(\text{level}), L$: from (d,p) only in 1975Mo29 . Level population is treated as uncertain by the evaluators.
506.0 ^{&} 3	1	10 3	$E(\text{level})$: 501 2 (1975Mo29). $L=1,3$ from 1975Mo29 . $d\sigma/d\Omega(90^\circ)(\text{d,t})=14$ mb/sr 2.
530.4 15	3 ^b	<5	Level either not populated in (d,p) or obscured by an impurity. $E(\text{level})$: 526 1 (1975Mo29). $L<5$ in 1976Be50 . $d\sigma/d\Omega(90^\circ)(\text{d,t})=20$ mb/sr 3.
557.6 ^{&} 3			Level either not populated in (d,p) or obscured by an impurity. $E(\text{level})$: 554 1 (1975Mo29). $L=3$ in 1975Mo29 is inconsistent with tentative $(3/2^-)$ assignment in authors' Fig. 4. $d\sigma/d\Omega(90^\circ)(\text{d,t})=20$ mb/sr 3.
599.7 ^a 14	1	193 14	$E(\text{level})$: 597 3 (1975Mo29). $L=1$ (1975Mo29,1976Be50). $d\sigma/d\Omega(90^\circ)(\text{d,t})=100$ mb/sr 4.
621.7 ^{#e} 19		8 2	σ at 125° in (d,p) (1975Mo29); <11 at 90° . $E(\text{level})$: 620 1 (1975Mo29). $L=(\text{high})$ in 1975Bo29 . $d\sigma/d\Omega(90^\circ)(\text{d,t})<5$ mb/sr.

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$^{188}\text{Os}(\text{d,p})$, $^{190}\text{Os}(\text{d,t})$ **1976Be50,1975Mo29 (continued)** ^{189}Os Levels (continued)

E(level) [‡]	L [†]	dσ/dΩ mb/sr ^c	Comments
679.4 ^{#@} 17	<5		Level either not populated in (d,p) or obscured by an impurity. E(level): 684 2 (1975Mo29). L=1 in 1976Be50. L=3 in 1975Mo29. dσ/dΩ(90°)(d,t)=149 mb/sr 5.
688.4 8	1,3		
716.9 ^a 15	3 ^b	18 2	E(level): 714 3 (1975Mo29). dσ/dΩ(90°)(d,t)=7 mb/sr 3.
735.1 ^a 13	1 ^b	12 2	E(level): 730 3 (1975Mo29). <5 from 1976Be50. dσ/dΩ(90°)(d,t)=53 mb/sr 3.
786.4 ^a 33		11 2	σ at 125° in (d,p) (1975Mo29). E(level): 793 3 (1975Mo29). L=(high) in 1975Bo29. dσ/dΩ(90°)(d,t)<5 mb/sr.
817.8 ^a 17	3 ^b	12 2	E(level): 813 2 (1975Mo29). L<5 in 1976Be50. dσ/dΩ(90°)(d,t)=49 mb/sr 3.
848.3 ^{#@} 19			E(level): 879 3 (1975Mo29); (d,p) only.
878.5 ^a 34		13 2	
898.2 [@] 18			Level from (d,t) in 1976Be50; not populated in (d,p).
907.7 [#] 19	1,3	82 6	E(level): 906 0 (1975Mo29); (d,p) only. L=1 (1975Mo29), L=3 (1976Be50).
957.3 ^{#@} 24			E(level): weighted average of (d,p), (d,t), and (n,γ) (1976Be50). E(level): 997 1 (1975Mo29); (d,p) only. L=1 (1975Mo29,1976Be50).
993.4 20	1	43 4	
1018 2			E(level), L: from 1975Mo29, L=high. dσ/dΩ(90°)(d,t)=13 mb/sr 2.
1028.5 [@] 3			Level from (d,t) in 1976Be50; not populated in (d,p).
1058.0 [@] 39			
1107.8 ^{#@} 18			E(level): 1187 1 (1975Mo29). Level from (d,t) in 1976Be50; not populated in (d,p).
1163.0 ^{@a} 38			
1188.0 [#] 18	1 ^b	27 3	Level from (d,t) in 1976Be50; not populated in (d,p).
1210.5 [@] 39			
1220.2 ^{#@} 20			Level from (d,t) in 1976Be50; not populated in (d,p). Level from (d,p) in 1975Mo29, not populated in (d,t). Not reported in 1976Be50. L=high (1975Bo29).
1242.8 [@] 43			
1269 1		11 2	Level from (d,t) in 1976Be50; not populated in (d,p).
1374.7 ^{#@&} 15			
1394.2 ^{@&} 20			Level from (d,t) in 1976Be50; not populated in (d,p).
1411.3 [#] 20	1 ^b	47 5	E(level): 1412 0 (1975Mo29).
1445.5 [#] 20	1 ^b	29 3	E(level): 1446 1 (1975Mo29).
1474.0 [#] 30	1 ^b	30 3	E(level): 1473 1 (1975Mo29).
1554.6 [#] 25	1 ^b	86 7	E(level): 1558 1 (1975Mo29).
1633.7 [#] 23			Level not in 1975Mo29.
1699.6 [#] 20	3 ^b	52 5	E(level): 1701 2 (1975Mo29).
1724.8 [#] 21	3 ^b	293 20	E(level): 1725 1 (1975Mo29).
1816 [#] 1	1,3	19 2	E(level), L: level only from (d,p) in 1975Mo29.

[†] From angular distributions at 20°, 30°, 40°, 45°, 55°, 60°, 75°, 95°, and 125° (d,p); and 75°, 90°, 95°, and 125° (d,t)

 $^{188}\text{Os}(\text{d,p}), ^{190}\text{Os}(\text{d,t})$ 1976Be50, 1975Mo29 (continued)

 ^{189}Os Levels (continued)

(1976Be50), except where noted. DWBA analysis. Values of L-transfers are also given by 1975Mo29 based on data for only two angles for (d,p) and three angles for (d,t).

‡ From 1976Be50, based on their (d,p), (d,t) and (n,γ) data and relative to the energy of the 95.35 level, except where noted.

Other levels at 898.2 18 and 1028 3 were not observed by 1975Mo29. Above 1018 keV excitation, levels in 1975Mo29 are populated only in (d,p), whereas 1976Be50 give levels in (d,t) up to 1394 keV.

Level seen only in (d,p); not populated in (d,t). Energy is from 1976Be50 unless otherwise stated.

@ Level not reported by 1975Mo29.

& From (n,γ) (1976Be50).

^a Average from (d,p) and (d,t).

^b From 1975Mo29, value not determined by 1976Be50 from transfer data.

^c Values are for 90° in (d,p) reaction from 1975Mo29. Cross section data for 125° in (d,p), and for 60°, 90° and 125° in (d,t) are also given by 1975Mo29. Cross sections at 20°, 30°, 40°, 45°, 55°, 60°, 75°, 95°, and 125° in (d,p); and 75°, 90°, 95°, and 125° in (d,t) are also listed by 1976Be50. Cross sections for 90° in (d,t) from 1975Mo29 are listed under comments.

^d Band(A): 3/2[512] band.

^e Band(B): 1/2[510] band.

$^{189}\text{Os}(\gamma,\gamma)$:Mossbauer

[1972Wa24](#), [1969Wa02](#): $^{189}\text{Os}(\gamma,\gamma)$, E=36, 69 keV; measured Mossbauer effect in OsO_2 , OsP_2 . ^{189}Os levels deduced g-ratio, γ -mixing ratio, $T_{1/2}$. Levels deduced quadrupole moment. See also, [1974Wa05](#), [1970Bo11](#).

[1969Gr10](#): $^{189}\text{Os}(\gamma,\gamma)$, E=69.6, 95.3 keV; measured Mossbauer effect. ^{189}Os level $T_{1/2}$, μ , γ -mixing. Ge(Li), Si(Li) detectors.

[1968Pe09](#): $^{189}\text{Os}(\gamma,\gamma)$, E=69.6 keV; measured Mossbauer effect. ^{189}Os level $T_{1/2}$, μ , γ -multipolarity.

 ^{189}Os Levels

E(level)	$T_{1/2}$	Comments
0.0		
36.2	0.50 ns 3	$T_{1/2}$: from 1969Wa02 .
69.6	1.8 ns 2	$T_{1/2}$: from 1968Pe09 . Other: >0.95 ns (1967Jh02).
95	0.20 ns 8	$T_{1/2}$: from 1969Gr10 . The authors indicate that $T_{1/2}$ =0.13 to 0.28 ns.

 $\gamma(^{189}\text{Os})$

E_γ	$E_i(\text{level})$	E_f	Mult.	δ	Comments
36.2	36.2	0.0			
69.6	69.6	0.0	M1+E2	+0.685 25	Mult., δ : from 1972Wa24 .

 $^{189}\text{Os}(\gamma,\gamma)$:MossbauerLevel Scheme

$^{189}\text{Os}(\gamma, \gamma')$ 1995La15, 1995La16

1995La15, 1995La16: source: Bremsstrahlung from 200 keV generator (1995La15) and ^{137}Cs , ^{60}Co (1995La15). Electrons detected with a 90 cm² flat 2π multiwire proportional counter. Level half-lives determined. See also, 1995La25 and 1995La26.

2000Ah03: source: x-rays from synchrotron; E=69.47-69.97 keV; Internal conversion L x-ray from 30.8 keV state measured with a Ge (LEPS) detector. $T_{1/2}$ determined.

 ^{189}Os Levels

E(level) [†]	J^π [†]	$T_{1/2}$ [‡]	Comments
0.0	$3/2^-$		
30.82	$9/2^-$	5.65 [#] h 15	
36.19	$1/2^-$		
69.54	$5/2^-$		
216.66	$5/2^-$	77 ps 10	
219.39	$7/2^-$		
275.92	$5/2^-$		
427.93	$5/2^-, 7/2^-$	>4.4 ps	$T_{1/2}$: >4.4 ps for $J^\pi=5/2^-$; >5.9 ps for $J^\pi 7/2^-$ (1995La16).
531.55	$5/2^-$	>0.26 ps	
550.03	$3/2^-$	>0.039 ps	
599.63	$3/2^-$		

[†] From Adopted Levels.

[‡] From (x,x') and (γ, γ') (1995La15, 1995La16), except as noted.

[#] From (x,x') (2000Ah03).

 $\gamma(^{189}\text{Os})$

E_γ [†]	E_i (level)	J^π_i	E_f	J^π_f	Mult. [†]
30.81	30.82	$9/2^-$	0.0	$3/2^-$	M3+E4
33.31	69.54	$5/2^-$	36.19	$1/2^-$	
36.17	36.19	$1/2^-$	0.0	$3/2^-$	
56.50	275.92	$5/2^-$	219.39	$7/2^-$	
59.3	275.92	$5/2^-$	216.66	$5/2^-$	
69.565 [‡] 30	69.54	$5/2^-$	0.0	$3/2^-$	
152.03	427.93	$5/2^-, 7/2^-$	275.92	$5/2^-$	
185.85	216.66	$5/2^-$	30.82	$9/2^-$	
188.55	219.39	$7/2^-$	30.82	$9/2^-$	
211.26	427.93	$5/2^-, 7/2^-$	216.66	$5/2^-$	
216.66	216.66	$5/2^-$	0.0	$3/2^-$	
219.39	219.39	$7/2^-$	0.0	$3/2^-$	
245.09	275.92	$5/2^-$	30.82	$9/2^-$	
273.6	550.03	$3/2^-$	275.92	$5/2^-$	
275.85	275.92	$5/2^-$	0.0	$3/2^-$	
312.17	531.55	$5/2^-$	219.39	$7/2^-$	
314.91	531.55	$5/2^-$	216.66	$5/2^-$	
323.7	599.63	$3/2^-$	275.92	$5/2^-$	
380.2	599.63	$3/2^-$	219.39	$7/2^-$	
382.95	599.63	$3/2^-$	216.66	$5/2^-$	
397.0	427.93	$5/2^-, 7/2^-$	30.82	$9/2^-$	
428.5	427.93	$5/2^-, 7/2^-$	0.0	$3/2^-$	
531.44	531.55	$5/2^-$	0.0	$3/2^-$	
550.0	550.03	$3/2^-$	0.0	$3/2^-$	
599.62	599.63	$3/2^-$	0.0	$3/2^-$	

Continued on next page (footnotes at end of table)

$^{189}\text{Os}(\gamma,\gamma')$ **1995La15,1995La16** (continued)

$\gamma(^{189}\text{Os})$ (continued)

[†] From Adopted Gammas, unless otherwise noted.

[‡] From (x,x') ([2000Ah03](#)).

 $^{189}\text{Os}(e,e')$ [1978Ot01](#)

$^{189}\text{Os}(e,e')$, $E=72\text{--}100$ keV; measured absolute isomer production $\sigma(E)$; Enriched target; windowless GM counter. The measurement consisted of L and M conversion electrons from the 6 hour isomer at 30.81 keV populated by a nonzero branching ratio from the 69.59 keV level as discussed in [1978Ot01](#).

 ^{189}Os Levels

<u>E(level)</u>	<u>Comments</u>
0.0	
30.81	
69.59	E(level): not directly observed.

$^{189}\text{Os}(\text{d},\text{d}')$ **1975Mo29**

1975Mo29: E(d)=12.1 MeV, measured deuteron spectra, DWBA analysis.

 ^{189}Os Levels

The B(E2) values here are derived from the relation $d\sigma/d\Omega(\theta=90^\circ)=1003[B(E2)]$.

E(level) [†]	T _{1/2} [‡]	L	dσ/dΩ [#]	Comments
0 ^a			86000	
70 ^a 1	1.8 ns 2	2	974 64	B(E2)↑=0.97 7
95 ^b 1	0.13 ns 5	2	168 12	B(E2)↑=0.17 2
219 ^a 2	>0.3 ns	2	800 59	B(E2)↑<0.8 B(E2) for E _γ (217+219)=0.8.
233 ^b 1	≈0.1 ns	2	93 8	B(E2)↑=0.093 8
346 [@] 3		&	≈25	
365 ^{@b} 2		2	≈23	B(E2)↑≈0.023
424 2		2	17 2	
502 3		2	72 6	
529 1		2	38 4	
554 1		2	49 6	
594 [@]		&	≈25	
599 [@]		(2)	≈6	B(E2)↑≈0.006
620 ^b 4		&	<1	
671 1		2	10 2	
733 1		2	79 6	
793 [@] 2		&	1.2 2	
815 1		2	30 3	

[†] From average taken over all angles.

[‡] From B(E2) values, with γ branching ratios and mixing ratios taken from the Adopted Levels, Gammas dataset.

[#] dσ/dΩ(90°) in μb/sr from **1975Mo29**. Cross section data at 125° and 150° are also given by the authors.

[@] Unresolved doublet.

& L>2.

^a Band(A): ν3/2[512] band.

^b Band(B): ν1/2[510] band.

Coulomb excitation 1997Br18,1983Jh01

1997Br18: $E(\alpha)=15$ MeV; 81.14% enriched ^{189}Os of thickness 20 mg/cm²; gammas measured with germanium detectors at 125° and 235° with another monitor detector at 30°. Levels, $J\pi$'s and $B(E2)$ values determined by normalizing to the neighboring 2^+ to 0^+ transitions intensities of ^{188}Os and ^{192}Os .

1983Jh01: $E(^{16}\text{O})=56$ MeV, gammas measured in coincidence with backscattered ^{16}O ions. $E\gamma$ values measured at 0° subtending large solid angle.

1967Hr01: measured $B(E2)$ for 219 and 233 levels.

1963Mc18, 1961Re02: measured ce, deduced $B(E2)$ for low-lying levels.

 ^{189}Os Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}^\text{@}$	Comments
0.0	$3/2^-$		
30.9 4	$9/2^-$		
36.3 5	$1/2^-$		
69.6 4	$5/2^-$	1.5 ns 3	$B(E2)\uparrow=1.2$ 2 $B(E2)\uparrow$: From 1961Re02. Other: 0.63 (1963Mc18). $E(\text{level})$: No γ transitions measured from this level. Only conversion electrons measured.
95.3 3	$3/2^-$	0.10 ns 2	$B(E2)\uparrow=0.200$ 18 (1997Br18) $B(E2)\uparrow$: other: 0.20 (1963Mc18).
216.5 4	$7/2^-$	0.41 ns 2	$B(E2)\uparrow=0.292$ 12 (1997Br18)
219.4 3	$7/2^-$	0.260 ns 11	$B(E2)\uparrow=0.526$ 20 (1997Br18) $B(E2)\uparrow$: others: 0.67 10 (1967Hr01) assuming $B(E2,0^+ \text{ to } 2^+)=2.30$ for ^{190}Os (1989Ra16 evaluation); 1.10 (1963Mc18) including contribution from 216 level.
233.7 3	$5/2^-$	0.27 ns +7-4	$B(E2)\uparrow=0.111$ 5 (1997Br18) $B(E2)\uparrow$: other: 0.07 2 (1967Hr01) assuming $B(E2,0^+ \text{ to } 2^+)=2.30$ for ^{190}Os (1989Ra16).
276.0 4	$5/2^-$	0.16 ns 4	$B(E2)\uparrow=0.017$ 3 (1997Br18)
350.1 5	$(9/2^-)^\#$		
365.9 4	$5/2^-, 7/2^-$		
499.9 5	$1/2^-, 3/2^-^\#$		
532.2 5			
557.7 4	$3/2^-^\#$		
594.9 5	$(11/2^-)^\#$		
630.6 4	$(9/2^-)^\#$		
634.2 5			
667.4 5			
735.5 5	$1/2^-, 3/2^-^\#$		
794.4 5			
817.0 10	$5/2^-, 7/2^-^\#$		

† Deduced from a least-square fit to γ -energies, 0.5 keV precision assumed for those γ -energies from only 1997Br18.

‡ From 1997Br18, except as noted.

$^\#$ From Adopted Levels.

$^\text{@}$ From $B(E2)$ and adopted branchings.

 $\gamma(^{189}\text{Os})$

$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π
59.1 ‡	95.3	$3/2^-$	36.3	$1/2^-$
95.3 ‡	95.3	$3/2^-$	0.0	$3/2^-$
124.2 ‡	219.4	$7/2^-$	95.3	$3/2^-$

Continued on next page (footnotes at end of table)

Coulomb excitation **1997Br18,1983Jh01 (continued)** $\gamma(^{189}\text{Os})$ (continued)

E_γ †	I_γ §&	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
138.6 5	10	233.7	$5/2^-$	95.3	$3/2^-$	
146.7 ^c § 5	68	216.5	$7/2^-$	69.6	$5/2^-$	
146.7 ^c § ^e 4		365.9	$5/2^-, 7/2^-$	219.4	$7/2^-$	
149.5 5	109	219.4	$7/2^-$	69.6	$5/2^-$	
163.8 ^d _e 5	30 ^d @	233.7	$5/2^-$	69.6	$5/2^-$	
163.8 ^d 5	^d @	794.4		630.6	$(9/2^-)$	
185.5 5	160	216.5	$7/2^-$	30.9	$9/2^-$	
188.6 5	87	219.4	$7/2^-$	30.9	$9/2^-$	
197.2 5	114	233.7	$5/2^-$	36.3	$1/2^-$	
216.5 5	581	216.5	$7/2^-$	0.0	$3/2^-$	
219.2 5	1318	219.4	$7/2^-$	0.0	$3/2^-$	
233.5 5	166	233.7	$5/2^-$	0.0	$3/2^-$	
245.0 ^d 5	≈ 23 ^d #	276.0	$5/2^-$	30.9	$9/2^-$	
245.0 ^d 5	≈ 18 ^d #	594.9	$(11/2^-)$	350.1	$(9/2^-)$	
270.6 5	6	365.9	$5/2^-, 7/2^-$	95.3	$3/2^-$	
276.1 5	2	276.0	$5/2^-$	0.0	$3/2^-$	
280.8 5	≈ 35 ^a	350.1	$(9/2^-)$	69.6	$5/2^-$	
280.8 ^e 5	≈ 18 ^a	630.6	$(9/2^-)$	350.1	$(9/2^-)$	
296.5 5	20	365.9	$5/2^-, 7/2^-$	69.6	$5/2^-$	
323.6 5	13	557.7	$3/2^-$	233.7	$5/2^-$	
^x 360.4 § 5	3					
^x 362.8 § 5	5					
365 [‡] 1		365.9	$5/2^-, 7/2^-$	0.0	$3/2^-$	E_γ : As this has a lower precision than other measured γ transitions in 1997Br18, evaluators used 1 keV as the uncertainty in generating the level energies in the least squared fit calculation.
375.3 5	21	594.9	$(11/2^-)$	219.4	$7/2^-$	
378.3 5	14	594.9	$(11/2^-)$	216.5	$7/2^-$	
397.2 5	31	630.6	$(9/2^-)$	233.7	$5/2^-$	
^x 403.6 § 5	10					
410.9 5	27	630.6	$(9/2^-)$	219.4	$7/2^-$	
^x 416 § ^e 1						
428.5 5	12	794.4		365.9	$5/2^-, 7/2^-$	
462.4 5	43	557.7	$3/2^-$	95.3	$3/2^-$	E_γ : Not in adopted gammas. In 1983Jh01, it is mentioned that a γ with this energy could be depopulating the 557.7 keV but this is not confirmed in (n, γ).
^x 470.0 § 5	32					
^x 481.0 § 5	7					
^x 496.0 § 5	6					
499.9 5	7	499.9	$1/2^-, 3/2^-$	0.0	$3/2^-$	
532.2 5	24	532.2		0.0	$3/2^-$	
^x 550.7 § 5	9					
558.2 ^b 5	36 ^b	557.7	$3/2^-$	0.0	$3/2^-$	E_γ : Not in adopted gammas. This was observed in 1983Jh01, but was not confirmed in (n, γ).
^x 565.7 § 5	3					
575 ^e 1	2	794.4		219.4	$7/2^-$	
^x 585.3 § 5	12					
597.9 ^e 5	7	667.4		69.6	$5/2^-$	
^x 603.3 § 5	7					

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Coulomb excitation 1997Br18,1983Jh01 (continued) $\gamma(^{189}\text{Os})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^{\S\&}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π
^x 628.0 [§] 5	5				
634.2 5	7	634.2		0.0	3/2 ⁻
667.4 5	49	667.4		0.0	3/2 ⁻
735.5 5	32	735.5	1/2 ⁻ , 3/2 ⁻	0.0	3/2 ⁻
817 1	7	817.0	5/2 ⁻ , 7/2 ⁻	0.0	3/2 ⁻

[†] Except as otherwise noted, E_γ are the values from 1983Jh01 as those from 1997Br18 agree very closely up to their highest level of 365 keV. but provide no uncertainties.

[‡] From 1997Br18, intensity not given.

[§] From 1983Jh01.

[&] Intensity for 146.7 γ was divided using adopted γ branchings. Note that the deduced value is $I_\gamma=115$ for the 146.7 γ from the 216 level, which is inconsistent with the experimental value from 1983Jh01.

[@] Divided using adopted γ branchings and mixing ratios. From adopted branchings $I_\gamma(\text{tot})=34$ in 1983Jh01.

[#] Divided using adopted γ branchings, $I_\gamma(\text{tot})=41$ (1983Jh01).

^a Divided assuming intensity is balanced through the 350 level, $I_\gamma(\text{tot})=53$ in 1983Jh01.

^b Mixed with ^{190}Os γ (1983Jh01).

^c Multiply placed.

^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.

$^{190}\text{Os}(^3\text{He},\alpha)$ [1973KIZZ](#)

E(t)=28 MeV. Measured at 35°, 60°.

^{189}Os Levels

<u>E(level)</u>	<u>L[†]</u>	<u>S[‡]</u>
287 3	6	2.7
874 4	6	1.7
1022 5	6	1.9

[†] No other levels below 1500 keV with L=6 were populated with a cross section exceeding 7% of the 287 cross section.

[‡] Relative strength.

Adopted Levels, Gammas

$Q(\beta^-) = -1980$ 14; $S(n) = 8176$ 16; $S(p) = 4601$ 13; $Q(\alpha) = 2945$ 13 2017Wa10

$S(2n) = 15040$ 30, $S(2p) = 11811$ 13 (2017Wa10).

^{189}Ir produced and identified by 1955Sm42 in $\text{Ir}(p, xn)$, $E = 50$ –130 MeV; ^{189}Ir obtained as daughter of ^{189}Pt decay. Measured half-life of the activity. Later studies of this decay: 1959Ka09, 1960Po07, 1962Ha24, 1963Gr22, 1963Cr06, 1964Le07, 1965Qa01, 1966Sy01, 1969Gr10, 1970Ma37, 1971Be71, 1975Ba35. 1950Ch11 may have identified this activity with a half-life of 12.6 d, but assigned it to ^{190m}Ir (see 2012Ro36 compilation).

 ^{189}Ir LevelsCross Reference (XREF) Flags

A	^{189}Ir IT decay (13.3 ms)	D	$^{187}\text{Re}(\alpha, 2n\gamma)$
B	^{189}Ir IT decay (3.7 ms)	E	$^{191}\text{Ir}(p, t)$
C	^{189}Pt ε decay (10.87 h)		

E(level) [†]	J^π	$T_{1/2}$	XREF	Comments
0.0 ^{&}	3/2 ⁺	13.2 d 1	ABCDE	$\% \varepsilon = 100$ $\mu = +0.147$ 7 (2006Ve10, 2014StZZ) $Q = +0.82$ 8 (2006Ve10, 2016St14) RMS charge radius $\langle r^2 \rangle^{1/2} = 5.390$ fm 106 (2013An02 evaluation). J^π : spin from atomic beam (1975Ru06, 1978Ru04); parity from $L(p, t) = 0$ from 3/2 ⁺ target. $T_{1/2}$: weighted average of 13.1 d 1 (1975Ba35), 13.3 d 1 (1964Le07), 13.3 d 2 (1963Gr22), and 13.8 d 7 (1959Ka09). Other values: 10.5 d (1965Qa01), 12.5 d (1960Po07) and 11 d (1955Sm42). μ : laser spectroscopy measurements (2006Ve10, also 2000Ve10, 2000Sa58). Other: 0.13 +3–4 (1980Be27, low-temperature nuclear orientation). Q : from 2016St14 evaluation. Measured values: +0.85 7 (2006Ve10, resonant ionization mass spectrometry/laser spectroscopy, also earlier reports 2000Ve10 and 2000Sa58), +0.878 10 (1996Se15, NMR on oriented nuclei), +0.79 6 (1992Ka49, 1992Ka48), +1.0 2 (1985Ha41, nuclear orientation), 1.0 1 (1980Mu07, quadrupole interaction nuclear orientation).
94.34 ^a 3	1/2 ⁺	11.4 ns 3	CDE	J^π : M1+E2 γ to 3/2 ⁺ ; E2 γ from 5/2 ⁺ ; band assignment. $T_{1/2}$: weighted average of delayed coincidence measurements 11.3 ns 3 (1969Ha03), and 11.6 ns 6 (1972Ba21) from ^{189}Pt ε decay.
113.831 [@] 23	5/2 ⁺ [#]	76 ps 18	ABCDE	$T_{1/2}$: from delayed coincidence (1972Ba21).
176.53 ^b 3	3/2 ⁺	22 ps 10	CDE	J^π : M1+E2 to 1/2 ⁺ and 5/2 ⁺ . $T_{1/2}$: from delayed coincidence (1972Ba21).
300.50 ^{&} 4	7/2 ⁺ [#]	<20 ps	ABCDE	J^π : M1+E2 to 5/2 ⁺ ; E2 to 3/2 ⁺ ; band assignment. $T_{1/2}$: delayed coincidence (1972Ba21).
317.68 ^a 3	5/2 ⁺		CDE	J^π : E2 to 1/2 ⁺ ; band assignment.
372.17 ^c 4	11/2 ⁻ [#]	13.3 ms 3	ABCDE	$\% \text{IT} = 100$ J^π : E3 to 5/2 ⁺ , M2(+E3) to 7/2 ⁺ , RUL. $T_{1/2}$: weighted average of 13.4 ms 2 (1973RoYQ), 12.3 ms 5 (1967Co20) and 14 ms 1 (1963Re13). Other values: 10.0 ms 6 (1960Mo19), 14 ms 3 (1968Io01).
453.95 [@] 9	9/2 ⁺ [‡]		B DE	
464.76 ^b 13	7/2 ⁺		DE	J^π : M1 to 5/2 ⁺ , band assignment.
539.85 [?] 9			C	
563.74 ^e 10	(9/2) ⁻	0.54 ns 10	D	J^π : E1 to 7/2 ⁺ , γ to 9/2 ⁺ , and 7/2 excluded by being fed by (13/2) ⁻ level at 742 keV in rotational band. $T_{1/2}$: measured by 2012MaZP from time difference between 178 feeding γ 263 depopulating transition.
607.50 4	5/2 ⁻		C	J^π : E1 to 3/2 ⁺ and 5/2 ⁺ , γ to 7/2 ⁺ .

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{189}Ir Levels (continued)

E(level) [†]	J ^π	T _{1/2}	XREF	Comments
615.58 5	7/2 ⁻	0.18 ns 2	CD	J ^π : M1+E2 from 1184 level, and E2 to 11/2 ⁻ uniquely establish J ^π (615)=7/2 ⁻ and J ^π (1184)=5/2 ⁻ . T _{1/2} : delayed coincidence from 1970Ba56.
644.29 6	(3/2,5/2) ⁺		C E	J ^π : M1(+E2) to 3/2 ⁺ and 5/2 ⁺ . 5/2 from tentative assignment as π5/2[402] state (1978St09).
719.09 ^a 17	9/2 ⁺		D	J ^π : γs to 5/2 ⁺ and 7/2 ⁺ , band assignment.
721.41 3	3/2 ⁺		C E	J ^π : L(p,t)=0 from 3/2 ⁺ target.
736.87 ^d 10	13/2 ⁻		B D	J ^π : M1 to 11/2 ⁻ , band assignment.
741.64 ^e 15	(13/2) ⁻		D	J ^π : stretched E2 to (9/2) ⁻ .
745.89 ^{&} 9	11/2 ⁺ [‡]		B D	
753 3	(1/2 to 7/2)(⁺)		E	J ^π : L(p,t)=(2) from 3/2 ⁺ target.
792.71 4	(1/2,3/2) ⁺		C E	J ^π : M1(+E2) to 1/2 ⁺ .
828.18 5	3/2 ⁻		C e	J ^π : E1 to 1/2 ⁺ and 3/2 ⁺ and γ to 5/2 ⁺ , 7/2 ⁻ .
831.80 16	(9/2,11/2) ⁻		De	J ^π : M1 to 11/2 ⁻ , γ to 7/2 ⁻ .
837.89 ^c 10	15/2 ⁻ [‡]		B D	
850.07? 11	1/2,3/2,5/2 ⁺		C	J ^π : γ to 1/2 ⁺ and 3/2 ⁺ .
899.40 ^b 19	(11/2 ⁺)		D	XREF: D(899.31).
				J ^π : γ to 9/2 ⁺ , (E2) to 7/2 ⁺ , band assignment.
900.14 11	(9/2) ⁻		CD	J ^π : M1 to 7/2 ⁻ , γ to 11/2 ⁻ .
902.65 6	(3/2) ⁺		C	J ^π : M1 to 1/2 ⁺ ; (M1) to 5/2 ⁺ .
912.21 6	3/2 ⁺		C E	J ^π : L(p,t)=0 from 3/2 ⁺ target.
918.17 [@] 16	13/2 ⁺		B D	J ^π : stretched E2 to 9/2 ⁺ , γ to 11/2 ⁺ .
924.76 8	(3/2,5/2) ⁻		C	J ^π : E1 to 3/2 ⁺ and 5/2 ⁺ .
945.9 4	(11/2) ⁻		D	J ^π : ΔJ=1 γ to (11/2) ⁻ .
948.74? 25			D	
958.66 7	(3/2 ⁻ ,5/2 ⁻)		C E	J ^π : γs to 3/2 ⁺ , 3/2 ⁻ and 7/2 ⁻ ; (M1+E2) γ to 5/2 ⁻ .
1052 3	(3/2 ⁺)		E	J ^π : L(p,t)=(0) from 3/2 ⁺ target.
1074.2? 4			D	
1100.84 ^e 18	(17/2) ⁻		D	J ^π : ΔJ=2 γ to (13/2) ⁻ , band assignment.
1106.38 7	(3/2,5/2) ⁺		C	J ^π : M1 to 5/2 ⁺ , M1+E2 to 3/2 ⁺ .
1114.52 24	-		D	J ^π : M1 to (9/2,11/2) ⁻ .
1137.27 15	(15/2) ⁻		D	J ^π : From M1 γ to 13/2 ⁻ .
1184.41 5	5/2 ⁻	<80 ps	C E	XREF: E(1175). J ^π : see comment on 615 level. T _{1/2} : delayed coincidence from 1970Ba56.
1203.26 6	3/2 ⁺		C E	J ^π : L(p,t)=0 from 3/2 ⁺ target.
1221.14 25	-		D	J ^π : M1+E2 to (9/2,11/2) ⁻ .
1238.73? 12	(3/2 ⁻ ,5/2,7/2 ⁺)		C	J ^π : log ft=8.8 from 3/2 ⁻ , γ to (7/2) ⁻ .
1248 3	3/2 ⁺		E	J ^π : L(p,t)=0 from 3/2 ⁺ target.
1249.0 ^a 3	(13/2 ⁺)		D	J ^π : band assignment.
1268.28 ^d 13	17/2 ⁻ [‡]		B D	J ^π : band assignment.
1288.0? 5			D	
1296.21 ^{&} 12	15/2 ⁺ [‡]		B D	J ^π : band assignment.
1312.33 10	(3/2 ⁺ ,5/2,7/2 ⁺)		C	J ^π : γ to 3/2 ⁺ , 5/2 ⁺ and 7/2 ⁺ , log ft=8.4 from 3/2 ⁻ .
1344.51 5	(3/2 ⁺ ,5/2 ⁺)		C E	J ^π : (E2) γ's to 3/2 ⁺ , 7/2 ⁺ and log ft=7.78 from 3/2 ⁻ .
1383.60 ^c 13	19/2 ⁻ [‡]		B D	J ^π : band assignment.
1395.8? 7			D	
1447.6? 4			D	
1451.58? 10	(5/2) ⁻		C	J ^π : M1+E2 to 7/2 ⁻ , log ft=8.35 from 3/2 ⁻ .
1468.99 12			C	
1476.46 10	1/2 ⁺ , 3/2 ⁽⁺⁾ , 5/2 ⁺		C	J ^π : gammas to 1/2 ⁺ and 5/2 ⁺ ; (E2+M1) γ to 3/2 ⁺ .

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Adopted Levels, Gammas (continued) ^{189}Ir Levels (continued)

E(level) [†]	J ^π	T _{1/2}	XREF	Comments
1481.61 @ 21	(17/2) ⁺		B D	J ^π : (E2) γ to 13/2 ⁺ , band assignment.
1500.19 7	(1/2,3/2) ⁻		C E	J ^π : E1 to 3/2 ⁺ , γ to 1/2 ⁺ , 5/2 ⁺ .
1501.35 11	(3/2 ⁻ ,5/2 ⁻)		C	J ^π : (E1) to 3/2 ⁺ , γ to 5/2 ⁺ .
1506 3	3/2 ⁺		E	J ^π : L(p,t)=0 form 3/2 ⁺ target.
1536.88 13			C	
1558.20 8			C	
1571.67 7	(3/2,5/2) ⁺		C	J ^π : M1+E2 to 5/2 ⁺ , γ to 1/2 ⁺ .
1578.37 25	(17/2) ⁻		D	J ^π : From M1 γ to (15/2 ⁻).
1608.8 ^e 4	(21/2) ⁻		D	J ^π : band member.
1610.24? 7	(3/2,5/2) ⁻		C	J ^π : M1,E2+E0 to 5/2 ⁻ , γ to 3/2 ⁺ .
1615.2 4			D	
1622.83 11	1/2 ⁺ ,3/2,5/2 ⁺		C	J ^π : γs to 1/2 ⁺ , 5/2 ⁺ .
1651.2 4			D	J ^π : γ to (17/2 ⁻).
1656.0 4	(19/2) ⁻		D	
1672.83 11			C	
1767.21 14	3/2,5/2 ⁺		C	J ^π : γs to 1/2 ⁺ , 5/2 ⁺ and 5/2 ⁻ .
1790.9? 4	(21/2) ⁻		D	J ^π : ΔJ=1 γ to 19/2 ⁻ .
1802.24 8	(5/2) ⁻		C	J ^π : (E1) to 7/2 ⁺ , log ft=6.57 from 3/2 ⁻ .
1814.86? 12	(1/2,3/2) ⁻		C	J ^π : M1 to 3/2 ⁻ , γ to 1/2 ⁺ .
1875.53 ^d 18	(21/2) ⁻		B D	J ^π : band assignment.
1910.28 19	(19/2) ⁺		B D	J ^π : ΔJ=(2) γ to 15/2 ⁺ .
1919.81 & 15	19/2 ⁺		B D	J ^π : ΔJ=2, E2 to 15/2 ⁺ , band assignment.
2059.89 21	(21/2) ⁻		B D	J ^π : ΔJ=1 γ to 19/2 ⁺ , γ from 23/2 ⁺ .
2085.04 ^c 22	23/2 ⁻		B D	J ^π : E2 to 19/2 ⁻ , band assignment.
2108.9 4	(21/2) ⁻		B D	J ^π : γ from (25/2 ⁺); see also J ^π comment on 2333 level.
2109.7 @ 4	(21/2) ⁺		D	J ^π : band assignment.
2127.89 21	23/2 ⁺		B D	J ^π : stretched E2 to 19/2 ⁺ .
2248.4 4	(23/2 ⁻ ,25/2 ⁻)		B D	J ^π : (E1) γ to 23/2 ⁺ .
2332.8 3	(25/2) ⁺	3.7 ms 2	B D	%IT=100 J ^π : E1+M2 to (23/2 ⁻ ,25/2 ⁻), (D) to 23/2 ⁻ , no γs to levels of J ^π ≤21/2 ⁻ with the possible exception of the 2109.5 level. The transition to the 2109.5 level is weak and the 223.8γ is consistent with M2 leading to a tentative assignment of J ^π (2109.5)=(21/2 ⁻). T _{1/2} : weighted average of 3.8 ms 2 (1975Ke06) and 3.2 ms 4 (1975An08); from γ(t).

[†] From least-squares fit to E_γ values.[‡] Level deexcited by M1 γ and stretched E2 γ to lower rotational band members.[#] J^π for the 113.8, 300.5 and 372.2 levels are determined to be 5/2⁺, 7/2⁺, and 11/2⁻ respectively based on E3-M1 and M2-E2, M2-M1-M1 γ cascades to the 3/2⁺ ground state assuming the 113.8 level is the 5/2⁺ member of the 3/2[402] rotational band.

@ Band(a): π3/2[402],α=+1/2.

& Band(A): π3/2[402],α=-1/2.

^a Band(B): π1/2[400],α=+1/2.^b Band(b): π1/2[400],α=-1/2.^c Band(C): π11/2[505],α=+1/2.^d Band(c): π11/2[505],α=-1/2.^e Band(D): ROTATIONAL BAND.

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Ir})$									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta^\&$	$\alpha^@$	Comments
94.34	1/2 ⁺	94.34 4	100	0.0	3/2 ⁺	M1+E2	3.2 3	5.99	B(M1)(W.u.)=2.9×10 ⁻⁵ 5; B(E2)(W.u.)=13.4 5
113.831	5/2 ⁺	113.82 4	100	0.0	3/2 ⁺	M1+E2	0.55 5	3.88 8	B(M1)(W.u.)=0.031 8; B(E2)(W.u.)=290 +90-55
176.53	3/2 ⁺	62.65 6	3.3 7	113.831	5/2 ⁺	M1+E2	<1.8	16 12	B(M1)(W.u.)=0.011 9 B(E2)↓: Strength derived from T _{1/2} exceeds RUL.
		82.22 4	100 9	94.34	1/2 ⁺	M1+E2	0.17 +3-4	10.71	B(M1)(W.u.)=0.14 +12-4; B(E2)(W.u.)=2.3×10 ² +19-7
		176.53 7	33.8 16	0.0	3/2 ⁺	M1+E2	0.7 2	0.99 9	B(M1)(W.u.)=0.0032 +27-10; B(E2)(W.u.)=20 +33-6
300.50	7/2 ⁺	186.70 6	59.7 18	113.831	5/2 ⁺	M1+E2	-0.7 2	0.84 8	B(M1)(W.u.)>0.024; B(E2)(W.u.)>100 δ: negative sign from parametric plots of A ₂ from ce(θ) and γ(θ) (1983Fa11).
		300.48 6	100 4	0.0	3/2 ⁺	E2		0.0943	B(E2)(W.u.)>82
		141.18 4	100 5	176.53	3/2 ⁺	M1+E2	<0.17	2.27	
		203.78 8	11.5 11	113.831	5/2 ⁺	M1+E2	<0.7	0.73 9	E _γ : Observed only in ε decay.
		223.35 10	35.6 23	94.34	1/2 ⁺	E2		0.239	
		317.65 6	78 5	0.0	3/2 ⁺	M1+E2	0.5 2	0.209 21	
372.17	11/2 ⁻	71.69 4	30 5	300.50	7/2 ⁺	M2(+E3)	<0.1	76 4	B(M2)(W.u.)=0.00034 6; B(E3)(W.u.)<0.65
		258.37 6	100 8	113.831	5/2 ⁺	E3		0.876	B(E3)(W.u.)=0.022 4
453.95	9/2 ⁺	153.6 3	7.5 16	300.50	7/2 ⁺				
		340.2 1	100 5	113.831	5/2 ⁺	E2		0.0657	
464.76	7/2 ⁺	147.2 3	34 7	317.68	5/2 ⁺	(D)			
		288.1 3	59 12	176.53	3/2 ⁺	(E2)			
		350.9 2	100 15	113.831	5/2 ⁺	M1		0.184	
539.85?		539.85 ^b 15	100	0.0	3/2 ⁺	(E1,E2)		0.013 7	
563.74	(9/2) ⁻	110.1 3	13 3	453.95	9/2 ⁺	[E1]		0.312 6	B(E1)(W.u.)=3.1×10 ⁻⁵ 9
		263.2 1	100 7	300.50	7/2 ⁺	E1		0.0346	B(E1)(W.u.)=1.7×10 ⁻⁵ +4-3
607.50	5/2 ⁻	306.80 15	1.1 2	300.50	7/2 ⁺				
		430.84 15	6.1 11	176.53	3/2 ⁺	E1		0.01100	
		493.30 10	12.1 11	113.831	5/2 ⁺	E1		0.00819	E _γ : somewhat poor fit, level-energy difference=493.67.
		607.60 5	100 39	0.0	3/2 ⁺	(E1)		0.00530	
615.58	7/2 ⁻	243.47 6	100	372.17	11/2 ⁻	E2		0.181	B(E2)(W.u.)=48 6
644.29	(3/2,5/2) ⁺	343.80 20	19 4	300.50	7/2 ⁺	(M1)		0.194	
		530.42 10	37 3	113.831	5/2 ⁺	M1(+E2)	<0.8	0.054 8	
		644.30 8	100 7	0.0	3/2 ⁺	M1(+E2)	<0.9	0.032 6	
719.09	9/2 ⁺	254.3 3	96 18	464.76	7/2 ⁺				
		401.2 3	100 24	317.68	5/2 ⁺				
		419.0 3	48 26	300.50	7/2 ⁺				
721.41	3/2 ⁺	403.90 15	15.2 8	317.68	5/2 ⁺	M1(+E2)	<0.03	0.1263	
		544.91 5	62.0 25	176.53	3/2 ⁺	M1+E2	+0.15 10	0.0566 17	
		607.60 5	59 11	113.831	5/2 ⁺	M1+E2	+0.23 +9-7	0.0420 14	
		627.08 8	25.3 10	94.34	1/2 ⁺	M1+E2	-0.7 4	0.031 7	

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Ir})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta^\&$	$\alpha^\@$	Comments
721.41	3/2 ⁺	721.38 5	100 4	0.0	3/2 ⁺	M1+E2	−0.87 +23−43	0.020 4	
736.87	13/2 [−]	364.7 1	100	372.17	11/2 [−]	D			
741.64	(13/2) [−]	177.9 1	100	563.74	(9/2) [−]	E2		0.516	
745.89	11/2 ⁺	292.1 2	24 8	453.95	9/2 ⁺	M1		0.302	
		445.3 [#] 1	100 12	300.50	7/2 ⁺	E2		0.0318	
792.71	(1/2,3/2) ⁺	616.10 15	3.3 5	176.53	3/2 ⁺				
		678.95 10	3.3 5	113.831	5/2 ⁺				
		698.33 8	15.9 16	94.34	1/2 ⁺	M1(+E2)	<1	0.025 5	
		792.67 5	100 6	0.0	3/2 ⁺	M1+E2	0.9 +4−3	0.0158 25	
828.18	3/2 [−]	212.72 10	29 8	615.58	7/2 [−]				
		288.34 10	18 3	539.85?					
		651.61 8	30 3	176.53	3/2 ⁺	(E1)		0.00460	
		714.90 15	20 6	113.831	5/2 ⁺				E_γ : somewhat poor fit, level-energy difference=714.35.
		733.73 15	100 16	94.34	1/2 ⁺	E1		0.00364	
		828.06 8	84 13	0.0	3/2 ⁺	E1+M2	0.19 +9−15	0.0045 18	
831.80	(9/2,11/2) [−]	216.3 3	18 6	615.58	7/2 [−]				I_γ : other: 50 from (p,n γ) in 1975Ke06 seems discrepant.
		459.5 2	100 18	372.17	11/2 [−]	M1		0.0898	
837.89	15/2 [−]	101.0 3	5 1	736.87	13/2 [−]	(M1)		5.95	
		465.7 1	100 12	372.17	11/2 [−]	E2		0.0283	
850.07?	1/2,3/2,5/2 ⁺	673.31 15	63 9	176.53	3/2 ⁺				
		755.95 15	100 15	94.34	1/2 ⁺				
899.40	(11/2 ⁺)	180.4 3	9 4	719.09	9/2 ⁺				
		434.6 3	100 11	464.76	7/2 ⁺	(E2)			
		445.3 [#] 3		453.95	9/2 ⁺				
900.14	(9/2) [−]	284.58 10	100 11	615.58	7/2 [−]	M1		0.324	
		528.0 3	16 11	372.17	11/2 [−]				E_γ : only from (α ,2n γ).
902.65	(3/2) ⁺	181.30 10	100 15	721.41	3/2 ⁺				
		584.95 10	63 9	317.68	5/2 ⁺				
		788.45 ^a 20	67 ^a 33	113.831	5/2 ⁺	(M1)		0.0222	
		809.00 25	48 10	94.34	1/2 ⁺	M1		0.0208	
		902.60 25	28 6	0.0	3/2 ⁺				
912.21	3/2 ⁺	190.83 10	30 8	721.41	3/2 ⁺	M1		0.978	
		594.60 10	29 3	317.68	5/2 ⁺	M1		0.0458	
		735.78 15	100 20	176.53	3/2 ⁺	M1(+E2)	<1.0	0.022 5	
		798.20 10	51 5	113.831	5/2 ⁺	M1		0.0215	
		912.30 20	11 2	0.0	3/2 ⁺				
918.17	13/2 ⁺	172.1 3	1.7 6	745.89	11/2 ⁺				
		464.4 2	100 17	453.95	9/2 ⁺	E2		0.0285	
924.76	(3/2,5/2) [−]	384.80 30	18 4	539.85?					

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Ir})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta^\&$	$\alpha^\@$	Comments
924.76	$(3/2, 5/2)^-$	811.05 20	45 7	113.831	$5/2^+$	E1		0.00300	
		924.75 8	100 8	0.0	$3/2^+$	E1		0.00235	
945.9	$(11/2^-)$	204 ^b		741.64	$(13/2)^-$				
		382.2 3	100 16	563.74	$(9/2)^-$	D			
948.74?		110.1 ^b 6		837.89	$15/2^-$				
		333.3 ^b 3		615.58	$7/2^-$				
		576.8 ^b 6	100 60	372.17	$11/2^-$				
958.66	$(3/2^-, 5/2^-)$	130.54 10	57 17	828.18	$3/2^-$				
		343.20 20	93 21	615.58	$7/2^-$				
		351.10 25	100 21	607.50	$5/2^-$	(M1+E2)		0.12 7	
		640.50 40	43 13	317.68	$5/2^+$				
		782.09 15	46 7	176.53	$3/2^+$				
1074.2?		242.4 ^b 3	100	831.80	$(9/2, 11/2)^-$				
1100.84	$(17/2^-)$	359.2 1	100	741.64	$(13/2)^-$	(E2)		0.0564	
1106.38	$(3/2, 5/2)^+$	384.80 30	28 6	721.41	$3/2^+$				
		788.45 ^a 20	32 ^a 21	317.68	$5/2^+$	(M1)		0.0222	
		929.71 18	22 6	176.53	$3/2^+$				
		992.76 10	45 7	113.831	$5/2^+$	M1		0.01236	
		1011.85 20	27 5	94.34	$1/2^+$				
		1106.30 15	100 10	0.0	$3/2^+$	M1+E2	<0.9	0.0083 12	
1114.52	-	214.6 3	57 15	900.14	$(9/2)^-$				
		282.5 3	100 26	831.80	$(9/2, 11/2)^-$	M1		0.331	
		498.9 ^b 3	30 15	615.58	$7/2^-$				
		743.9 ^b 3	85 22	372.17	$11/2^-$				
1137.27	$(15/2)^-$	400.4 1	100	736.87	$13/2^-$	M1		0.129	
1184.41	$5/2^-$	568.85 5	100 4	615.58	$7/2^-$	M1+E2	-0.214 28	0.0499 16	B(M1)(W.u.)>0.0013; B(E2)(W.u.)>0.056
		576.85 15	0.63 13	607.50	$5/2^-$				
		1007.80 10	1.36 20	176.53	$3/2^+$	E1		0.00200	B(E1)(W.u.)>3.2×10 ⁻⁸
		1070.65 ^a 10	0.5 ^a 3	113.831	$5/2^+$	(E1)			
		1184.15 20	0.50 8	0.0	$3/2^+$				
1203.26	$3/2^+$	885.60 10	66 7	317.68	$5/2^+$	M1+E2	0.9 +11-6	0.0121 36	
		1026.73 7	100 17	176.53	$3/2^+$	(M1+E2)		0.008 4	
		1089.55 15	10 2	113.831	$5/2^+$				
		1108.73 15	34 3	94.34	$1/2^+$	E2(+M1)	>0.6	0.0061 19	
1221.14	-	275.4 ^b 3	<39	945.9	$(11/2^-)$				I_γ : includes contribution from ($\alpha, n\gamma$) channel.
		479.5 2	100 11	741.64	$(13/2)^-$	M1+E2	1.1 +7-4	0.051 12	δ : from conversion electron measurement (1975Ke06).
1238.73?	$(3/2^-, 5/2, 7/2^+)$	623.15 10	100	615.58	$7/2^-$				
1249.0	$(13/2^+)$	349.5 3	25 15	899.40	$(11/2^+)$	(M1)		0.186	

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Ir})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. §	$\delta^\&$	$\alpha^\@$	Comments
1249.0	(13/2 ⁺)	502.6 ^b 3	43 13	745.89	11/2 ⁺				
		530.0 3	100 25	719.09	9/2 ⁺				
1268.28	17/2 ⁻	430.4 1	100 13	837.89	15/2 ⁻	M1		0.1067	
		531.4 3	19 5	736.87	13/2 ⁻				I_γ : other: 7.3 from 1975Ke06 seems too low.
1288.0?		342.1 3	100	945.9	(11/2 ⁻)				
1296.21	15/2 ⁺	378.1 3	14 2	918.17	13/2 ⁺	(M1+E2)			Mult.: D+Q from $\gamma(\theta)$, $\Delta J\pi$ suggests (M1+E2). δ : negative sign from parametric plots of A_2 from $\text{ce}(\theta)$ and $\gamma(\theta)$ (1983Fa11). Value not given.
		550.3 1	100 13	745.89	11/2 ⁺	E2		0.0188	
1312.33	(3/2 ⁺ , 5/2, 7/2 ⁺)	1011.85 20	76 15	300.50	7/2 ⁺				
		1198.50 15	28 6	113.831	5/2 ⁺				
		1312.30 15	100 15	0.0	3/2 ⁺	(E1, M1+E2)		0.0033 21	
1344.51	(3/2 ⁺ , 5/2 ⁺)	623.15 16	100 35	721.41	3/2 ⁺	(M1+E2)		0.027 14	
		1026.73 7	47 24	317.68	5/2 ⁺				
		1044.11 10	46 7	300.50	7/2 ⁺	(E2)		0.00479	
		1167.96 20	24 4	176.53	3/2 ⁺				
		1230.70 15	47 7	113.831	5/2 ⁺	(E2)		0.00349	
		1344.62 15	41 6	0.0	3/2 ⁺	(E2)		0.00297	
1383.60	19/2 ⁻	115.2 3	2.9 10	1268.28	17/2 ⁻	[M1+E2]		3.3 8	
		246.2 ^b	<0.7	1137.27	(15/2) ⁻				
		545.7 1	100 14	837.89	15/2 ⁻	E2		0.0192	
1395.8?		281.6 3	100	1114.52	-				
1447.6?		333.1 ^b 3	100	1114.52	-				
1451.58?	(5/2) ⁻	836.00 8	100	615.58	7/2 ⁻	M1+E2	1.0 +20-7	0.0133 49	
1468.99		284.58 10	100	1184.41	5/2 ⁻				
1476.46	1/2 ⁺ , 3/2 ⁽⁺⁾ , 5/2 ⁺	1300.25 30	6 2	176.53	3/2 ⁺				
		1362.56 15	25 4	113.831	5/2 ⁺	(E1, E2)		0.0021 8	
		1381.64 20	13 7	94.34	1/2 ⁺				
		1476.91 20	100 23	0.0	3/2 ⁺	(E2+M1)	>0.8		
1481.61	(17/2) ⁺	563.5 2	100	918.17	13/2 ⁺	(E2)		0.0178	
1500.19	(1/2, 3/2) ⁻	855.73 20	9 2	644.29	(3/2, 5/2) ⁺				
		1323.66 7	100 7	176.53	3/2 ⁺	E1		1.30×10 ⁻³	
		1405.95 25	22 3	94.34	1/2 ⁺				
1501.35	(3/2 ⁻ , 5/2 ⁻)	708.35 15	35 7	792.71	(1/2, 3/2) ⁺				
		1387.75 25	65 10	113.831	5/2 ⁺				
		1501.70 20	100 15	0.0	3/2 ⁺	(E1)		1.17×10 ⁻³	
1536.88		744.30 20	100 16	792.71	(1/2, 3/2) ⁺				
		1423.00 20	98 20	113.831	5/2 ⁺				

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Ir})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta\&$	$\alpha^@$
1536.88		1536.70 30	29 7	0.0	3/2 ⁺			
1558.20		655.61 10	100 16	902.65	(3/2) ⁺			
		765.40 15	76 16	792.71	(1/2,3/2) ⁺			
		914.25 60	30 10	644.29	(3/2,5/2) ⁺			
		1240.66 35	42 12	317.68	5/2 ⁺			
		1381.64 20	40 40	176.53	3/2 ⁺			
		1443.67 40	50 18	113.831	5/2 ⁺			
		1558.26 [#] 25	40 20	0.0	3/2 ⁺			
1571.67	(3/2,5/2) ⁺	1254.03 7	100 6	317.68	5/2 ⁺	M1+E2	<2.0	0.0055 15
		1395.23 30	8 2	176.53	3/2 ⁺			
		1457.85 20	58 6	113.831	5/2 ⁺	E2		0.00258
		1476.91 20	25 13	94.34	1/2 ⁺			
		1571.60 20	20 2	0.0	3/2 ⁺			
1578.37	(17/2 ⁻)	441.1 2	100 15	1137.27	(15/2) ⁻	M1		0.0325
		840.9 ^b 3	46 15	736.87	13/2 ⁻			
1608.8	(21/2 ⁻)	508.0 3	100	1100.84	(17/2 ⁻)			
1610.24?	(3/2,5/2) ⁻	651.61 8		958.66	(3/2 ⁻ ,5/2 ⁻)			
		782.09 15		828.18	3/2 ⁻			
		1002.65 10	100 20	607.50	5/2 ⁻	M1,E2+E0		0.029 10
		1070.65 ^{ab} 10	73 ^a 36	539.85?				
		1292.35 30	22 4	317.68	5/2 ⁺			
		1496.30 ^{ab} 25	36 ^a 18	113.831	5/2 ⁺			
		1610.85 40	42 5	0.0	3/2 ⁺			
1615.2		394.1 3	100	1221.14	-			
1622.83	1/2 ⁺ ,3/2,5/2 ⁺	1305.25 20	21 6	317.68	5/2 ⁺			
		1446.37 25	96 15	176.53	3/2 ⁺			
		1508.25 40	27 4	113.831	5/2 ⁺			
		1528.42 20	100 19	94.34	1/2 ⁺			
		1623.05 30	22 7	0.0	3/2 ⁺			
1651.2		550.4 3		1100.84	(17/2 ⁻)			
1656.0	(19/2 ⁻)	387.7 3	100	1268.28	17/2 ⁻	(M1)		0.1407
1672.83		880.05 15	100 16	792.71	(1/2,3/2) ⁺	(E1,E2)		0.0047 21
		952.00 20	24 7	721.41	3/2 ⁺			
		1496.30 ^{ab} 25	67 ^a 33	176.53	3/2 ⁺			
		1558.26 [#] 25	22 11	113.831	5/2 ⁺			
		1672.80 ^{#b} 40		0.0	3/2 ⁺			
1767.21	3/2,5/2 ⁺	1159.60 20	35 7	607.50	5/2 ⁻			
		1653.60 25	93 13	113.831	5/2 ⁺			
		1672.8 [#] 4	33 5	94.34	1/2 ⁺			
		1767.08 40	100 10	0.0	3/2 ⁺			

Adopted Levels, Gammas (continued)

 $\gamma(^{189}\text{Ir})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta^\&$	$\alpha^\@$	Comments
1790.9?	(21/2 ⁻)	407.3 ^b 3	100	1383.60	19/2 ⁻	D			
1802.24	(5/2 ⁻)	1080.80 10	74 11	721.41	3/2 ⁺	(E1,E2)		0.0031 14	
		1157.95 20	19 4	644.29	(3/2,5/2) ⁺				
		1195.11 40	13 5	607.50	5/2 ⁻				
		1501.70 20	100 15	300.50	7/2 ⁺	(E1)		1.17×10 ⁻³	
		1688.49 30	17 4	113.831	5/2 ⁺				
		1802.35 40	22 6	0.0	3/2 ⁺				
1814.86?	(1/2,3/2) ⁻	986.63 12	100 16	828.18	3/2 ⁻	M1		0.01255	
		1637.92 40	43 10	176.53	3/2 ⁺				
		1720.92 30	31 5	94.34	1/2 ⁺				
		1815.45 80	17 9	0.0	3/2 ⁺				
1875.53	(21/2 ⁻)	491.9 2	100 14	1383.60	19/2 ⁻				I_γ : other: 82 in 1975Ke06 .
		607.4 3	69 20	1268.28	17/2 ⁻				
1910.28	(19/2 ⁺)	429 1	25 8	1481.61	(17/2) ⁺				
		614.0 2	100 19	1296.21	15/2 ⁺	(Q)			
1919.81	19/2 ⁺	438.3 3	33 5	1481.61	(17/2) ⁺	M1		0.1016	I_γ : other: 15 in 1975Ke06 .
		623.6 1	100 13	1296.21	15/2 ⁺	E2		0.01411	
2059.89	(21/2 ⁻)	140.1 3	100 30	1919.81	19/2 ⁺	(E1)		0.169	Mult.: from intensity balance arguments in 3.7-ms IT decay.
		149.6 3	60 25	1910.28	(19/2 ⁺)	(E1)		0.143	Mult.: dipole from $\gamma(\theta)$, (E1) from $\Delta J\pi$.
		676.3 3	60 25	1383.60	19/2 ⁻				
2085.04	23/2 ⁻	209.3 6	9 6	1875.53	(21/2 ⁻)				
		701.4 2	100 21	1383.60	19/2 ⁻	E2		0.01087	
2108.9	(21/2 ⁻)	725.3 3	100	1383.60	19/2 ⁻				
2109.7	(21/2 ⁺)	628.1 3	100	1481.61	(17/2) ⁺				
2127.89	23/2 ⁺	(68.1)	32×10 ¹ 24	2059.89	(21/2 ⁻)	[E1]		0.220	I_γ : from IT decay.
		208.2 3	100 14	1919.81	19/2 ⁺	E2		0.301	
		217.5 3	54 11	1910.28	(19/2 ⁺)				
		252.5 3	59 11	1875.53	(21/2 ⁻)				
2248.4	(23/2 ⁻ ,25/2 ⁻)	120.8 3	100	2127.89	23/2 ⁺	(E1)		0.246	
2332.8	(25/2 ⁺)	84.5 3	20 7	2248.4	(23/2 ⁻ ,25/2 ⁻)	(E1+M2)	0.18 +4-6	3.7 17	B(E1)(W.u.)=8×10 ⁻¹² 6; B(M2)(W.u.)=0.00017 15 Mult., δ : from $\alpha(\text{exp})$ deduced from intensity balance argument in 3.7-ms IT decay.
		224 1	5.6 23	2108.9	(21/2 ⁻)	(M2)		2.93	B(M2)(W.u.)=1.1×10 ⁻⁵ 6
		247.6 3	100 33	2085.04	23/2 ⁻	(E1)		0.0402	B(E1)(W.u.)=1.6×10 ⁻¹² 8

[†] Weighted average of γ -ray energies from ¹⁸⁹Pt ε decay and ¹⁸⁷Re(α ,2 γ) ([1975An08](#)) when applicable.[‡] Weighted average of branching ratios from ¹⁸⁹Ir IT decay (3.7 ms), ¹⁸⁹Pt ε decay, ¹⁸⁷Re(α ,2 γ) ([1975An08](#)) and ¹⁸⁹Os(p, γ) ([1975Ke06](#)).[§] From conversion electron measurements summarized in ¹⁸⁹Pt ε decay and ¹⁸⁷Re(α ,2 γ), angular distribution measurements from ¹⁸⁷Re(α ,2 γ), and level

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Ir})$ (continued)

- scheme branching intensities in ^{189}Ir IT decay (3.7 ms).
- & Magnitudes of mixing ratios are from conversion electron data. Signs are from low temperature nuclear orientation $\gamma(\theta)$ data ([1980Be27](#)).
 - @ Theoretical values from BrIcc code ([2008Ki07](#)) with “Frozen Orbitals” approximation, unless otherwise stated.
 - # Multiply placed.
 - ^a Multiply placed with intensity suitably divided.
 - ^b Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

Adopted Levels, Gammas (continued)

Band(D): ROTATIONAL BAND

¹⁸⁹Ir₇₇

^{189}Ir IT decay (13.3 ms)

Parent: ^{189}Ir : E=372.17 4; $J^\pi=11/2^-$; $T_{1/2}=13.3$ ms 3; %IT decay=100

 ^{189}Ir Levels

E(level) [†]	J^π [†]	$T_{1/2}$ [†]	Comments
0.0	$3/2^+$		
113.831 23	$5/2^+$		
300.50 4	$7/2^+$		
372.17 4	$11/2^-$	13.3 ms 3	%IT=100 $T_{1/2}$: weighted average of 13.4 ms 2 (1973RoYQ), 12.3 ms 5 (1967Co20), and 14 ms 1 (1963Re13). Other values: 10.0 ms 6 (1960Mo19), 14 ms 3 (1968Io01).

[†] From Adopted Levels.

 $\gamma(^{189}\text{Ir})$

I γ normalization: I(γ +ce)(71.7 γ +258.4 γ)=100.

E_γ [†]	I_γ ^{&}	E_i (level)	J^π_i	E_f	J^π_f	Mult. [†]	δ [†]	α [§]	Comments
71.69 4	30 [†] 5	372.17	$11/2^-$	300.50	$7/2^+$	M2(+E3)	<0.1	76 4	Mult.: in 1967Co20, this was assumed to be M2, although a strong $K\alpha$ x-ray obscured the transition so the analysis was not possible.
113.82 4	$28 \times 10^{1\frac{+}{-}}$ 6	113.831	$5/2^+$	0.0	$3/2^+$	M1+E2	0.55 5	3.88 8	
186.70 6	$62 \times 10^{1\frac{+}{-}}$ 13	300.50	$7/2^+$	113.831	$5/2^+$	M1+E2	-0.7 2	0.84 8	
258.37 6	100 [†] 8	372.17	$11/2^-$	113.831	$5/2^+$	E3		0.876	Mult.: in 1967Co20, M2 was obtained by comparing the ratio of x-ray intensity to that of the isomeric transition. Subsequent electron conversion measurements from electron capture establish E3.
300.51 6	$103 \times 10^{1\frac{+}{-}}$ 22	300.50	$7/2^+$	0.0	$3/2^+$	E2		0.0943	

[†] From Adopted Gammas.

[‡] From intensity balance, with branching ratios from Adopted Gammas.

[§] Theoretical values from BrIcc code (2008Ki07) with "Frozen Orbitals" approximation, unless otherwise stated.

[&] For absolute intensity per 100 decays, multiply by 0.040 7.

^{189}Ir IT decay (13.3 ms)

Decay Scheme

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

Legend

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

^{189}Ir IT decay (3.7 ms) [1975Ke06,1975An08](#)Parent: ^{189}Ir : E=2332.8 3; $J^\pi=(25/2^+)$; $T_{1/2}=3.7$ ms 2; %IT decay=100 ^{189}Ir Levels

E(level) [†]	J^π [‡]	$T_{1/2}$ [‡]	Comments
0.0	$3/2^+$		
113.8 8	$5/2^+$		
300.4 8	$7/2^+$		
372.1 12	$11/2^-$	13.3 ms 3	Total transition intensity feeding this isomer is 11 5 in relative units.
453.9 12	$9/2^+$		
736.8 15	$13/2^-$		
745.8 12	$11/2^+$		
837.8 14	$15/2^-$		
918.1 17	$13/2^+$		
1268.2 17	$17/2^-$		
1296.2 14	$15/2^+$		
1383.5 16	$19/2^-$		
1481.6 22	$(17/2)^+$		
1875.48 21	$(21/2^-)$		
1910.2 21	$(19/2^+)$		
1919.8 16	$19/2^+$		
2059.8 22	$(21/2^-)$		
2085.0 24	$23/2^-$		
2108.8 4	$(21/2^-)$		841 γ and a tentative 972 γ placed by 1975An08 deexciting this level, but the intensity balance arguments for levels fed by these two transitions do not support these placements.
2127.8 23	$23/2^+$		
2248.5 3	$(23/2^-, 25/2^-)$		
2332.8 3	$(25/2^+)$	3.7 ms 2	$T_{1/2}$: weighted average of 3.8 ms 2 (1975Ke06) and 3.2 ms 4 (1975An08); from $\gamma(t)$.

[†] From least-squares fit to E_γ values.[‡] From Adopted Levels.

$\gamma(^{189}\text{Ir})$

I γ normalization: From I(γ +ce)(120.8 γ +224 γ +247.6 γ)=100.

E_γ [‡]	I γ ^{†f}	E _i (level)	J $^\pi_i$	E _f	J $^\pi_f$	Mult. ^b	δ^b	α^e	I(γ +ce) ^f	Comments
(68.1)	4.1 25	2127.8	23/2 ⁺	2059.8	(21/2 ⁻)	[E1]		0.220	5.0 31	I(γ +ce): deduced from intensity balance at 2128 level. I γ : from I(γ +ce) and α .
71.7 1	@	372.1	11/2 ⁻	300.4	7/2 ⁺	M2(+E3)	<0.1	76 4		
84.5 3	1.8 6	2332.8	(25/2 ⁺)	2248.5	(23/2 ⁻ , 25/2 ⁻)	(E1+M2)	0.18 +4-6	3.7 17		Mult.: from α (exp)=3.7 17 (deduced from intensity balance at 2248 level).
101.0 3	0.2 ^a 1	837.8	15/2 ⁻	736.8	13/2 ⁻	(M1)		5.95		
113.8 1	0.9 [§] 2	113.8	5/2 ⁺	0.0	3/2 ⁺	M1+E2	0.55 5	3.88 8		
115.2 3	0.31 & 15	1383.5	19/2 ⁻	1268.2	17/2 ⁻	[M1+E2]		3.3 8		
120.8 3	6.8 23	2248.5	(23/2 ⁻ , 25/2 ⁻)	2127.8	23/2 ⁺	(E1)		0.246		%I γ =34 9, using the deduced normalization factor.
140.1 3	2.8 9	2059.8	(21/2 ⁻)	1919.8	19/2 ⁺	(E1) ^c		0.169		
149.6 3	1.6 ^d 5	2059.8	(21/2 ⁻)	1910.2	(19/2 ⁺)	(E1) ^c		0.143		
153.6 3	0.2 & 1	453.9	9/2 ⁺	300.4	7/2 ⁺	[M1+E2]		1.3 5		
172.1 3	0.034 & 21	918.1	13/2 ⁺	745.8	11/2 ⁺	[M1+E2]		0.9 4		
186.7 1	1.1 [§] 2	300.4	7/2 ⁺	113.8	5/2 ⁺	M1+E2	-0.7 2	0.84 8		
208.2 3	1.3 6	2127.8	23/2 ⁺	1919.8	19/2 ⁺	E2		0.301		
209.3 6	0.9 & 6	2085.0	23/2 ⁻	1875.48	(21/2 ⁻)	[M1+E2]		0.53 23		
217.5 4	0.8 4	2127.8	23/2 ⁺	1910.2	(19/2 ⁺)	[E2]		0.261		
224 1	0.5 2	2332.8	(25/2 ⁺)	2108.8	(21/2 ⁻)	(M2)		2.93		%I γ =2.5 11, using the calculated normalization. Mult.: from α (exp)=2.2 11 (deduced from intensity balance at 2108 level).
247.6 3	9 3	2332.8	(25/2 ⁺)	2085.0	23/2 ⁻	(E1)		0.0402		%I γ =45 11, using the calculated normalization.
252.5 3	0.8 4	2127.8	23/2 ⁺	1875.48	(21/2 ⁻)	[E1]		0.038		
258.3 2	@	372.1	11/2 ⁻	113.8	5/2 ⁺	E3		0.876		
292.1 2	1.4 ^a 7	745.8	11/2 ⁺	453.9	9/2 ⁺	M1		0.302		
300.4 1	1.9 [§] 5	300.4	7/2 ⁺	0.0	3/2 ⁺	E2		0.0943		
340.2 1	2.2 6	453.9	9/2 ⁺	113.8	5/2 ⁺	E2		0.0657		
364.7 1	2.8 7	736.8	13/2 ⁻	372.1	11/2 ⁻	[M1+E2]		0.11 6		
378.1 3	0.9 3	1296.2	15/2 ⁺	918.1	13/2 ⁺	(M1+E2)		0.10 5		
^x 400.6 2										E γ : observed only by ¹⁹⁷⁵ An08 in delayed $\gamma\gamma$ coincidence data.

γ(¹⁸⁹Ir) (continued)

E_γ [‡]	I_γ ^{†f}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ^b	α ^e	Comments
429 1	0.5 ^{&} 3	1910.2	(19/2 ⁺)	1481.6	(17/2 ⁺)			
430.4 1	1.1 6	1268.2	17/2 ⁻	837.8	15/2 ⁻	M1	0.1067	I_γ : from $I_\gamma(429+430)=1.5$ 5 and $I_\gamma(429)=0.44$ from adopted γ branching ratios.
438.3 3	0.63 21	1919.8	19/2 ⁺	1481.6	(17/2 ⁺)	M1	0.1016	
445.3 1	3.5 9	745.8	11/2 ⁺	300.4	7/2 ⁺	E2	0.0318	
464.4 2	2 [#] 1	918.1	13/2 ⁺	453.9	9/2 ⁺	E2	0.0285	
465.7 1	8 [#] 4	837.8	15/2 ⁻	372.1	11/2 ⁻	E2	0.0283	
491.9 2	1.2 3	1875.48	(21/2 ⁻)	1383.5	19/2 ⁻	[M1+E2]	0.05 3	
531.4 3	0.6 ^a 3	1268.2	17/2 ⁻	736.8	13/2 ⁻	[E2]	0.0205	
545.7 1	9.6 24	1383.5	19/2 ⁻	837.8	15/2 ⁻	E2	0.0192	
550.3 1	4.4 11	1296.2	15/2 ⁺	745.8	11/2 ⁺	E2	0.0188	
563.5 2	1.2 6	1481.6	(17/2 ⁺)	918.1	13/2 ⁺	(E2)	0.0178	I_γ : from intensity balance at 1481 level.
607.4 3	0.8 ^{&} 4	1875.48	(21/2 ⁻)	1268.2	17/2 ⁻	[E2]	0.015	
614.0 2	2.0 7	1910.2	(19/2 ⁺)	1296.2	15/2 ⁺	(E2)	0.0146	
623.6 1	3.8 13	1919.8	19/2 ⁺	1296.2	15/2 ⁺	E2	0.01411	
676.3 3	0.31 ^d 15	2059.8	(21/2 ⁻)	1383.5	19/2 ⁻			
701.4 2	8.7 29	2085.0	23/2 ⁻	1383.5	19/2 ⁻	E2	0.01087	
725.3 3	1.6 5	2108.8	(21/2 ⁻)	1383.5	19/2 ⁻			

[†] Delayed intensities from **1975Ke06**, except where noted. Uncertainties of $\approx 30\%$ are assigned by the evaluators.

[‡] From ¹⁸⁷Re($\alpha, 2n\gamma$).

[§] Deduced from intensity balance, not including the feeding from 13.3-ms isomer.

[&] Relative intensity calculated from prompt- γ data.

[@] Due to the long half-life of the isomer at 372 keV, the intensities of the gamma rays are time-dependent, thus cannot be deduced.

[#] Intensity of 464.7 γ and 466.0 γ divided by evaluators on the basis of the level scheme intensity balance. $I_\gamma(465\gamma+466\gamma)=8.8$.

^a From branching ratios in Adopted Gammas.

^b From Adopted Gammas, except for the assumed multipolarities, which are from $\Delta J\pi$, and listed in square brackets here.

^c From intensity balance arguments.

^d The relative intensities of the 149 γ and 676 γ are equal in the prompt ¹⁸⁷Re($\alpha, 2n\gamma$) data but differ by a factor of 5 in the delayed data.

^e Theoretical values from BrIcc code (**2008Ki07**) with “Frozen Orbitals” approximation, unless otherwise stated.

^f For absolute intensity per 100 decays, multiply by 5.0 11.

^x γ ray not placed in level scheme.

^{189}Ir IT decay (3.7 ms) 1975Ke06,1975An08

Decay Scheme

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

Legend

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

$^{189}_{77}\text{Ir}_{112}$

^{189}Pt ε decay (10.87 h) [1972He05,1972Ba21](#)

Parent: ^{189}Pt : $E=0.0$; $J^\pi=3/2^-$; $T_{1/2}=10.87$ h 12; $Q(\varepsilon)=1980$ 14; $\% \varepsilon + \% \beta^+$ decay=100

^{189}Pt - J^π , $T_{1/2}$: From ^{189}Pt Adopted Levels.

^{189}Pt - $Q(\varepsilon)$: From [2017Wa10](#).

[1972He05](#), [1972Ba21](#): measured $E\gamma$, $I\gamma$, $E(\text{ce})$, $I(\text{ce})$, $\gamma\gamma$ -coin, $(\text{ce})\text{ce}(\text{t})$, $\gamma(\text{ce})(\text{t})$.

Decay scheme is from [1972He05](#).

[1980Be27](#): $\gamma(\theta, \text{H}, \text{Temp})$; deduced multipolarity, mixing ratio.

[1971Pi08](#), [1970Pi06](#), [1969Pi06](#): $E\gamma$, $I\gamma$, $I(\text{ce})$, $\gamma\gamma$ -coin, $E\beta$, $I\beta$.

[1970Ba56](#): $E(\text{ce})$, $I(\text{ce})$, $\gamma\gamma$ -coin, $(\text{x ray})\gamma(\text{t})$, $(\text{ce})\text{ce}(\text{t})$, $\gamma(\text{ce})(\text{t})$.

[1970Ba10](#): $E\gamma$, $I\gamma$.

[1969Ha03](#): $\gamma(\text{ce})(\text{t})$.

[1966Kr08](#): $\gamma(\text{ce})(\text{t})$.

[1965Ja12](#): $\gamma\gamma(\text{t})$, $\gamma(\text{ce})(\text{t})$; deduced level half-lives.

[1964Kr03](#): $\gamma(\text{ce})$ -coin.

[1964Le07](#): $E\gamma$, $I\gamma$, ce , half-lives of ^{189}Pt and ^{189}Ir decays; deduced multipolarities.

[1955Sm42](#): measured half-life of ^{189}Pt decay.

Other $E\gamma$, $I\gamma$, ce measurements: [1962Kr04](#), [1962Ha24](#), [1962Gr27](#), [1961Kr02](#), [1960Ma28](#).

 ^{189}Ir Levels

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$T_{1/2}$	Comments
0.0	$3/2^+$		
94.34 3	$1/2^+$	11.4 ns 3	$T_{1/2}$: weighted average of 11.3 ns 3 (1969Ha03) and 11.6 ns 6 (1972Ba21). Other values: 12 ns 1 (1965Ja12), 11 ns 1 (1966Kr08).
113.834 24	$5/2^+$	76 [#] ps 18	$T_{1/2}$: other value: <300 ps (1966Kr08).
176.53 3	$3/2^+$	22 [#] ps 10	
300.50 4	$7/2^+$	<20 ps	
317.68 3	$5/2^+$		
372.17 4	$11/2^-$		
539.76? 7			
607.51 4	$5/2^-$		
615.58 5	$7/2^-$	0.18 [@] ns 2	
644.29 6	$(3/2, 5/2)^+$		
721.41 3	$3/2^+$		
792.71 4	$(1/2, 3/2)^+$		
828.18 5	$3/2^-$		
850.07? 11	$1/2, 3/2, 5/2^+$		
900.16? 12	$(7/2, 9/2)^-$		
902.65 6	$(3/2)^+$		
912.21 6	$3/2^+$		
924.76 8	$(3/2, 5/2)^-$		
958.68 7	$(3/2^-, 5/2^-)$		
1106.39 7	$(3/2, 5/2)^+$		
1184.41 5	$5/2^-$	<80 [@] ps	
1203.26 6	$3/2^+$		
1238.73? 12	$(3/2^-, 5/2, 7/2^+)$		
1312.33 10	$(3/2^+, 5/2, 7/2^+)$		
1344.51 5	$(3/2^+, 5/2^+)$		
1451.58? 10	$(5/2)^-$		
1468.99? 12	-		
1476.46 10	$1/2^+, 3/2^{(+)}, 5/2^+$		
1500.19 7	$(1/2, 3/2)^-$		
1501.35 11	$(1/2^-, 3/2^-, 5/2^-)$		
1536.89 13			
1558.20 8			

Continued on next page (footnotes at end of table)

^{189}Pt ε decay (10.87 h) $^{1972}\text{He05},^{1972}\text{Ba21}$ (continued) ^{189}Ir Levels (continued)

E(level) [†]	$J^{\pi\ddagger}$	E(level) [†]	$J^{\pi\ddagger}$
1571.67 7	(3/2,5/2) ⁺	1672.83 11	
1610.28? 6	(3/2,5/2) ⁻	1767.21 14	3/2,5/2 ⁺
1622.83 11	1/2 ⁺ ,3/2,5/2 ⁺	1802.25 8	(5/2 ⁻)
		1814.86? 12	(1/2,3/2) ⁻

[†] From least-squares fit to $E\gamma$ data. Reduced $\chi^2=1.5$ as compared to critical $\chi^2=1.4$, with two γ ray-energies deviating by about 3σ .

[‡] From Adopted Levels.

From $^{1972}\text{Ba21}$.

@ From $^{1970}\text{Ba56}$.

 ε, β^+ radiations

E(decay) [†]	E(level)	$I\beta^+ \ddagger$	$I\varepsilon^{\ddagger}$	Log ft	$I(\varepsilon + \beta^+)^{\ddagger}$
(165# 14)	1814.86?		0.12 4	6.9 2	0.12 4
(178 14)	1802.25		0.21 6	6.8 2	0.21 6
(213 14)	1767.21		0.12 4	7.3 2	0.12 4
(307 14)	1672.83		0.15 5	7.6 2	0.15 5
(357 14)	1622.83		0.14 4	7.8 2	0.14 4
(370# 14)	1610.28?		0.12 4	7.9 2	0.12 4
(408 14)	1571.67		0.66 19	7.2 2	0.66 19
(422 14)	1558.20		0.15 5	7.9 2	0.15 5
(443 14)	1536.89		0.081 24	8.2 2	0.081 24
(479 14)	1501.35		0.17 5	8.0 2	0.17 5
(480 14)	1500.19		0.30 9	7.7 2	0.30 9
(504 14)	1476.46		0.34 11	7.7 2	0.34 11
(511# 14)	1468.99?		0.15 6	8.1 2	0.15 6
(528# 14)	1451.58?		0.072 21	8.4 2	0.072 21
(635 14)	1344.51		0.41 13	7.9 2	0.41 13
(668 14)	1312.33		0.11 4	8.5 2	0.11 4
(741# 14)	1238.73?		0.06 4	8.9 3	0.06 4
(777 14)	1203.26		0.49 14	8.0 2	0.49 14
(796 14)	1184.41		6.3 17	6.9 1	6.3 17
(874 14)	1106.39		0.38 11	8.2 2	0.38 11
(1021 14)	958.68		0.54 17	8.2 2	0.54 17
(1055 14)	924.76		0.39 11	8.4 2	0.39 11
(1068 14)	912.21		0.81 23	8.1 2	0.81 23
(1077 14)	902.65		0.33 11	8.5 2	0.33 11
(1130# 14)	850.07?		0.10 3	9.0 2	0.10 3
(1152 14)	828.18		0.62 20	8.2 2	0.62 20
(1187 14)	792.71		1.3 4	8.0 2	1.3 4
(1259 14)	721.41		21 6	6.8 1	21 6
(1336 14)	644.29		0.84 23	8.3 1	0.84 23
(1372 14)	607.51		2.4 11	7.8 2	2.4 11
(1440# 14)	539.76?		0.11 5	9.2 2	0.11 5
(1662 14)	317.68	0.037 10	15 4	7.2 1	15 4
(1680# 14)	300.50		<1.8	>9.1	<1.8
(1803 14)	176.53	0.07 3	13 5	7.3 2	13 5
(1866# 14)	113.834	<0.0085	<1.2	>8.4	<1.2
(1886 14)	94.34	0.09 5	12 6	7.4 2	12 6

Continued on next page (footnotes at end of table)

 ^{189}Pt ε decay (10.87 h) $^{1972}\text{He}05,^{1972}\text{Ba}21$ (continued)

 ε, β^+ radiations (continued)

<u>E(decay)[†]</u>	<u>E(level)</u>	<u>$I\beta^+$ [‡]</u>	<u>$I\varepsilon$ [‡]</u>	<u>Log ft</u>	<u>$I(\varepsilon + \beta^+)$ [‡]</u>	<u>Comments</u>
(1980 [#] 14)	0.0	0.24 24	21 21	>6.9	21 21	$I(\varepsilon + \beta^+)$: $^{1972}\text{He}05$ determined 43% 15 from their K x-ray and Auger electron intensities, but the values for K x-ray intensities were not given. Value of 21% 21 given here is deduced by the evaluators from γ normalization factor of 0.079 21.

[†] $^{1971}\text{Pl}08$ report two positron components with endpoint energies of 885 10 and 479 20, respectively, and $I\beta^+(885)/I\beta^+(479)=11$
2. These cannot be ascribed directly to known levels and are probably composite.

[‡] Absolute intensity per 100 decays.

[#] Existence of this branch is questionable.

γ(¹⁸⁹Ir)

Measured Auger electron intensities (on scale as relative I_γ) from Table 2 in ¹⁹⁷²Ba21: KL₁L₁=4.9 7, KL₁L₂=7.0 5, KL₁L₃=5.0 8, KL₂L₃=8.9 6, KL₃L₃=3.3 7. Unless otherwise stated, experimental K-conversion coefficients are from ¹⁹⁷²He05 and experimental subshell ratios are from ¹⁹⁷²Ba21, both papers are from the same group.

A₂U₂ from ¹⁹⁸⁰Be27 defined by W(θ)=Σ_KB_KA_KU_KP_K(cosθ), where B_K is related to the magnetic field and U_K is the disorientation coefficient.

I_γ normalization: Weighted average of 0.061 21 (from I_ε+I_β feeding of 43% 15 to the ground state as determined by ¹⁹⁷²He05 from measured K x-ray and Auger electron intensities, the latter are given in ¹⁹⁷²Ba21, but the K x-ray intensities are not given in either ¹⁹⁷²He05 or ¹⁹⁷²Ba21); and 0.104 25 (deduced by evaluators using the measured Auger electron intensities from ¹⁹⁷²Ba21, on the same relative scale as I_γ, and the theoretical Auger probabilities per K vacancy from ¹⁹⁹¹PeZY, Evaluated Atomic Data Library from LLNL). The total K vacancies were corrected for the contribution from internal conversion, and εK/ε=0.81 was assumed. 15% uncertainty, as recommended by ¹⁹⁹¹PeZY was assigned to the theoretical Auger intensities. ¹⁹⁶³Th07 reported I(K x-ray)=1270, which corresponds to I_γ normalization of 0.11.

E _γ [†]	I _γ ^{†a}	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. [‡]	δ [§]	α [#]	Comments
62.65 6	1.01 22	176.53	3/2 ⁺	113.834	5/2 ⁺	M1+E2	<1.8	16 12	L1:L2:L3=2.9 6:1.5 6:<0.9. I _γ : calculated from I(ce(L1) 62γ)/I(721γ)=2.9 6/100 4. L1:L2:L3=41 4:<6:13.8 14 (¹⁹⁷² Ba21); L1:L2:L3:M12=100:11:38:90 (¹⁹⁶⁴ Le07); L1:L2:L3=50:10:16 (¹⁹⁶² Ha24). I _γ : from I(ce(L1) 71γ)/I(721γ)=41 3/100 4. δ: from L1/L3 in ¹⁹⁷² Ba21 and L1/L2 (with 20% uncertainty) in ¹⁹⁶⁴ Le07.
71.69 4	1.03 23	372.17	11/2 ⁻	300.50	7/2 ⁺	M2(+E3)	<0.1	76 4	α(L1)exp=1.3 2; L1:L2:L3=40 4:6.7 9:3.7 10 K:L1:L2:L3=88 35:10.6 11:126 7:113 6; α(K)exp=1.1 5 I _γ : %I _γ =7.63 57. K:L2:L3=86 7:7.0 7:4.9 5; α(K)exp=2.8 4 I _γ : %I _γ =2.89 28. α: other values: K:L1:L2:L3=110 10:<60:15 5:14 5 (¹⁹⁶⁴ Le07). K:L1:L2:L3::>92:≈33:11:7 (¹⁹⁶² Ha24).
82.22 4	31 3	176.53	3/2 ⁺	94.34	1/2 ⁺	M1+E2	0.17 +3-4	10.71	
94.34 4	82 6	94.34	1/2 ⁺	0.0	3/2 ⁺	M1+E2	3.2 3	5.99	
113.82 4	31.1 22	113.834	5/2 ⁺	0.0	3/2 ⁺	M1+E2	0.55 5	3.88 8	
130.54 10	0.80 24	958.68	(3/2 ⁻ ,5/2 ⁻)	828.18	3/2 ⁻	[M1+E2]		2.2 7	
141.18 4	45.2 23	317.68	5/2 ⁺	176.53	3/2 ⁺	M1+E2	<0.17	2.27	K:L2:L3=88 5:1.53 23:0.23 12; α(K)exp=1.94 14
176.53 7	10.6 5	176.53	3/2 ⁺	0.0	3/2 ⁺	M1+E2	0.7 2	0.99 9	K:L1:L2:L3=11.2 3:1.23 13:0.72 7:0.47 8; α(K)exp=1.1 3 I _γ : %I _γ =0.986 90.
181.30 10	1.20 18	902.65	(3/2) ⁺	721.41	3/2 ⁺	[M1+E2]		0.8 4	
186.70 6	24.0 24	300.50	7/2 ⁺	113.834	5/2 ⁺	M1+E2	-0.7 2	0.84 8	α(K)exp=0.66 8 δ: negative sign from parametric plots of A ₂ from ce(θ) and γ(θ) (¹⁹⁸³ Fa11) in ¹⁹² Os(d,xn) reaction. K:L1:L2:L3:M=15.8 12:2.2 3:0.54 11:0.37 10:0.83 9 (¹⁹⁷² Ba21).

$\gamma(^{189}\text{Ir})$ (continued)

E_γ †	I_γ †a	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ‡	δ §	α #	Comments
190.83 10	1.2 3	912.21	3/2 ⁺	721.41	3/2 ⁺	M1		0.978	$\alpha(\text{K})_{\text{exp}}=0.92$ 30
203.78 8	5.2 5	317.68	5/2 ⁺	113.834	5/2 ⁺	M1+E2	<0.7	0.73 9	$\alpha(\text{K})_{\text{exp}}=0.77$ 25 K:L1:L2:L3=4.0 12:0.8 2:<0.25:<0.2.
212.72 ^e 10	1.1 3	828.18	3/2 ⁻	615.58	7/2 ⁻	[E2]		0.281	
223.34 10	16.0 11	317.68	5/2 ⁺	94.34	1/2 ⁺	E2		0.239	$\alpha(\text{K})_{\text{exp}}=0.109$ 19
243.50 6	75 11	615.58	7/2 ⁻	372.17	11/2 ⁻	E2		0.181	K:L1:L2:L3=8.1 6:1.1 3:2.2 4:1.5 3; $\alpha(\text{K})_{\text{exp}}=0.108$ 19 K:L12:L3=160 20:75 20:42 13 (1964Le07) K:L2:L3=100:70:17 (1962Ha24) K/L12=2.1 (1964Le07)
^x 251.99 25	0.45 14					E2(+M1)	>2.5	0.182 21	K:L1:L2:L3=0.78 8:0.25 13:0.98 10:0.45 6; $\alpha(\text{K})_{\text{exp}}=0.23$ 4
258.37 6	3.4 3	372.17	11/2 ⁻	113.834	5/2 ⁺	E3		0.876	
^x 263.07 15	0.4 2								
284.58 ^{de} 10	0.1 ^d 1	900.16?	(7/2,9/2) ⁻	615.58	7/2 ⁻				
284.58 ^d 10	1.6 ^d 4	1468.99?	-	1184.41	5/2 ⁻	[M1+E2]		0.22 11	I_γ : $I_\gamma(\text{doublet})=1.7$ 3.
288.34 10	0.70 11	828.18	3/2 ⁻	539.76?		[D,E2]		0.17 14	
300.51 6	40.0 20	300.50	7/2 ⁺	0.0	3/2 ⁺	E2		0.0943	$\alpha(\text{K})_{\text{exp}}=0.059$ 6 I_γ : % $I_\gamma=3.72$ 34.
306.80 15	0.32 6	607.51	5/2 ⁻	300.50	7/2 ⁺	[E1]		0.0239	
317.65 6	35.0 18	317.68	5/2 ⁺	0.0	3/2 ⁺	M1+E2	0.5 2	0.209 21	$\alpha(\text{K})_{\text{exp}}=0.171$ 16; K/L12=6.7 14 (1964Le07) I_γ : % $I_\gamma=3.26$ 30.
343.20 20	1.3 3	958.68	(3/2 ⁻ ,5/2 ⁻)	615.58	7/2 ⁻	[M1,E2]		0.13 7	
343.80 20	1.3 3	644.29	(3/2,5/2) ⁺	300.50	7/2 ⁺	(M1)		0.194	$\alpha(\text{K})_{\text{exp}}(343.2+343.8)=0.15$ 6.
351.10 25	1.4 3	958.68	(3/2 ⁻ ,5/2 ⁻)	607.51	5/2 ⁻	(M1+E2)		0.12 7	$\alpha(\text{K})_{\text{exp}}(351.1+352.6)=0.071$ 24. $\alpha(\text{K})_{\text{exp}}(351.1+352.6)=0.071$ 24.
^x 352.63 15	1.7 3								
^x 383.80 20	0.90 18								
384.80 ^c 30	0.53 ^c 11	924.76	(3/2,5/2) ⁻	539.76?					
384.80 ^c 30	0.53 ^c 11	1106.39	(3/2,5/2) ⁺	721.41	3/2 ⁺				
403.90 15	15.2 8	721.41	3/2 ⁺	317.68	5/2 ⁺	M1(+E2)	<0.3	0.123 4	$\alpha(\text{K})_{\text{exp}}=0.115$ 11 A ₂ U ₂ =+0.075 91 gives $\delta=-0.02$ +12-8 (1980Be27).
430.84 15	1.7 3	607.51	5/2 ⁻	176.53	3/2 ⁺	E1		0.01100	$\alpha(\text{K})_{\text{exp}}<0.012$
^x 459.60 20	0.90 18					M1		0.0897	$\alpha(\text{K})_{\text{exp}}=0.089$ 33
^x 484.62 30	0.29 7								
493.30 10	3.4 3	607.51	5/2 ⁻	113.834	5/2 ⁺	E1		0.00819	$\alpha(\text{K})_{\text{exp}}<0.0074$ E_γ : poor fit. Level-energy difference=493.67.
530.42 10	2.50 20	644.29	(3/2,5/2) ⁺	113.834	5/2 ⁺	M1(+E2)	<0.8	0.054 8	$\alpha(\text{K})_{\text{exp}}=0.052$ 14
539.85 ^e 15	3.1 3	539.76?		0.0	3/2 ⁺	(E1,E2)		0.013 7	$\alpha(\text{K})_{\text{exp}}<0.016$ I_γ : % $I_\gamma=0.288$ 36.
544.91 5	62.0 25	721.41	3/2 ⁺	176.53	3/2 ⁺	M1+E2	+0.15 10	0.0566 17	$\alpha(\text{K})_{\text{exp}}=0.057$ 5 δ : from A ₂ U ₂ =-0.552 52 (1980Be27).
568.85 5	76 3	1184.41	5/2 ⁻	615.58	7/2 ⁻	M1+E2	-0.214 28	0.0499 16	$\alpha(\text{K})_{\text{exp}}=0.046$ 4

$\gamma(^{189}\text{Ir})$ (continued)

E_γ †	I_γ †a	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ‡	δ §	α #	Comments
									K:L12:L3=3.5 3:0.59 6:<0.04. δ : from $A_2U_2=-0.142$ 31 (1980Be27).
576.85 15	0.48 10	1184.41	5/2 ⁻	607.51	5/2 ⁻				
584.95 10	0.75 11	902.65	(3/2) ⁺	317.68	5/2 ⁺				
594.60 10	1.15 12	912.21	3/2 ⁺	317.68	5/2 ⁺	M1		0.0458	$\alpha(K)\text{exp}=0.044$ 10
607.60 ^{de} 5	28 ^{d@} 11	607.51	5/2 ⁻	0.0	3/2 ⁺	[E1]		0.00530	I_γ : % $I_\gamma=2.6$ 10.
607.60 ^d 5	59 ^{d@} 11	721.41	3/2 ⁺	113.834	5/2 ⁺	M1+E2	+0.23 +9-7	0.0420 14	$\alpha(K)\text{exp}=0.041$ 9 K:L12:L3=66 12:11 1:<1 (1964Le07). δ : from $A_2U_2=+0.342$ 44 (1980Be27).
616.10 15	0.48 7	792.71	(1/2,3/2) ⁺	176.53	3/2 ⁺				
623.15 ^d 10	0.8 ^d 4	1238.73?	(3/2 ⁻ ,5/2,7/2 ⁺)	615.58	7/2 ⁻				$\alpha(K)\text{exp}(623.2+623.2)=0.020$ 7. I_γ : $I_\gamma(623.2+623.2)=2.5$ 4.
623.15 ^d 15	1.7 ^d 6	1344.51	(3/2 ⁺ ,5/2 ⁺)	721.41	3/2 ⁺	(M1+E2)		0.027 14	$\alpha(K)\text{exp}(623.2+623.2)=0.020$ 7. I_γ : $I_\gamma(623.2+623.2)=2.5$ 4.
627.08 8	25.3 10	721.41	3/2 ⁺	94.34	1/2 ⁺	M1+E2	-0.7 4	0.031 7	$\alpha(K)\text{exp}=0.027$ 5; K/L12=4.8 12 K/(L1+L2) from 1964Le07. δ : from $A_2U_2=+0.94$ 11 (1980Be27).
640.50 40	0.60 18	958.68	(3/2 ⁻ ,5/2 ⁻)	317.68	5/2 ⁺				
644.30 8	6.8 5	644.29	(3/2,5/2) ⁺	0.0	3/2 ⁺	M1(+E2)	<0.9	0.032 6	$\alpha(K)\text{exp}=0.031$ 9 I_γ : % $I_\gamma=0.632$ 68. $A_2U_2=+0.30$ 18 gives $\delta=0.00$ +12-15 (1980Be27).
651.61 ^b 8	1.14 11	828.18	3/2 ⁻	176.53	3/2 ⁺	(E1)		0.00460	$\alpha(K)\text{exp}<0.0175$ Mult.: Supported by parity change and $\alpha(K)\text{exp}$, although $\alpha(K)\text{exp}$ does not exclude E2. I_γ : $I_\gamma(\text{doublet})=1.14$ 11.
651.61 ^{be} 8		1610.28?	(3/2,5/2) ⁻	958.68	(3/2 ⁻ ,5/2 ⁻)				
655.61 10	0.50 8	1558.20		902.65	(3/2) ⁺				
673.31 ^e 15	0.47& 7	850.07?	1/2,3/2,5/2 ⁺	176.53	3/2 ⁺				
678.95 10	0.48 7	792.71	(1/2,3/2) ⁺	113.834	5/2 ⁺				
698.33 8	2.30 23	792.71	(1/2,3/2) ⁺	94.34	1/2 ⁺	M1+E2	<1	0.025 5	$\alpha(K)\text{exp}=0.026$ 9
708.35 ^e 15	0.38 8	1501.35	(1/2 ⁻ ,3/2 ⁻ ,5/2 ⁻)	792.71	(1/2,3/2) ⁺				
714.90 15	0.75 23	828.18	3/2 ⁻	113.834	5/2 ⁺				E_γ : poor fit. Level-energy difference=714.34.
721.38 5	100 4	721.41	3/2 ⁺	0.0	3/2 ⁺	M1+E2	-0.87 +23-43	0.020 4	$\alpha(K)\text{exp}=0.023$ 3 I_γ : % $I_\gamma=9.30$ 81. Mult.: from $\alpha(K)\text{exp}$. δ : from $A_2U_2=+0.492$ 63 (1980Be27). $\alpha(K)\text{exp}<0.0053$
733.73 15	3.8 6	828.18	3/2 ⁻	94.34	1/2 ⁺	E1		0.00364	

$\gamma(^{189}\text{Ir})$ (continued)

E_γ †	I_γ † ^a	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ‡	δ §	α #	Comments
735.78 15	4.0 & 8	912.21	3/2 ⁺	176.53	3/2 ⁺	M1(+E2)	<1.0	0.022 5	$\alpha(\text{K})\text{exp}=0.022\ 7$
744.30 20	0.45 7	1536.89		792.71	(1/2,3/2) ⁺				
^x 751.03 10	0.65 10								
755.95 ^e 15	0.75 & 11	850.07?	1/2,3/2,5/2 ⁺	94.34	1/2 ⁺				
765.40 15	0.38 8	1558.20		792.71	(1/2,3/2) ⁺				
^x 772.00 15	0.20 6								
^x 778.10 40	0.17 & 5								
782.09 ^b 15	0.64 & 10	958.68	(3/2 ⁻ ,5/2 ⁻)	176.53	3/2 ⁺				I_γ : main intensity of this γ belongs to the decay of 959 level, decay from a tentative level at 1610 is uncertain. I_γ : $I_\gamma(\text{doublet})=0.64\ 10$.
782.09 ^{be} 15		1610.28?	(3/2,5/2) ⁻	828.18	3/2 ⁻				
788.45 ^d 20	0.8 ^d 4	902.65	(3/2) ⁺	113.834	5/2 ⁺	(M1)		0.0222	$\alpha(\text{K})\text{exp}(788.4+788.4)=0.21\ 7$.
788.45 ^d 20	0.6 ^d 4	1106.39	(3/2,5/2) ⁺	317.68	5/2 ⁺	(M1)		0.0222	
792.67 5	14.5 9	792.71	(1/2,3/2) ⁺	0.0	3/2 ⁺	M1+E2	0.9 +4-3	0.0158 25	$\alpha(\text{K})\text{exp}=0.0131\ 21$ I_γ : % $I_\gamma=1.35\ 13$. δ : if J=3/2, $A_2U_2=-0.03\ 7$ is consistent only with $\delta<0.4$. The isotropic distribution of this γ ray favors J=1/2.
798.20 10	2.05 21	912.21	3/2 ⁺	113.834	5/2 ⁺	M1		0.0215	$\alpha(\text{K})\text{exp}=0.018\ 6$
809.00 25	0.58 12	902.65	(3/2) ⁺	94.34	1/2 ⁺	M1		0.0208	$\alpha(\text{K})\text{exp}=0.021\ 8$
811.05 20	1.35 20	924.76	(3/2,5/2) ⁻	113.834	5/2 ⁺	E1		0.00300	$\alpha(\text{K})\text{exp}<0.0037$
^x 820.00 50	0.16 5								
828.06 8	3.2 & 5	828.18	3/2 ⁻	0.0	3/2 ⁺	E1+M2	0.19 +9-15	0.0045 18	$\alpha(\text{K})\text{exp}=0.0038\ 13$ I_γ : % $I_\gamma=0.298\ 52$.
836.00 ^e 8	0.90 9	1451.58?	(5/2) ⁻	615.58	7/2 ⁻	M1+E2	1.0 +20-7	0.0133 49	$\alpha(\text{K})\text{exp}=0.011\ 4$
855.73 20	0.25 6	1500.19	(1/2,3/2) ⁻	644.29	(3/2,5/2) ⁺				
880.05 15	0.90 14	1672.83		792.71	(1/2,3/2) ⁺	(E1,E2)		0.0047 21	$\alpha(\text{K})\text{exp}<0.0056$
885.60 10	1.90 & 19	1203.26	3/2 ⁺	317.68	5/2 ⁺	M1+E2	0.9 +11-6	0.0121 36	$\alpha(\text{K})\text{exp}=0.010\ 3$
^x 892.50 20	0.42 6								
902.60 25	0.34 7	902.65	(3/2) ⁺	0.0	3/2 ⁺				I_γ : % $I_\gamma=0.0316\ 69$.
912.30 20	0.44 9	912.21	3/2 ⁺	0.0	3/2 ⁺				I_γ : % $I_\gamma=0.0409\ 89$.
914.25 60	0.15 5	1558.20		644.29	(3/2,5/2) ⁺				
924.75 8	3.00 24	924.76	(3/2,5/2) ⁻	0.0	3/2 ⁺	E1		0.00235	$\alpha(\text{K})\text{exp}<0.0023$ I_γ : % $I_\gamma=0.279\ 31$.
929.71 18	0.41 12	1106.39	(3/2,5/2) ⁺	176.53	3/2 ⁺				
^x 933.90 30	0.30 6								
952.00 20	0.22 6	1672.83		721.41	3/2 ⁺				
^x 955.50 20	0.18 5								
986.63 ^e 12	0.77 & 12	1814.86?	(1/2,3/2) ⁻	828.18	3/2 ⁻	M1		0.01255	$\alpha(\text{K})\text{exp}=0.016\ 6$

$\gamma(^{189}\text{Ir})$ (continued)

E_γ †	I_γ †a	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ‡	δ §	α #	Comments
992.76 10	0.86 13	1106.39	(3/2,5/2) ⁺	113.834	5/2 ⁺	M1		0.01236	$\alpha(\text{K})_{\text{exp}}=0.014$ 5
1002.65 ^e 10	0.55 11	1610.28?	(3/2,5/2) ⁻	607.51	5/2 ⁻	M1,E2+E0		0.029 10	$\alpha(\text{K})_{\text{exp}}=0.022$ 8 α : from $\alpha(\text{K})_{\text{exp}}$, with $\approx 30\%$ added for higher shells. Mult.: $\alpha(\text{K})_{\text{exp}}$ consistent with pure M1 ($\alpha(\text{K})(\text{M1})=0.010$) within 1.5σ or with E2+E0 ($\alpha(\text{K})(\text{E2})=0.0042$) with large E0 component.
1007.80 10	1.03 15	1184.41	5/2 ⁻	176.53	3/2 ⁺	E1		0.00200	$\alpha(\text{K})_{\text{exp}}<0.0039$
1011.85 ^c 20	0.52 ^c 10	1106.39	(3/2,5/2) ⁺	94.34	1/2 ⁺				$\alpha(\text{K})_{\text{exp}}(1011.8+1011.8)<0.0135$.
1011.85 ^c 20	0.52 ^c 10	1312.33	(3/2 ⁺ ,5/2,7/2 ⁺)	300.50	7/2 ⁺				
1026.73 ^d 7	2.9 ^d 5	1203.26	3/2 ⁺	176.53	3/2 ⁺	(M1+E2)		0.008 4	$\alpha(\text{K})_{\text{exp}}(1026.7+1026.7)=0.0081$ 18. I_γ : $I_\gamma(1026.7+1026.7)=3.70$ 22.
1026.73 ^d 7	0.8 ^d 4	1344.51	(3/2 ⁺ ,5/2 ⁺)	317.68	5/2 ⁺				
^x 1033.74 10	0.50 8					(M1,E2+E0)			$\alpha(\text{K})_{\text{exp}}=0.20$ 6
1044.11 10	0.78 12	1344.51	(3/2 ⁺ ,5/2 ⁺)	300.50	7/2 ⁺	(E2)		0.00479	$\alpha(\text{K})_{\text{exp}}<0.0051$ Mult.: $\alpha(\text{K})_{\text{exp}}$ does not exclude E1, but additional argument for E2 comes from log f_t support for J^π assignment.
1070.65 ^d 10	0.4 ^d 2	1184.41	5/2 ⁻	113.834	5/2 ⁺	(E1)			$\alpha(\text{K})_{\text{exp}}(1070.6+1070.6)<0.0059$. I_γ : $I_\gamma(1070.6+1070.6)=0.85$ 13.
1070.65 ^{de} 10	0.4 ^d 2	1610.28?	(3/2,5/2) ⁻	539.76?					
1080.80 10	0.80 12	1802.25	(5/2 ⁻)	721.41	3/2 ⁺	(E1)		0.00176	$\alpha(\text{K})_{\text{exp}}<0.0075$ Mult.: $\alpha(\text{K})_{\text{exp}}$ allows E1, E2 or M1, but proposed $\Delta J\pi$ favors E1.
1089.55 15	0.30 5	1203.26	3/2 ⁺	113.834	5/2 ⁺				
1106.30 15	1.90 19	1106.39	(3/2,5/2) ⁺	0.0	3/2 ⁺	M1(+E2)	<0.9	0.0083 12	$\alpha(\text{K})_{\text{exp}}=0.0079$ 18 I_γ : % $I_\gamma=0.177$ 22.
1108.73 15	1.00 10	1203.26	3/2 ⁺	94.34	1/2 ⁺	E2(+M1)	>0.6	0.0061 19	$\alpha(\text{K})_{\text{exp}}=0.0050$ 16
^x 1123.80 15	0.21 4								
^x 1143.94 15	0.33 ^{&} 10								
1157.95 20	0.21 4	1802.25	(5/2 ⁻)	644.29	(3/2,5/2) ⁺				
1159.60 20	0.21 4	1767.21	3/2,5/2 ⁺	607.51	5/2 ⁻				
1167.96 20	0.40 6	1344.51	(3/2 ⁺ ,5/2 ⁺)	176.53	3/2 ⁺				
1184.15 20	0.38 6	1184.41	5/2 ⁻	0.0	3/2 ⁺				I_γ : % $I_\gamma=0.0353$ 62.
1195.11 40	0.14 5	1802.25	(5/2 ⁻)	607.51	5/2 ⁻				
1198.50 15	0.19 4	1312.33	(3/2 ⁺ ,5/2,7/2 ⁺)	113.834	5/2 ⁺				
1230.70 15	0.80 12	1344.51	(3/2 ⁺ ,5/2 ⁺)	113.834	5/2 ⁺	(E2)		0.00349	$\alpha(\text{K})_{\text{exp}}<0.00375$ Mult.: $\alpha(\text{K})_{\text{exp}}$ does not exclude E1, but additional argument for E2 comes from log f_t support for J^π assignment.

$\gamma(^{189}\text{Ir})$ (continued)

E_γ †	I_γ † ^a	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ‡	δ §	α #	Comments
1240.66 35	0.21 6	1558.20		317.68	5/2 ⁺				
1254.03 7	3.94 24	1571.67	(3/2,5/2) ⁺	317.68	5/2 ⁺	M1+E2	<2.0	0.0055 15	$\alpha(\text{K})\text{exp}=0.0046$ 12
1292.35 ^e 30	0.12 2	1610.28?	(3/2,5/2) ⁻	317.68	5/2 ⁺				
1300.25 30	0.18 5	1476.46	1/2 ⁺ , 3/2 ⁽⁺⁾ , 5/2 ⁺	176.53	3/2 ⁺				
1305.25 20	0.14 ^{&} 4	1622.83	1/2 ⁺ , 3/2, 5/2 ⁺	317.68	5/2 ⁺				
1312.30 15	0.68 10	1312.33	(3/2 ⁺ , 5/2, 7/2 ⁺)	0.0	3/2 ⁺	(M1+E2, E1)		0.0033 21	$\alpha(\text{K})\text{exp}<0.0044$ I_γ : % $I_\gamma=0.063$ 10. Mult.: $\alpha(\text{K})\text{exp}$ gives M1+E2 with $\delta>0.6$ or E1.
1323.66 7	2.90 ^{&} 20	1500.19	(1/2, 3/2) ⁻	176.53	3/2 ⁺	E1		1.30×10 ⁻³	$\alpha(\text{K})\text{exp}<0.0017$
1344.62 15	0.70 10	1344.51	(3/2 ⁺ , 5/2 ⁺)	0.0	3/2 ⁺	(E2)		0.00297	$\alpha(\text{K})\text{exp}<0.00286$ I_γ : % $I_\gamma=0.065$ 10. Mult.: $\alpha(\text{K})\text{exp}$ does not exclude E1, but additional argument for E2 comes from log ft support for J^π assignment.
^x 1356.35 30	0.28 6								
1362.56 15	0.75 11	1476.46	1/2 ⁺ , 3/2 ⁽⁺⁾ , 5/2 ⁺	113.834	5/2 ⁺	(E1, E2)		0.0021 8	$\alpha(\text{K})\text{exp}<0.0027$
1381.64 ^d 20	0.4 ^d 2	1476.46	1/2 ⁺ , 3/2 ⁽⁺⁾ , 5/2 ⁺	94.34	1/2 ⁺				I_γ : $I_\gamma(1381.6+1381.6)=0.63$ 10.
1381.64 ^d 20	0.2 ^d 2	1558.20		176.53	3/2 ⁺				
1387.75 25	0.70 11	1501.35	(1/2 ⁻ , 3/2 ⁻ , 5/2 ⁻)	113.834	5/2 ⁺				
1395.23 30	0.33 8	1571.67	(3/2, 5/2) ⁺	176.53	3/2 ⁺				
1405.95 25	0.63 9	1500.19	(1/2, 3/2) ⁻	94.34	1/2 ⁺				
^x 1408.52 25	0.61 9								
1423.00 20	0.44 9	1536.89		113.834	5/2 ⁺				
1443.67 40	0.25 9	1558.20		113.834	5/2 ⁺				
1446.37 25	0.64 ^{&} 10	1622.83	1/2 ⁺ , 3/2, 5/2 ⁺	176.53	3/2 ⁺				
1457.85 20	2.30 ^{&} 23	1571.67	(3/2, 5/2) ⁺	113.834	5/2 ⁺	E2		0.00258	$\alpha(\text{K})\text{exp}=0.0022$ 7
1476.91 ^d 20	3.0 ^d 7	1476.46	1/2 ⁺ , 3/2 ⁽⁺⁾ , 5/2 ⁺	0.0	3/2 ⁺	(E2+M1)	>0.8	0.0031 6	I_γ : % $I_\gamma=0.279$ 68. $\alpha(\text{K})\text{exp}(1476.9+1476.9)=0.0025$ 6. I_γ : $I_\gamma(1476.9+1476.9)=4.0$ 4.
1476.91 ^d 20	1.0 ^d 5	1571.67	(3/2, 5/2) ⁺	94.34	1/2 ⁺				
^x 1485.20 30	0.17 3								
1496.30 ^{de} 25	0.2 ^d 1	1610.28?	(3/2, 5/2) ⁻	113.834	5/2 ⁺				I_γ : $I_\gamma(1496.3+1496.3)=0.75$ 19.
1496.30 ^{de} 25	0.6 ^d 3	1672.83		176.53	3/2 ⁺				
1501.70 ^c 20	1.08 ^c 16	1501.35	(1/2 ⁻ , 3/2 ⁻ , 5/2 ⁻)	0.0	3/2 ⁺	(E1)		1.17×10 ⁻³	I_γ : % $I_\gamma=0.100$ 16. $\alpha(\text{K})\text{exp}(1501.7+1501.7)<0.0018$.
1501.70 ^c 20	1.08 ^c 16	1802.25	(5/2 ⁻)	300.50	7/2 ⁺	(E1)		1.17×10 ⁻³	
^x 1504.00 30	0.36 7								
1508.25 40	0.18 3	1622.83	1/2 ⁺ , 3/2, 5/2 ⁺	113.834	5/2 ⁺				
1528.42 20	0.67 13	1622.83	1/2 ⁺ , 3/2, 5/2 ⁺	94.34	1/2 ⁺				

$\gamma(^{189}\text{Ir})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^\ddagger a$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
1536.70 ³⁰	0.13 ³	1536.89		0.0	3/2 ⁺	I_γ : % I_γ =0.0121 29.
^x 1554.76 ⁴⁰	0.13 ⁴					
1558.26 ^d ²⁵	0.2 ^{d&} ¹	1558.20		0.0	3/2 ⁺	I_γ : % I_γ =0.0186 94. I_γ : $I_\gamma(1558.3+1558.3)$ =0.40 6.
1558.26 ^d ²⁵	0.2 ^{d&} ¹	1672.83		113.834	5/2 ⁺	
1571.60 ²⁰	0.80 ⁸	1571.67	(3/2,5/2) ⁺	0.0	3/2 ⁺	I_γ : % I_γ =0.0744 95.
^x 1579.85 ⁵⁰	0.09 ⁴					
^x 1593.24 ²⁰	0.38 ⁶					
^x 1601.70 ³⁰	0.15 ³					
1610.85 ^e ⁴⁰	0.23 ³	1610.28?	(3/2,5/2) ⁻	0.0	3/2 ⁺	I_γ : % I_γ =0.0214 32.
^x 1613.85 ⁴⁰	0.37 ⁶					
1623.05 ³⁰	0.15 ⁵	1622.83	1/2 ⁺ , 3/2,5/2 ⁺	0.0	3/2 ⁺	I_γ : % I_γ =0.0140 47.
^x 1635.40 ⁸⁰	0.22 ⁸					
1637.92 ^e ⁴⁰	0.33 ⁸	1814.86?	(1/2,3/2) ⁻	176.53	3/2 ⁺	
1653.60 ²⁵	0.56 ^{&} ⁸	1767.21	3/2,5/2 ⁺	113.834	5/2 ⁺	
1672.8 ^{be} ⁴		1672.83		0.0	3/2 ⁺	I_γ : $I_\gamma(\text{doublet})$ =0.20 3.
1672.80 ^b ⁴⁰	0.20 ³	1767.21	3/2,5/2 ⁺	94.34	1/2 ⁺	
^x 1683.70 ³⁰	0.27 ⁴					
1688.49 ³⁰	0.18 ^{&} ⁴	1802.25	(5/2 ⁻)	113.834	5/2 ⁺	
1720.92 ^e ³⁰	0.24 ⁴	1814.86?	(1/2,3/2) ⁻	94.34	1/2 ⁺	
^x 1740.23 ⁴⁰	0.19 ³					
1767.08 ⁴⁰	0.60 ⁶	1767.21	3/2,5/2 ⁺	0.0	3/2 ⁺	I_γ : % I_γ =0.0558 71.
^x 1785.96 ⁴⁰	0.15 ⁶					
^x 1792.00 ⁴⁰	0.20 ⁵					
^x 1798.04 ⁴⁰	0.30 ⁶					
1802.35 ⁴⁰	0.24 ^{&} ⁷	1802.25	(5/2 ⁻)	0.0	3/2 ⁺	I_γ : % I_γ =0.0223 67.
^x 1811.34 ⁸⁰	0.14 ^{&} ⁷					
1815.45 ^e ⁸⁰	0.13 ⁷	1814.86?	(1/2,3/2) ⁻	0.0	3/2 ⁺	

[†] From ¹⁹⁷²He05.[‡] From conversion electron data of ¹⁹⁷²He05 and ¹⁹⁷²Ba21, except where noted.[§] Magnitudes of δ values are from conversion electron data. Signs are from low temperature $\gamma(\theta)$ data (¹⁹⁸⁰Be27).[&] Corrected for ¹⁸⁸Ir contamination.[@] $I_\gamma(\text{tot})$ =87 4, intensity divided assuming intensity balance through the 113.8 level.[#] Theoretical values from BrIcc code (²⁰⁰⁸Ki07) with “Frozen Orbitals” approximation, unless otherwise stated.^a For absolute intensity per 100 decays, multiply by 0.079 21.^b Multiply placed.^c Multiply placed with undivided intensity.

¹⁸⁹Pt ε decay (10.87 h) 1972He05,1972Ba21 (continued)

γ(¹⁸⁹Ir) (continued)

- ^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.

¹⁸⁹Pt ε decay (10.87 h) 1972He05,1972Ba21

Decay Scheme

Legend

- I_γ < 2% × I_γ^{max}
 —→ I_γ < 10% × I_γ^{max}
 —→ I_γ > 10% × I_γ^{max}
 - - - - - γ Decay (Uncertain)

Intensities: I_(γ+ε) per 100 parent decays
 @ Multiply placed: intensity suitably divided
 & Multiply placed: undivided intensity given

¹⁸⁹Pt ε decay (10.87 h) ¹⁹⁷²He05,¹⁹⁷²Ba21

Decay Scheme (continued)

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

^{189}Pt ϵ decay (10.87 h) 1972He05,1972Ba21

Decay Scheme (continued)

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

@ Multiply placed: intensity suitably divided

& Multiply placed: undivided intensity given

$3/2^-$ 0.0 10.87 h 12
 $Q^+ = 1980$ 14
 $^{189}\text{Pt}_{111}$

$^{189}_{77}\text{Ir}_{112}$

¹⁸⁹Pt ϵ decay (10.87 h) 1972He05,1972Ba21

Decay Scheme (continued)

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)
- Coincidence

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiply placed: intensity suitably divided
 & Multiply placed: undivided intensity given

^{189}Pt ϵ decay (10.87 h) 1972He05,1972Ba21

Decay Scheme (continued)

Legend

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

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiply placed: intensity suitably divided
 & Multiply placed: undivided intensity given

¹⁸⁷Re($\alpha,2n\gamma$) [1975Ke06,1975An08](#)

Includes ¹⁸⁹Os(p,n γ) from [1975Ke06](#).

[1975Ke06](#): ¹⁸⁷Re($\alpha,2n\gamma$), E α =23,27 MeV; ¹⁸⁹Os(p,n γ), E(p)=10 MeV; Enriched target; measured E γ , I γ , $\gamma(\theta,t)$, $\gamma\gamma$ -coin, $\gamma(t)$, I(ce). Prompt and delayed γ rays detected.

[1975An08](#): ¹⁸⁷Re($\alpha,2n\gamma$), E=23-43 MeV; measured E γ , I γ , $\gamma(\theta)$, $\gamma\gamma$ -coin, $\gamma(t)$. Prompt and delayed γ rays detected.

[1978Ya06](#): E=28 MeV. Measured E γ , I γ . Five γ rays of 243.3, 247.6, 252.5, 254.5 and 545.6 keV shown in a singles γ -ray spectrum; and another nine γ rays are shown in a level-scheme Fig. 2 with relative intensities. The gamma-ray energy precision is claimed to be 0.06 keV. Main emphasis of this work is on establishing an upper limit of intensity for a 246.2-keV transition from 19/2⁻ level to 15/2⁻ level in order to make a comparison with predictions of Meyer-ter-Vehn's triaxial rotor model.

[1983Fa11](#): ¹⁹²Os(d,5n γ), E=52 MeV. Measured conversion electron spectra, and ce(θ) using permanent magnets and a Si(Li) detector. Positive A₂ values obtained for 300.5, 340.3, 445.3, 550.4, 563.6 and 623.7 keV transitions in the 3/2⁺ band; and for 364.8, 400.6, 401.2, 430.5, 441.2 and 545.8 keV transitions in the 11/2⁻ band, which are consistent with their being stretched quadrupole transitions. Negative A₂ for 186.7 and 378.1 keV transitions in the 3/2⁺ band, and for 387.9 keV transition in the 11/2⁻ band are consistent with stretched dipole transitions.

[2012MaZP](#): ¹⁸⁶W(⁷Li,4n γ): E(⁷Li)=31 MeV from tandem van de Graaff accelerator at IFIN-HH in Bucharest. Measured E γ , $\gamma\gamma$, half-life of 564-keV state in ¹⁸⁹Ir by $\gamma\gamma(t)$ method using an array of eight HPGe detectors and 11 LaBr₃:Ce detectors. Half-life was measured from time difference between feeding and depopulating transitions.

Level scheme is from [1975Ke06](#) and [1975An08](#).

¹⁸⁹Ir Levels

A tentative 2186.8 level proposed by [1975Ke06](#) (also in [1978Ya06](#)) is omitted here as the 531.3 γ is placed from a 1268 level, as proposed by [1975An08](#).

A tentative 688.4, (9/2⁺) level proposed by [1975An08](#) is omitted here as the 223.5⁻ and 387.9-keV gammas from this level are doubly placed in [1975An08](#), but singly placed in [1975Ke06](#).

A tentative 1667.5 level proposed by [1975An08](#) is omitted here as the 529.9 gamma from this level is placed from a 1248 level in [1975Ke06](#).

A 2096.5, 21/2⁺ level proposed by [1975An08](#) is omitted here as the 614.1 gamma from this level is placed from a 1910, 19/2⁺ level in [1975Ke06](#), and a tentatively placed 177 γ in [1975An08](#) is placed from 741 level in [1975Ke06](#).

E(level) [†]	J π [‡]	T _{1/2} [#]	Comments
0.0@	3/2 ⁺	13.2 d 1	
94.24& 20	1/2 ⁺		
113.74@ 8	5/2 ⁺		
176.53& 18	3/2 ⁺		
300.44@ 8	7/2 ⁺		
317.60& 17	5/2 ⁺		
372.12 ^a 12	11/2 ⁻	13.3 ms 3	
453.87@ 11	9/2 ⁺		
464.69& 16	7/2 ⁺		
563.67 ^b 13	9/2 ⁻	0.54 ns 10	T _{1/2} : measured by 2012MaZP from time difference between the 178 γ feeding this level, and the deexciting 263 γ .
615.48 15	7/2 ⁻	0.18 ns 2	
719.01& 18	9/2 ⁺		Level only from 1975Ke06 .
736.82 ^a 15	13/2 ⁻		
741.57 ^b 16	13/2 ⁻		
745.82@ 12	11/2 ⁺		
831.72 20	(9/2,11/2) ⁻		Level only from 1975Ke06 .
837.84 ^a 14	15/2 ⁻		
899.32& 20	11/2 ⁺		
899.92 23	9/2 ⁻		

Continued on next page (footnotes at end of table)

$^{187}\text{Re}(\alpha, 2n\gamma)$ **1975Ke06, 1975An08 (continued)** ^{189}Ir Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2} [#]	Comments
918.10 [@] 17	13/2 ⁺		
945.9 4	11/2 ⁻		
948.7? 3	(11/2 ⁻)		Level only from 1975An08.
1074.1? 4			Level only from 1975Ke06, in authors' Fig. 6, E(level)=1054.0 seems a misprint.
1100.77 ^b 19	17/2 ⁻		
1114.4 3	11/2 ⁻		
1137.22 18	15/2 ⁻		
1221.1 3	15/2 ⁻		
1248.9 ^{&} 3	13/2 ⁺		Level only from 1975Ke06.
1268.23 ^a 16	17/2 ⁻		
1288.0 5	(13/2 ⁻)		Level only from 1975Ke06.
1296.14 [@] 14	15/2 ⁺		
1383.54 ^a 16	19/2 ⁻		
1396.0? 4			Level only from 1975Ke06.
1447.5 4			Level only from 1975Ke06.
1481.54 [@] 22	17/2 ⁺		
1578.3 3	(17/2 ⁻)		
1608.8 ^b 4	21/2 ⁻		Level only from 1975Ke06.
1615.2 4	(17/2 ⁻)		
1651.2 4	(19/2 ⁻)		
1655.9 4	19/2 ⁻		
1790.8? 4			Level only from 1975Ke06.
1875.47 ^a 21	21/2 ⁻		
1910.21 20	19/2 ⁺		Level only from 1975Ke06.
1919.74 [@] 16	19/2 ⁺		
2059.83 22			Level only from 1975Ke06.
2085.00 ^a 24	23/2 ⁻		
2108.8 4			841 γ and a tentative 972 γ placed by 1975An08 deexciting this level, but the intensity balance arguments for levels fed by these two transitions in the 3.7-ms IT decay dataset do not support these placements. The 841 γ is tentatively placed from a 1548 level, and the 972 γ is unplaced here.
2109.6 [@] 4	(21/2 ⁺)		
2127.82 22	23/2 ⁺		
2248.4 3	(23/2 ⁻)		E(level), J ^π : this level is defined at 2212 keV with J ^π =(25/2, 27/2) ⁺ in 1975An08 due to reversed ordering of the 121 γ -85 γ cascade.
2332.8 4	25/2 ⁺	3.7 ms 2	J ^π : (27/2) ⁻ in 1975An08. T _{1/2} : weighted average of 3.8 ms 2 (1975Ke06) and 3.2 ms 4 (1975An08); from $\gamma(t)$.

[†] From least-squares fit to E γ values.[‡] As proposed in 1975Ke06 and 1975An08 based on $\gamma(\theta)$ data, multipolarity assignments from conversion coefficients and band associations.[#] From Adopted Levels, unless otherwise stated.[@] Band(A): $\pi 3/2[402]$ band.[&] Band(B): $\pi 1/2[400]$ band.^a Band(C): $\pi h_{11/2}$ band.^b Band(D): $\pi h_{9/2}$ band.

$\gamma(^{189}\text{Ir})$

Experimental conversion coefficients are from [1975Ke06](#), typical uncertainty in electron intensity is stated by the authors as 30%. Evaluators assign the same uncertainty in experimental conversion coefficients in Table 3 of [1975Ke06](#).

E_γ [†]	I_γ ^{&}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [@]	δ	α^e	Comments
(68.1)		2127.82	23/2 ⁺	2059.83					
(71.7 <i>l</i>)	1.5 [#] 4	372.12	11/2 ⁻	300.44	7/2 ⁺				
82.3 <i>3</i>	1.2 <i>2</i>	176.53	3/2 ⁺	94.24	1/2 ⁺				E γ =82.3 (1975An08), mixed with ($\alpha, 3n\gamma$) channel. E γ =82.2, I γ =11.7 in (p,n γ), 1.1 in ($\alpha, 2n\gamma$) (1975Ke06).
84.5 ^b <i>3</i>	0.40 <i>15</i>	2332.8	25/2 ⁺	2248.4	(23/2) ⁻	(E1+M2)	0.18 +5-6	3.8 <i>19</i>	Mult., δ : from Adopted Gammas. E γ =84.4 (1975An08), placed from a 2213 level. E γ =84.6, I γ =0.6 in ($\alpha, 2n\gamma$) (1975Ke06).
94.3 <i>3</i>	3.7 <i>4</i>	94.24	1/2 ⁺	0.0	3/2 ⁺				E γ =94.3 (1975An08), possibly mixed with ($\alpha, 3n\gamma$) channel. E γ =94.3, I γ =22.0 in (p,n γ), 2.6 in ($\alpha, 2n\gamma$) (1975Ke06).
^x 98.6 [‡] <i>6</i>	1.9 <i>3</i>								
101.0 <i>3</i>	1.7 <i>3</i>	837.84	15/2 ⁻	736.82	13/2 ⁻	(M1)		5.95	A ₂ =-0.13 <i>12</i> ; A ₄ =+0.4 <i>2</i> (1975An08); A ₂ =-0.2 <i>2</i> (1975Ke06) E γ =101.0 (1975An08). E γ =101.0, I γ =1.8 in ($\alpha, 2n\gamma$) (1975Ke06). Mult.: dipole from $\gamma(\theta)$, M1 from intensity balance arguments.
110.1 [‡] <i>3</i>	4.5 ^c <i>10</i>	563.67	9/2 ⁻	453.87	9/2 ⁺	[E1]		0.312	Note that 110.1 <i>3</i> and 110.1 <i>6</i> γ rays, the latter from tentative 949 level are not resolved, however, based on results from 1975An08 , most of the intensity of the 110 γ belongs from the decay of 564 level.
110.1 ^{‡f} <i>6</i>		948.7?	(11/2) ⁻	837.84	15/2 ⁻				I γ : see comment for 110.1 γ from 564 level.
113.8 <i>l</i>	39.5 <i>30</i>	113.74	5/2 ⁺	0.0	3/2 ⁺	D+Q			A ₂ =-0.22 <i>2</i> ; A ₄ =-0.03 <i>3</i> (1975An08); A ₂ =-0.04 <i>8</i> (1975Ke06) E γ =113.8 (1975An08), mixed with ($\alpha, 3n\gamma$) channel. E γ =113.7, I γ =50.0 in (p,n γ), 38.3 in ($\alpha, 2n\gamma$) (1975Ke06). E γ , I γ : from 1975Ke06 . In 1975An08 , E γ =115 seen only in $\gamma\gamma$ -coin.
115.2 <i>3</i>	0.6 <i>2</i>	1383.54	19/2 ⁻	1268.23	17/2 ⁻				
120.8 ^b <i>3</i>	1.9 <i>3</i>	2248.4	(23/2) ⁻	2127.82	23/2 ⁺	(E1)		0.246	A ₂ =-0.05 <i>10</i> ; A ₄ =-0.14 <i>15</i> (1975An08); A ₂ =+0.26 <i>16</i> (1975Ke06) Mult.: dipole from $\gamma(\theta)$, intensity balance suggests E1. E γ =120.8 (1975An08), mixed with ($\alpha, 3n\gamma$) channel. Placed from a 2333 level to 2213 level, and also tentatively from a 1221 level. E γ =120.7, I γ =2.7 in ($\alpha, 2n\gamma$) (1975Ke06).
140.1 ^a <i>3</i>	2.0 ^a <i>6</i>	2059.83		1919.74	19/2 ⁺				
141.0 ^a <i>3</i>	2.5 ^a <i>8</i>	317.60	5/2 ⁺	176.53	3/2 ⁺				E γ =141.2, I γ =4.7 <i>6</i> (1975An08), but mixed with contribution from 3n channel. E γ =141.0, I γ =12.0 in (p,n γ), 2.5 in ($\alpha, 2n\gamma$) (1975Ke06).
^x 141.6 ^a <i>3</i>	1.7 ^a <i>5</i>								

$\gamma(^{189}\text{Ir})$ (continued)

E_γ [†]	I_γ ^{&}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [@]	α^e	Comments
147.2 3	2.3 5	464.69	7/2 ⁺	317.60	5/2 ⁺	(D)		$A_2 = -0.10$ 14 (1975Ke06) $E_\gamma = 147.3$ (1975An08). $E_\gamma = 147.1$, $I_\gamma = 5.7$ in (p,n γ), 1.8 in (α ,2n γ) (1975Ke06). $A_2 = -0.13$ 17 (1975Ke06) $E_\gamma = 149.5$ (1975An08). $E_\gamma = 149.8$, $I_\gamma = 0.9$ in (α ,2n γ) (1975Ke06). Placement from 1975Ke06.
149.6 3	1.2 5	2059.83		1910.21	19/2 ⁺	D		$A_2 = -0.54$ 14; $A_4 = 0.0$ 2 (1975An08); $A_2 = -0.31$ 11 (1975Ke06) $E_\gamma = 153.7$ (1975An08). $E_\gamma = 153.5$, $I_\gamma = 3.0$ in (p,n γ), 2.6 in (α ,2n γ) (1975Ke06).
153.6 3	2.8 6	453.87	9/2 ⁺	300.44	7/2 ⁺	D		$I_\gamma = 2.9$ in (p,n γ) (1975Ke06). In 1975An08, a 177 γ , seen only in $\gamma\gamma$ -coin data, is tentatively placed from a 2096 level.
^x 159.1 ^a 3	0.37 ^a 11							$\alpha(K)\text{exp} = 0.25$ 8
172.1 ^a 3	0.3 ^a 1	918.10	13/2 ⁺	745.82	11/2 ⁺			$A_2 = +0.35$ 3; $A_4 = -0.06$ 4 (1975An08); $A_2 = +0.30$ 5 (1975Ke06)
176.4 ^a 3	0.4 ^a 2	176.53	3/2 ⁺	0.0	3/2 ⁺			Mult.: $\alpha(K)\text{exp}$ gives $\delta(E2/M1) > 2.5$. The ce(K) for 177.9 transition used for normalization of other ce data.
177.9 1	18.5 10	741.57	13/2 ⁻	563.67	9/2 ⁻	E2	0.517	$E_\gamma = 178.0$ (1975An08). $E_\gamma = 177.8$, $I_\gamma = 5.3$ in (p,n γ), 18.3 in (α ,2n γ) (1975Ke06).
180.4 ^a 3	0.4 ^a 2	899.32	11/2 ⁺	719.01	9/2 ⁺			$A_2 = -0.20$ 2; $A_4 = -0.06$ 6
186.7 1	59.0 20	300.44	7/2 ⁺	113.74	5/2 ⁺	D+Q		δ : negative sign from parametric plots of A_2 from ce(θ) and $\gamma(\theta)$ (1983Fa11). $E_\gamma = 186.7$ (1975An08), placed also tentatively from a 1482 level. $E_\gamma = 186.6$, $I_\gamma = 66.7$ in (p,n γ), 61.7 in (α ,2n γ) (1975Ke06). This γ seen only in $\gamma\gamma$ -coin and placed from a 1159 level (1975An08).
^x 195 [‡]								
^x 200.4 ^a 3	1.0 ^a 3							
204 ^f		945.9	11/2 ⁻	741.57	13/2 ⁻			
208.2 3	3.7 5	2127.82	23/2 ⁺	1919.74	19/2 ⁺	E2 ^d	0.301	$\alpha(K)\text{exp} = 0.11$ 3 $A_2 = +0.34$ 7; $A_4 = -0.24$ 10 (1975An08); $A_2 = +0.41$ 7 (1975Ke06) $E_\gamma = 208.3$ (1975An08). $E_\gamma = 208.1$, $I_\gamma = 4.3$ in (α ,2n γ) (1975Ke06).
209.3 [‡] 6	0.6 4	2085.00	23/2 ⁻	1875.47	21/2 ⁻			$E_\gamma = 214.8$ (1975An08).
214.6 3	1.5 4	1114.4	11/2 ⁻	899.92	9/2 ⁻			$E_\gamma = 214.3$, $I_\gamma = 2.0$ in (p,n γ), 1.3 in (α ,2n γ) (1975Ke06). $I_\gamma = 5.7$ in (p,n γ) (1975Ke06).
216.3 ^a 3	1.0 ^a 3	831.72	(9/2,11/2) ⁻	615.48	7/2 ⁻			$E_\gamma = 217.3$ (1975An08).
217.5 3	2.0 4	2127.82	23/2 ⁺	1910.21	19/2 ⁺			$E_\gamma = 217.8$, $I_\gamma = 1.8$ in (α ,2n γ) (1975Ke06). Placement from 1975Ke06.

$\gamma(^{189}\text{Ir})$ (continued)

E_γ †	I_γ &	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. @	α^e	Comments
223.4 3	1.0 2	317.60	5/2 ⁺	94.24	1/2 ⁺	(E2)	0.239	$A_2=+0.22$ 14 (1975Ke06) E γ =223.5 (1975An08), placed tentatively also from a 688 level. E γ =223.2, I γ =5.0 in (p,n γ), 1.1 in ($\alpha, 2n\gamma$) (1975Ke06). E γ : from 1975Ke06. In delayed spectrum, I γ =0.5 relative to 1.8 for 84.5 γ . In 1975An08, a 223.5 γ with I γ =1.0 2 is placed from 318 and tentatively from 688 level.
224 1		2332.8	25/2 ⁺	2108.8				
242.4 ^{af} 3	1.7 ^a 5	1074.1?		831.72	(9/2, 11/2) ⁻			I γ =2.2 in (p,n γ) (1975Ke06).
243.4 1	16.4 15	615.48	7/2 ⁻	372.12	11/2 ⁻	(E2)	0.181	$A_2=+0.07$ 5; $A_4=+0.06$ 6 (1975An08); $A_2=+0.11$ 4 (1975Ke06) E γ =243.5 (1975An08), 243.3 (1978Ya06). E γ =243.4, I γ =50.0 in (p,n γ), 15.0 in ($\alpha, 2n\gamma$) (1975Ke06).
246.2 ^f	<0.14	1383.54	19/2 ⁻	1137.22	15/2 ⁻			I γ : from 1978Ya06.
247.6 3	2.7 5	2332.8	25/2 ⁺	2085.00	23/2 ⁻	(D)		$A_2=+0.03$ 14; $A_4=+0.06$ 20 (1975An08); $A_2=+0.03$ 7 (1975Ke06) E γ =247.6 (1975An08), 247.6 (1978Ya06). E γ =247.6, I γ =3.0 in ($\alpha, 2n\gamma$) (1975Ke06).
252.5 3	2.2 4	2127.82	23/2 ⁺	1875.47	21/2 ⁻			E γ =252.6 (1975An08), 252.5 (1978Ya06).
254.3 3	2.6 5	719.01	9/2 ⁺	464.69	7/2 ⁺			E γ =252.5, I γ =4.0 in (p,n γ), 2.2 in ($\alpha, 2n\gamma$) (1975Ke06). E γ =254.4 (1975An08), 254.5 (1978Ya06).
258.3 2	5.1 8	372.12	11/2 ⁻	113.74	5/2 ⁺	E3	0.877	E γ =254.1, I γ =5.7 in (p,n γ), 2.6 in ($\alpha, 2n\gamma$) (1975Ke06). Placement from 1975Ke06. $\alpha(\text{L})\text{exp}=0.46$ 14 $A_2=-0.02$ 10; $A_4=-0.22$ 20 (1975An08); $A_2=+0.02$ 6 (1975Ke06) The ce(L) for 258.3 transition used for normalization of other ce data. Mult.: $\alpha(\text{L})\text{exp}$ gives $\delta(\text{M4/E3})<0.1$. E γ =258.4 (1975An08).
263.2 1	36.0 25	563.67	9/2 ⁻	300.44	7/2 ⁺	E1	0.0346	E γ =258.2, I γ =5.0 in (p,n γ), 5.7 in ($\alpha, 2n\gamma$) (1975Ke06). $\alpha(\text{K})\text{exp}=0.05$ 2 $A_2=-0.19$ 2; $A_4=-0.03$ 3 (1975An08); $A_2=-0.15$ 2 (1975Ke06) Mult.: $\alpha(\text{K})\text{exp}$ gives $\delta(\text{M2/E1})<0.2$. E γ =263.2 (1975An08). E γ =263.1, I γ =27.7 in (p,n γ), 35.0 in ($\alpha, 2n\gamma$) (1975Ke06).
275.4 ^{‡f} 3	2.5 5	1221.1	15/2 ⁻	945.9	11/2 ⁻			I γ : includes contribution from ($\alpha, n\gamma$) channel.
281.6 ^{af} 3	1.3 ^a 4	1396.0?		1114.4	11/2 ⁻			In 1975An08, a 281.3 γ seen in delayed spectrum assigned tentatively to ($\alpha, 3n\gamma$) channel.
282.5 3	2.7 7	1114.4	11/2 ⁻	831.72	(9/2, 11/2) ⁻	M1	0.331	$\alpha(\text{K})\text{exp}=0.36$ 11; $A_2=+0.05$ 8 (1975Ke06) Mult.: $\alpha(\text{K})\text{exp}$ gives $\delta(\text{E2/M1})<0.4$. E γ =282.5 (1975An08). E γ =282.6, I γ =3.3 in (p,n γ), 2.9 in ($\alpha, 2n\gamma$) (1975Ke06). Placement from 1975Ke06.
284.5 2	6.4 7	899.92	9/2 ⁻	615.48	7/2 ⁻	M1	0.325	$\alpha(\text{K})\text{exp}=0.33$ 10; $A_2=+0.15$ 5 (1975Ke06) Mult.: $\alpha(\text{K})\text{exp}$ gives $\delta(\text{E2/M1})<0.5$. E γ =284.6 (1975An08). E γ =284.3, I γ =12.0 in (p,n γ), 6.3 in ($\alpha, 2n\gamma$) (1975Ke06).

$\gamma(^{189}\text{Ir})$ (continued)

E_γ [†]	I_γ ^{&}	E_i (level)	J_i^π	E_f	J_f^π	Mult. [@]	α^e	Comments
288.1 3	4.0 8	464.69	7/2 ⁺	176.53	3/2 ⁺	(E2)	0.1071	$A_2=+0.24$ 7 (1975Ke06) $E_\gamma=288.1$ (1975An08). $E_\gamma=288.1$, $I_\gamma=9.0$ in (p,n γ), 4.2 in ($\alpha, 2n\gamma$) (1975Ke06). $\alpha(K)\text{exp}=0.29$ 9 $A_2=-0.42$ 8 (1975Ke06) Mult.: $\alpha(K)\text{exp}$ gives $\delta(E2/M1)<0.6$. $E_\gamma=292.2$ (1975An08). $E_\gamma=291.9$, $I_\gamma=4.7$ in ($\alpha, 2n\gamma$) (1975Ke06). $\alpha(K)\text{exp}=0.053$ 16 $A_2=+0.07$ 2; $A_4=-0.03$ 2 (1975An08); $A_2=+0.05$ 6 (1975Ke06) Mult.: $\alpha(K)\text{exp}$ gives $\delta(E2/M1)>4$. The ce(K) for 300.3 transition used for normalization of other ce data. $E_\gamma=300.5$ (1975An08). $E_\gamma=300.3$, $I_\gamma=100$ in (p,n γ), 100 in ($\alpha, 2n\gamma$) (1975Ke06). $A_2=-0.45$ 7; $A_4=0.0$ 1 (1975An08); $A_2=-0.48$ 10 (1975Ke06) $E_\gamma=317.5$ (1975An08). $E_\gamma=317.4$, $I_\gamma=10.7$ in (p,n γ), 2.6 in ($\alpha, 2n\gamma$) (1975Ke06). $A_2=-0.52$ 14 (1975Ke06) $E_\gamma=323.2$ (1975An08), not assigned to any reaction channel. $E_\gamma=322.8$, $I_\gamma=1.4$ in ($\alpha, 2n\gamma$) (1975Ke06). $A_2=-0.2$ 3 (1975Ke06) Note that 333.1 3 and 333.3 3 γ rays, the latter from tentative 949 level are not resolved. The placement here is mainly assigned to 1447 level based on results from 1975Ke06. $E_\gamma=333.3$ (1975An08), placed from only the 949 level. $E_\gamma=332.8$, $I_\gamma=1.3$ in ($\alpha, 2n\gamma$) (1975Ke06), placed from 1448 level. In 1975Ke06, a 332.8 γ placed only from the 1448 level. See comment for 333.1 3 γ ray from 1448 level. $\alpha(K)\text{exp}=0.039$ 13 $A_2=+0.26$ 2; $A_4=-0.06$ 4 (1975An08); $A_2=+0.23$ 3 (1975Ke06) Mult.: $\alpha(K)\text{exp}$ gives $\delta(E2/M1)>3.5$. $E_\gamma=340.3$ (1975An08). $E_\gamma=340.1$, $I_\gamma=33.3$ in (p,n γ), 33.3 in ($\alpha, 2n\gamma$) (1975Ke06).
292.1 2	6.0 20	745.82	11/2 ⁺	453.87	9/2 ⁺	M1	0.302	
300.4 1	100.0	300.44	7/2 ⁺	0.0	3/2 ⁺	E2	0.0944	
317.5 3	2.6 5	317.60	5/2 ⁺	0.0	3/2 ⁺	D+Q		
^x 323.2 6	2.0 4					D		
333.1 3	1.8 5	1447.5		1114.4	11/2 ⁻			
333.3 ^f 3		948.7?	(11/2 ⁻)	615.48	7/2 ⁻			
340.2 1	37.5 20	453.87	9/2 ⁺	113.74	5/2 ⁺	E2	0.0658	
342.1 ^a 3	1.3 ^a 4	1288.0	(13/2 ⁻)	945.9	11/2 ⁻			
349.5 3	1.0 6	1248.9	13/2 ⁺	899.32	11/2 ⁺	(M1)	0.186	$\alpha(K)\text{exp}=0.16$ 5 Mult.: $\alpha(K)\text{exp}$ gives $\delta(E2/M1)<0.8$, but the 349.5 γ is a weak component therefore the multipolarity assignment is considered as tentative. $\alpha(K)\text{exp}$ for 349+351 doublet. $E_\gamma=349.5$ (1975An08). $E_\gamma=349.6$, $I_\gamma=1.7$ in ($\alpha, 2n\gamma$) (1975Ke06). Placement from 1975Ke06.
350.9 2	6.8 10	464.69	7/2 ⁺	113.74	5/2 ⁺	M1	0.184	$\alpha(K)\text{exp}=0.16$ 5

$\gamma(^{189}\text{Ir})$ (continued)

E_γ †	I_γ &	E_i (level)	J_i^π	E_f	J_f^π	Mult. @	α^e	Comments
								$A_2 = -0.41$ 14; $A_4 = +0.2$ 2 (1975An08) $\alpha(K)$ exp for 349+351 doublet. Mult.: $\alpha(K)$ exp gives $\delta(E2/M1) < 0.8$. $E_\gamma = 351.0$ (1975An08). $E_\gamma = 350.8$, $I_\gamma = 14.3$ in (p,n γ), 5.7 in ($\alpha, 2n\gamma$) (1975Ke06). $A_2 = +0.38$ 4; $A_4 = -0.18$ 6 (1975An08); $A_2 = +0.30$ 4 (1975Ke06) $E_\gamma = 359.3$ (1975An08). $E_\gamma = 358.9$, $I_\gamma = 11.7$ in ($\alpha, 2n\gamma$) (1975Ke06). $A_2 = +0.14$ 2; $A_4 = -0.06$ 3 (1975An08); $A_2 = +0.12$ 2 (1975Ke06) E_γ : γ assigned from 836.4-keV level in 1975Ke06. $E_\gamma = 364.8$ (1975An08). $E_\gamma = 364.5$, $I_\gamma = 14.7$ in (p,n γ), 36.7 in ($\alpha, 2n\gamma$) (1975Ke06). $E_\gamma = 364.7$, $I_\gamma = 43$ (1978Ya06). $A_2 = -0.58$ 18; $A_4 = -0.1$ 3 (1975An08); $A_2 = -0.47$ 7 (1975Ke06) δ : negative sign from parametric plots of A_2 from $\text{ce}(\theta)$ and $\gamma(\theta)$ (1983Fa11). Value not given. $E_\gamma = 378.1$ (1975An08). $E_\gamma = 378.0$, $I_\gamma = 3.2$ in ($\alpha, 2n\gamma$) (1975Ke06). $A_2 = -0.44$ 9; $A_4 = 0.0$ 2 (1975An08); $A_2 = -0.40$ 8 (1975Ke06) $E_\gamma = 382.3$ (1975An08). $E_\gamma = 382.1$, $I_\gamma = 6.3$ in (p,n γ), 4.3 in ($\alpha, 2n\gamma$) (1975Ke06). $\alpha(K)$ exp=0.26 8; $A_2 = +0.16$ 8 (1975Ke06) $A_2 = +0.06$ 7; $A_4 = -0.16$ 12 (1975An08) $\alpha(K)$ exp is about a factor of two larger than $\alpha(K)$ (theory,M1)=0.117, there may be some impurity mixed in the ce line for 387.7 transition. $E_\gamma = 387.9$ (1975An08); also tentative placement from a 688 level. $E_\gamma = 387.6$, $I_\gamma = 4.1$ in ($\alpha, 2n\gamma$) (1975Ke06). $E_\gamma = 387.7$, $I_\gamma = 4.7$ (1978Ya06). $E_\gamma = 394.3$ (1975An08). $E_\gamma = 393.8$, $I_\gamma = 1.1$ in ($\alpha, 2n\gamma$) (1975Ke06). $\alpha(K)$ exp=0.11 3 $A_2 = +0.16$ 3; $A_4 = -0.20$ 4 (1975An08) Mult.: $\alpha(K)$ exp gives $\delta(E2/M1) < 0.8$. $\alpha(K)$ exp for 400.6+401.2 doublet. $E_\gamma = 400.6$ (1975An08). $E_\gamma = 400.2$, $I_\gamma = 11.3$ in ($\alpha, 2n\gamma$) (1975Ke06). $E_\gamma = 400.3$, $I_\gamma = 16.3$ (1978Ya06). $\alpha(K)$ exp=0.11 3 Mult.: $\alpha(K)$ exp gives $\delta(E2/M1) < 0.8$, but 401.2 component is much weaker than the 400.6, thus the multipolarity assignment is tentative. $\alpha(K)$ exp for 400.6+401.2 doublet. $I_\gamma = 7.0$ in (p,n γ) (1975Ke06).
359.2 1	12.5 15	1100.77	17/2 ⁻	741.57	13/2 ⁻	(E2)	0.0564	
364.7 1	39.0 30	736.82	13/2 ⁻	372.12	11/2 ⁻	D		
378.1 3	3.3 4	1296.14	15/2 ⁺	918.10	13/2 ⁺	D+Q		
382.2 3	4.5 7	945.9	11/2 ⁻	563.67	9/2 ⁻	D		
387.7 3	4.5 7	1655.9	19/2 ⁻	1268.23	17/2 ⁻	(M1)	0.1409	
394.1 3	1.4 6	1615.2	(17/2 ⁻)	1221.1	15/2 ⁻			
400.4 1	15.8 16	1137.22	15/2 ⁻	736.82	13/2 ⁻	M1	0.1293	
401.2 ^a 3	2.7 ^a 9	719.01	9/2 ⁺	317.60	5/2 ⁺			

¹⁸⁷Re($\alpha, 2n\gamma$) **1975Ke06,1975An08 (continued)** $\gamma(^{189}\text{Ir})$ (continued)

E_γ †	I_γ &	E_i (level)	J_i^π	E_f	J_f^π	Mult. @	α^e	Comments
407.3 ^f 3	2.2 5	1790.8?		1383.54	19/2 ⁻	D		$A_2 = -0.30$ 14 (1975Ke06) E γ =407.3 (1975An08). E γ =407.3, I_γ =2.1 in ($\alpha, 2n\gamma$) (1975Ke06). Placement from 1975Ke06.
419.0 3	1.3 7	719.01	9/2 ⁺	300.44	7/2 ⁺			E γ =419.0 (1975An08). E γ =418.2, I_γ =1.5 in ($\alpha, 2n\gamma$) (1975Ke06). Placement from 1975Ke06.
429 ^a 1	1.3 ^a 4	1910.21	19/2 ⁺	1481.54	17/2 ⁺			
430.4 1	15.0 20	1268.23	17/2 ⁻	837.84	15/2 ⁻	M1	0.1067	$\alpha(L)\text{exp}=0.028$ 9; $A_2=+0.17$ 3 (1975Ke06) $A_2=+0.14$ 3; $A_4=-0.05$ 6 (1975An08) E γ =430.5 (1975An08). E γ =430.4, I_γ =6.0 in (p, $n\gamma$), 13.7 in ($\alpha, 2n\gamma$) (1975Ke06). E γ =430.4, I_γ =15.0 (1978Ya06). Mult.: for M1 assignment, $\alpha(L)\text{exp}$ is twice as large as the theoretical value of 0.014, but agrees within about 1.5σ . Moreover, E1 has $\alpha(L)=0.001419$ E2 has $\alpha(L)=0.00742$, thus the measured value is only consistent with M1.
434.6 3	4.5 5	899.32	11/2 ⁺	464.69	7/2 ⁺	(E2)	0.0338	$A_2=+0.11$ 12; $A_4=-0.3$ 2 (1975An08); $A_2=+0.14$ 12 (1975Ke06) E γ =434.7 (1975An08). E γ =434.5, I_γ =4.3 in (p, $n\gamma$), 4.3 in ($\alpha, 2n\gamma$) (1975Ke06).
438.3 3	3.8 6	1919.74	19/2 ⁺	1481.54	17/2 ⁺	M1	0.1017	$\alpha(K)\text{exp}=0.08$ 2 Mult.: $\alpha(K)\text{exp}$ gives $\delta(E2/M1)<0.7$. $\alpha(K)\text{exp}$ for 438+441 doublet. E γ =438.5 (1975An08). E γ =438.1, I_γ =1.7 in ($\alpha, 2n\gamma$) (1975Ke06).
441.1 2	6.5 10	1578.3	(17/2 ⁻)	1137.22	15/2 ⁻	M1	0.1000	$\alpha(K)\text{exp}=0.08$ 2; $A_2=+0.33$ 8 (1975Ke06) $A_2=+0.21$ 9; $A_4=-0.15$ 14 (1975An08) Mult.: $\alpha(K)\text{exp}$ gives $\delta(E2/M1)<0.7$. $\alpha(K)\text{exp}$ for 438+441 doublet. E γ =441.2 (1975An08), mixed with ($\alpha, 3n\gamma$) channel. E γ =441.1, I_γ =4.7 in ($\alpha, 2n\gamma$) (1975Ke06). E γ =441.1, I_γ =4.3 (1978Ya06).
445.3 1	25.0 30	745.82	11/2 ⁺	300.44	7/2 ⁺	E2	0.0318	$\alpha(K)\text{exp}=0.024$ 8 $A_2=+0.19$ 2; $A_4=-0.19$ 4 (1975An08); $A_2=+0.21$ 2 (1975Ke06) Note that 445.3 1 and 445.3 3 γ rays, the latter from 899 level are not resolved, however, based on γ -branching ratios in ¹⁸⁹ Ir IT decay (3.7 ms), most of the intensity of the 445 γ must belong from the decay of 746 level. Mult.: $\alpha(K)\text{exp}$ gives $\delta(E2/M1)>2.5$. $\alpha(K)\text{exp}$ for doublet. The ce(K) for 445.3 transition used for normalization of other ce data. E γ =445.3 (1975An08), also tentative placement from 899 level. E γ =445.4, I_γ =11.0 in (p, $n\gamma$), 22.7 in ($\alpha, 2n\gamma$) (1975Ke06). I_γ : see comment for 445.3 γ from 745 level.
445.3 3		899.32	11/2 ⁺	453.87	9/2 ⁺			
459.5 2	5.5 10	831.72	(9/2,11/2) ⁻	372.12	11/2 ⁻	M1	0.0898	$\alpha(K)\text{exp}=0.09$ 3; $A_2=+0.06$ 11 (1975Ke06)

$\gamma(^{189}\text{Ir})$ (continued)									
E_γ [†]	I_γ ^{&}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [@]	δ	α^e	Comments
									Mult.: $\alpha(\text{K})\text{exp}$ gives $\delta(\text{E2/M1})<0.6$. $E\gamma=459.5$ (1975An08). $E\gamma=459.6$, $I\gamma=11.3$ in (p,n γ), 5.0 in (α ,2n γ) (1975Ke06). Placement from 1975Ke06. $\alpha(\text{K})\text{exp}=0.020$ 7; $A_2=+0.27$ 5 (1975Ke06) Mult.: $\alpha(\text{K})\text{exp}$ gives $\delta(\text{E2/M1})>2.7$. $\alpha(\text{K})\text{exp}$ for 465+466 doublet. $E\gamma=464.7$ (1975An08). $E\gamma=464.1$, $I\gamma=19.3$ in (α ,2n γ) (1975Ke06). $\alpha(\text{K})\text{exp}=0.020$ 7; $A_2=+0.30$ 4 (1975Ke06) Mult.: $\alpha(\text{K})\text{exp}$ gives $\delta(\text{E2/M1})>2.7$. $\alpha(\text{K})\text{exp}$ for 465+466 doublet. $E\gamma=466.0$ (1975An08). $E\gamma=465.6$, $I\gamma=35.3$ in (α ,2n γ) (1975Ke06). $E\gamma=465.6$, $I\gamma=33.7$ (1978Ya06).
464.4 2	18.0 30	918.10	13/2 ⁺	453.87	9/2 ⁺	E2		0.0285	
465.7 1	32.5 40	837.84	15/2 ⁻	372.12	11/2 ⁻	E2		0.0283	
^x 469.6 ^a 3 479.5 2	1.3 ^a 4 6.4 7	1221.1	15/2 ⁻	741.57	13/2 ⁻	M1+E2	1.1 +7-4	0.051 12	$\alpha(\text{K})\text{exp}=0.04$ 1; $A_2=-0.93$ 8 (1975Ke06) $E\gamma=479.5$ (1975An08). $E\gamma=479.5$, $I\gamma=5.3$ in (α ,2n γ) (1975Ke06). Mult., δ : from $\alpha(\text{K})\text{exp}$ and $\gamma(\theta)$. $A_2=+0.17$ 5 (1975Ke06) $E\gamma=492.0$ (1975An08). $E\gamma=492.0$, $I\gamma=4.0$ in (α ,2n γ) (1975Ke06). $E\gamma=491.8$, $I\gamma=3.7$ (1978Ya06). $E\gamma=499.2$ (1975An08). $E\gamma=498.5$, $I\gamma=1.0$ in (α ,2n γ) (1975Ke06).
491.9 2	5.1 7	1875.47	21/2 ⁻	1383.54	19/2 ⁻				
498.9 ^f 3	0.8 4	1114.4	11/2 ⁻	615.48	7/2 ⁻				
502.6 ^a ^f 3 508.0 ^a 3	1.7 ^a 5 4.0 ^a 13	1248.9 1608.8	13/2 ⁺ 21/2 ⁻	745.82 1100.77	11/2 ⁺ 17/2 ⁻				
528.0 [‡] ^f 3 530.0 3	1.0 7 4.0 10	899.92 1248.9	9/2 ⁻ 13/2 ⁺	372.12 719.01	11/2 ⁻ 9/2 ⁺				Placement from 1975Ke06. Other placement from 1667 level in 1975An08 rejected by evaluators assuming incorrect assignment on the basis of coincidence with 400 γ doublet. $E\gamma=529.9$ (1975An08). $E\gamma=530.1$, $I\gamma=2.7$ in (α ,2n γ) (1975Ke06). $E\gamma=531.6$ (1975An08). $E\gamma=531.3$, $I\gamma=1.0$ in (α ,2n γ) (1975Ke06) placed tentatively from a 2187 level. $E\gamma=531.2$, $I\gamma=1.7$ (1978Ya06) placed tentatively from 2187 level.
531.4 3	2.9 8	1268.23	17/2 ⁻	736.82	13/2 ⁻				
545.7 1	21.0 30	1383.54	19/2 ⁻	837.84	15/2 ⁻	E2		0.0192	$\alpha(\text{K})\text{exp}=0.017$ 5; $A_2=+0.23$ 4 (1975Ke06) $A_2=+0.26$ 4; $A_4=-0.12$ 6 (1975An08)

¹⁸⁷Re($\alpha, 2n\gamma$) **1975Ke06, 1975An08** (continued) $\gamma(^{189}\text{Ir})$ (continued)

E_γ †	I_γ &	E_i (level)	J_i^π	E_f	J_f^π	Mult. @	α^e	Comments
550.3 1	23.0 30	1296.14	15/2 ⁺	745.82	11/2 ⁺	E2	0.0188	Mult.: $\alpha(K)\text{exp}$ gives $\delta(E2/M1) > 1.8$. $E_\gamma = 545.8$ (1975An08). $E_\gamma = 545.7$, $I_\gamma = 18.7$ in ($\alpha, 2n\gamma$) (1975Ke06). $E_\gamma = 545.6$, $I_\gamma = 17.0$ (1978Ya06). $\alpha(K)\text{exp} = 0.020$ 6; $A_2 = +0.10$ 3 (1975Ke06) $A_2 = +0.14$ 4; $A_4 = -0.15$ 6 (1975An08) Note that 550.3 1 and 550.4 3 γ rays, the latter from 1651.2 level are not resolved, however, based on γ -branching ratios in ¹⁸⁹ Ir IT decay (3.7 ms), most of the intensity of the 550 γ must belong from the decay of 1296 level. Mult.: $\alpha(K)\text{exp}$ gives $\delta(E2/M1) > 1.3$. $E_\gamma = 550.4$ (1975An08). $E_\gamma = 550.1$, $I_\gamma = 19.0$ in ($\alpha, 2n\gamma$) (1975Ke06). I_γ : see comment for 550.3 γ from 1296 level. $A_2 = +0.22$ 4; $A_4 = -0.17$ 6 (1975An08); $A_2 = +0.26$ 3 (1975Ke06) $E_\gamma = 563.6$ (1975An08). $E_\gamma = 563.4$, $I_\gamma = 9.0$ in ($\alpha, 2n\gamma$) (1975Ke06).
550.4 3 563.5 2	9.5 15	1651.2 1481.54	(19/2 ⁻) 17/2 ⁺	1100.77 918.10	17/2 ⁻ 13/2 ⁺	(E2)	0.01783	$E_\gamma = 607.5$ (1975An08). $E_\gamma = 607.2$, $I_\gamma = 10.0$ in (p, γ), 3.3 in ($\alpha, 2n\gamma$) (1975Ke06); doublet, placed also from a 607.2 level based on a previous work.
576.8 ‡f 6 607.4 3	0.7 4 3.5 10	948.7? 1875.47	(11/2 ⁻) 21/2 ⁻	372.12 1268.23	11/2 ⁻ 17/2 ⁻			
^x 610.2 ‡ 6 614.0 2	2.3 8 5.2 10	1910.21	19/2 ⁺	1296.14	15/2 ⁺	(Q)		$A_2 = +0.32$ 15 (1975Ke06) Placement from 1975Ke06. $E_\gamma = 614.1$ (1975An08), placement from a 2096 level. $E_\gamma = 613.8$, $I_\gamma = 6.0$ in ($\alpha, 2n\gamma$) (1975Ke06). $\alpha(K)\text{exp} = 0.013$ 4; $A_2 = +0.28$ 4 (1975Ke06) $A_2 = +0.3$ 1; $A_4 = -0.3$ 2 (1975An08) Mult.: $\alpha(K)\text{exp}$ gives $\delta(E2/M1) > 1.7$. $E_\gamma = 623.7$ (1975An08). $E_\gamma = 623.5$, $I_\gamma = 11.3$ in ($\alpha, 2n\gamma$) (1975Ke06). $E_\gamma = 628.3$ (1975An08). $E_\gamma = 627.9$, $I_\gamma = 2.2$ in ($\alpha, 2n\gamma$) (1975Ke06). Placement from 1975Ke06.
623.6 1	11.5 15	1919.74	19/2 ⁺	1296.14	15/2 ⁺	E2	0.01411	
628.1 3	2.3 5	2109.6	(21/2 ⁺)	1481.54	17/2 ⁺			
^x 641.3 § 6 ^x 644.8 § 6 ^x 665.2 § 6 676.3 3	1.5 5 1.5 5 1.3 5 1.2 5	2059.83		1383.54	19/2 ⁻			$E_\gamma = 676.2$ (1975An08). $E_\gamma = 676.5$, $I_\gamma = 0.87$ in ($\alpha, 2n\gamma$) (1975Ke06). Placement from 1975Ke06.
701.4 2	7.0 15	2085.00	23/2 ⁻	1383.54	19/2 ⁻	E2	0.01087	$\alpha(K)\text{exp} = 0.007$ 2; $A_2 = +0.14$ 7 (1975Ke06) $A_2 = +0.26$ 7; $A_4 = -0.1$ 1 (1975An08)

$\gamma(^{189}\text{Ir})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^\&$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
725.3 3	1.5 5	2108.8		1383.54	19/2 ⁻	Mult.: $\alpha(K)\text{exp}$ gives $\delta(E2/M1)>6$. E γ =701.4 (1975An08). E γ =701.5, I γ =6.7 in ($\alpha, 2n\gamma$) (1975Ke06). E γ =725.5 (1975An08). E γ =725.1, I γ =1.7 in ($\alpha, 2n\gamma$) (1975Ke06).
^x 733.2 $\S$ 6	0.8 3					
743.9 $\ddagger f$ 3	2.3 6	1114.4	11/2 ⁻	372.12	11/2 ⁻	
^x 760.3 $\S$ 6	1.6 4					
^x 772.0 $\S$ 6	1.3 5					
^x 800.7 $\S$ 6	2.0 8					
840.9 $\ddagger f$ 3	3.0 10	1578.3	(17/2 ⁻)	736.82	13/2 ⁻	placement from 2109 level by 1975An08 seems incorrect due to intensity imbalance in the 3.7-ms IT decay dataset. Evaluators suggest placement from 1578 level based on energy difference and possible coincidence with 364.8 γ .
^x 971.0 $\ddagger$ 6	2.0 10					In 1975An08, γ tentatively placed from 2109 to 1137 level, but the energy agreement is poor, and also in 3.7 ms IT decay dataset, intensity balance arguments do not support the placement.

[†] From unweighted average of values from 1975An08, 1975Ke06 and a few values available in 1978Ya06. All the energy values are listed in comments. Uncertainties are assigned by the evaluators as follows: 0.1 keV for gamma rays with I γ ≥10, 0.2 keV for I γ =5-10, 0.3 keV for I γ <5, 0.6 keV for some uncertain weak (I γ <1) γ rays from 1975An08. These uncertainties are based on the following general statements by different authors: 0.1 to 0.3 keV stated by 1975Ke06, 0.1 to 0.2 keV general and 0.6 keV for poorly resolved peaks stated by 1975An08, and 0.06 keV by 1978Ya06.

[‡] This γ from only 1975An08.

$\S$ This γ from only 1975An08 with a tentative assignment to ($\alpha, 2n\gamma$).

$\&$ From ¹⁸⁷Re($\alpha, 2n\gamma$) at E=27.6 MeV (1975An08). Values of intensity ratios for E(α)=31.4 MeV and 27.6 MeV are also available in 1975An08. Delayed γ intensities are reported at E(α)=31.6 MeV. 1975Ke06 provide intensity data for E(α)=27 and 23 MeV and for E(p)=10 MeV. Their values at E(α)=27 MeV and E(p)=10 MeV are listed under comments. The branching ratios obtained from these values are compared with those from 1975An08 and found to be in general agreement. Note that the intensities given in 1975Ke06 are divided by a factor of 3, and those in 1975An08 by a factor of 10 to express these values relative to 100 for the 300.4 γ .

[@] From $\alpha(K)\text{exp}$ from 1975Ke06 with 178.0, 258.4 and 300.5 γ rays for normalization; and A₂, A₄ from 1975An08, or 1975Ke06. For the conversion electrons from 1975Ke06, the authors state that only those with uncertainties less than 50% are given and that uncertainties of 30% may be typical. For deducing mixing ratios, evaluators assigned 30% uncertainty in conversion coefficients. Only the dominant multipolarity such as M1 or E2 is given in the data field while the other possible admixture is stated in comments as an upper or lower limit of $\delta(E2/M1)$.

[#] From Adopted Gammas.

^a This γ from only 1975Ke06, listed intensity is divided by a factor of 3 to normalize to 100 for 300.4 γ .

^b Ordering of the 85 γ -121 γ cascade is reversed in 1975An08.

^c Corrected by 1975An08 for contribution from ¹⁶O(α, p).

^d Based on γ intensity balance in the delayed γ decay data from 1975Ke06.

^e Theoretical values from BrIcc code (2008Ki07) with “Frozen Orbitals” approximation, unless otherwise stated.

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

^x γ ray not placed in level scheme.

$^{191}\text{Ir}(\text{p,t})$ [1978Lo07,1978St09](#)

$J\pi(^{191}\text{Ir g.s.})=3/2^+$.

[1978Lo07](#): E=18 MeV. Measured triton spectra, $\sigma(\theta)$ from 10° to 75° in steps of 5° using Enge-split pole magnetic spectrograph and nuclear emulsions. Estimated FWHM $\approx$ 10 keV, as in authors' other (p,t) experiments for example in [1975St08](#) for ^{165}Er experiment. DWBA analysis of $\sigma(\theta)$ data. Enriched target. Deduced levels, L-transfer, $J\pi$, Q value.

[1978St09](#): E=34.7 MeV. Measured triton spectra, $\sigma(\theta)$ from 15° to 60° in steps of 5° using a Q3D magnetic spectrograph and a position-sensitive wire proportional counter, FWHM=13 keV. Absolute cross sections accurate to 25% while the relative values are within 4%. Enriched target. Deduced levels, L-transfers, J, π .

 ^{189}Ir Levels

E(level) [†]	L [‡]	dσ/dΩ (μb/sr) [#]	Comments
0 ^c	0	469	E=0, σ=243.8 mb (1978St09). 3/2 ⁺ bandhead of π3/2[402] band.
95 ^d 3	(2)	4	E=93, σ=2.2 mb (1978St09). 1/2 ⁺ bandhead of π1/2[400] band.
114 ^c 3	(2)	25	E=112, σ=15.8 mb (1978St09). 5/2 ⁺ member of π3/2[402] band.
178 ^d 3		6	E=173, σ=1.4 mb (1978St09). L: σ(θ) for 173 level in 1978St09 is given under L=0 cases in their Fig. 3, but σ(θ) distribution for this level in 1978St09 as well as in 1978Lo07 differs significantly from those for other L=0 transitions.
301 ^c 3	(2)	16	3/2 ⁺ member of π1/2[400] band. E=296, σ=16.6 mb (1978St09). 7/2 ⁺ member of π3/2[402] band.
318 ^d 3	(2)	3	E=312, σ=3.1 mb (1978St09). 5/2 ⁺ member of π1/2[400] band.
371 [@] 3	<i>a</i>		Tentatively interpreted as π5/2[402] state (1978St09). σ=0.2 mb (1978St09). Possible πh _{11/2} , Jπ=11/2 ⁻ state.
454 ^c 3	<i>a</i>	3	E=453, σ=3.9 mb (1978St09). 9/2 ⁺ member of π3/2[402] band.
644 [@] 3	(2)		σ=0.3 mb (1978St09). Tentatively interpreted as π5/2[402] state (1978St09).
722 ^e 3	0	7	E=719, σ=6.2 mb (1978St09). 3/2 ⁺ member of π1/2[411] band.
753 3	(2)	11	E=748, σ=3.4 mb (1978St09). Interpreted as 7/2 ⁺ , γ-vibrational state based on the g.s. (1978Lo07).
794 [@] 3	<i>a</i>		σ=0.3 mb (1978St09).
838 [@] 3	<i>a</i>		σ=0.4 mb (1978St09).
914 3	0	8	E=916, σ=8.0 mb (1978St09).
964 [@] 3	<i>a</i>		σ=1.2 mb (1978St09).
1052 [@] 3	(0)		σ=0.3 mb (1978St09). L: from 1978St09 , fit only at lower angles.
1175 ^b 3	<i>a</i>	3	E=1184, σ=3.4 mb (1978St09) The 1184 keV value is used in the Adopted Levels supported by γ transitions.
1202 ^b 3	0	7	E=1213, σ=5.4 mb (1978St09).
1248 ^b 3	0	16	E=1261, σ=19.1 mb (1978St09).
1345 ^{&} 3		4	
1506 ^{&} 3	0	13	L: from 1978Lo07 .

[†] From [1978Lo07](#), except where indicated. Values from [1978St09](#) are given in comments.

[‡] L=0 values are from [1978St09](#) and [1978Lo07](#), unless otherwise stated. The L=2 and other assignments are from [1978St09](#).

 $^{191}\text{Ir}(\text{p,t})$ [1978Lo07](#), [1978St09](#) (continued)

 ^{189}Ir Levels (continued)

Evaluators treat L=2 assignments in [1978St09](#) as tentative since these are not supported by DWBA analysis or any other scattering model considerations.

From [1978Lo07](#) at 20°. Authors give values at 40° also. Relative cross sections are known to 10% whereas absolute σ are within 20%. Summed cross sections in μb are provided by [1978St09](#) and listed here under comments.

@ Level observed only by [1978St09](#). Energy uncertainty is not given by the authors, assigned here as 3 keV by the evaluators.

& Level observed only by [1978Lo07](#).

^a Not 0 or 2.

^b Taken from [1978Lo07](#).

^c Band(A): $\pi 3/2[402]$ band.

^d Band(B): $\pi 1/2[400]$ band.

^e Band(C): $\pi 1/2[411]$ band.

Adopted Levels, Gammas

$Q(\beta^-) = -2887$ 22; $S(n) = 6720$ 11; $S(p) = 5413$ 14; $Q(\alpha) = 3912$ 10 2017Wa10

$S(2n) = 15927$ 26, $S(2p) = 9828$ 10 (2017Wa10).

^{189}Pt produced and identified by 1955Sm42 in $\text{Ir}(p, xn)$, $E = 50$ –130 MeV. Measured β , γ and half-life of the activity. Later studies of this decay: 1960Po07, 1960Ma28, 1961Kr02, 1961An02, 1962Kr04, 1962Ha24, 1962Gr27, 1963Th07, 1964Le07, 1964Kr03, 1965Ja12, 1967Na02, 1970Ba10, 1970Ba56, 1971Pl08, 1972Ba21, 1972He05, 1975Ru06, 1980Be27, 2000Mo05, 2000Zi04.

 ^{189}Pt LevelsCross Reference (XREF) Flags

A	^{189}Au ε decay (28.7 min)	D	$^{188}\text{Os}(\alpha, 3n\gamma)$, $^{191}\text{Ir}(p, 3n\gamma)$
B	^{189}Au ε decay (4.59 min)	E	$^{190}\text{Pt}(p, d)$
C	$^{176}\text{Yb}(^{18}\text{O}, 5n\gamma)$		

E(level) [†]	J^π [‡]	$T_{1/2}$	XREF	Comments
0.0 ^e	3/2 ⁻	10.87 h 12	ABCDE	$\% \varepsilon + \% \beta^+ = 100$ $\mu = -0.422$ 7 (1989Du01, 2000SaZZ, 2014StZZ) $Q = -0.95$ 4 (1992Hi07, 1989Du01, 2016St14) RMS charge radius $\langle r^2 \rangle^{1/2} = 5.4060$ fm 35 (2013An02 evaluation). J^π : spin from atomic beam (1975Ru06), parity from M1+E2 γ from 3/2 ⁻ . $T_{1/2}$: from 1964Le07. Other values: 12.1 h 15 (2000Mo05, 2000Zi04), 11 h (1975Ru06), 10.9 h (1967Na02), 10.9 h 10 (1963Th07), 11.1 h 4 (1961An02), 11.5 h (1960Po07), 10.5 h 10 (1955Sm42). μ : laser resonance ionization mass spectroscopy (1989Du01, 2000SaZZ). Other values: -0.440 8 (1992Hi07, laser ionization mass spectroscopy), 0.439 9 (1985Ed05, 1985Ed03, nuclear magnetic resonance on oriented nuclei), 0.433 9, (1985Oh05, nuclear magnetic resonance on oriented nuclei), 0.42 3 (1980Be27, static nuclear orientation with gamma detection). Q : laser resonance ionization mass spectroscopy (1992Hi07, 1989Du01). Others: -1.03 5 (1989Du01, laser spectroscopy), -1.21 6 from $Q(^{189}\text{Pt})/Q(^{191}\text{Pt}) = 1.235$ 8 (1998Hi08) and $Q(^{191}\text{Pt}) = -0.89$ 5 (1988Ro20, 1989Du01); -1.27 3 (1993HaZU, NMR-ON), -1.1 2 (1992Hi07), -0.7 3 (1985Ed05).
6.40 ^e 3	5/2 ⁻ #		ABCD	
45.78 25	(1/2) ⁻		A E	J^π : L=1 in (p,d), M1+E2 to 3/2 ⁻ , E2 to 5/2 ⁻ .
88.30 3	3/2 ⁻ #		A E	
172.79 6	9/2 ⁻ #	464 ns 25	BCDE	$\%IT = 100$
191.4 ^a 2	(13/2 ⁺)	143 μs 5	BCDE	$T_{1/2}$: from $\gamma\gamma(t)$ (1970Fi16) in ^{189}Au ε decay (4.59 min). $\%IT = 100$ J^π : L(d,p)=6,5 and systematics of odd-A Pt isotopes. $T_{1/2}$: from 1976Pi03 in $^{188}\text{Os}(\alpha, 3n\gamma)$, $^{191}\text{Ir}(p, 3n\gamma)$.
202.2 5	(11/2 ⁺)		D	
222.30 4	(3/2, 5/2) ⁻		A	J^π : M1+E2 to 3/2 ⁻ and 5/2 ⁻ .
237.4 ^e 1	(9/2) ⁻		A CD	J^π : stretched E2 to 5/2 ⁻ . $J^\pi = 7/2^-$ in ($\alpha, 3n\gamma$) conflicts with stretched E2 to 5/2 ⁻ .
261 5	1/2 ⁻ , 3/2 ⁻		E	J^π : L=1 in (p,d).
285 5			E	
348.45 5	(5/2, 3/2) ⁻		A E	XREF: E(340). J^π : M1+E2 to 3/2 ⁻ ; possible γ to (9/2) ⁻ makes 3/2 less likely.
356.72 23	(9/2 ⁻)		CD	
447.67 8	(3/2, 5/2) ⁻		A E	J^π : M1+E2 to 3/2 ⁻ , 5/2 ⁻ .
493.3 4	11/2 ⁻ #		B DE	
499.2 ^a 2	(17/2 ⁺)	211.4 [@] ps 55	CD	$Q(\text{transition}) = 11.05$ 29 (2013He25).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{189}Pt Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2}	XREF	Comments
529.62 11	(1/2,3/2,5/2) ⁻		A	J ^π : M1(+E2) to 3/2 ⁻ .
531.3 ^b 3	(15/2 ⁺)		CD	
574 5	1/2 ⁻ , 3/2 ⁻		E	J ^π : L=1 in (p,d).
608.6 ^e 2	(13/2 ⁻)		CD	J ^π : in (α,3nγ) this was assigned 11/2 ⁻ . In (^{18}O ,5nγ) this is tentatively assigned as (13/2 ⁻) based on a DCO measurement and expectation of yrast levels being more strongly populated in that reaction.
653.8 2	(15/2 ⁺)		CD	
712.0 2	(13/2 ⁻)		CD	
843.7 6	(13/2 ⁻)		D	
902.9 7			D	
944.0 ^c 2	(17/2 ⁺)		CD	
955.0 ^a 2	(21/2 ⁺)	175.4 [@] ps 49	CD	Q(transition)=2.49 7 (2013He25).
983.5 ^b 3	(19/2 ⁺)		CD	
1048.5 7	(15/2 ⁻)		D	
1081.1 ^e 2	(17/2 ⁻)		CD	J ^π : in (α,3nγ) this was assigned 15/2 ⁻ . In (^{18}O ,5nγ) this is tentatively assigned as (17/2 ⁻) based on a DCO measurement and expectation of yrast levels being more strongly populated in that reaction.
1160.87 14	(3/2 ⁺)		A	J ^π : E1 to 3/2 ⁻ , strongly populated by ε decay from 1/2 ⁺ .
1185.31 20	(19/2 ⁺)		CD	
1361.5 2	(17/2 ⁻)		CD	
1414.0 6			D	
1415.9 8	(17/2 ⁻)		D	
1444.0 ^c 3	(21/2 ⁺)		CD	
1490.4 ^e 2	(19/2 ⁻)		CD	
1512.1 2	(21/2 ⁻)		CD	
1529.3 ^a 3	(25/2 ⁺)		CD	
1555.7 ^b 3	(23/2 ⁺)		CD	
1695.7 3	(23/2 ⁻)		C	
1714.3 ^f 3	(25/2 ⁻)		CD	
1727.4 4	(23/2 ⁺)		D	
2009.5 ^c 3	(25/2 ⁺)		C	
2055.2 3	(27/2 ⁻)		CD	
2189.5 ^a 3	(29/2 ⁺)		CD	
2219.4 ^b 4	(27/2 ⁺)		CD	
2291.4 ^g 3	(29/2 ⁻)		CD	
2303.7 ^f 3	(29/2 ⁻)		C	
2539.7 4	(27/2 ⁺)		C	
2620.4 3	(31/2 ⁻)		C	
2635.5 ^c 3	(29/2 ⁺)		C	
2688.4 3	(31/2 ⁻)		CD	
2729.4 3	(29/2 ⁺)		C	
2818.6 5			C	
2839.8 ^f 3	(33/2 ⁻)		C	
2864.7 ^a 3	(33/2 ⁺)		CD	
2874.2 ^g 3	(33/2 ⁻)		C	
2931.6 ^b 4	(31/2 ⁺)		C	
2979.3 3	(31/2 ⁺)		C	
3066.2 4	(33/2 ⁺)		C	
3201.0 ^c 3	(33/2 ⁺)		C	
3292.4 3	(35/2 ⁻)		C	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{189}Pt Levels (continued)

E(level) [†]	J ^π [‡]	XREF	E(level) [†]	J ^π [‡]	XREF	E(level) [†]	J ^π [‡]	XREF
3376.4 ^a 4	(37/2 ⁺)	C	4168.6 ^f 6	(41/2 ⁻)	C	5502.1 ^d 4	(53/2 ⁻)	C
3420.1 3	(35/2 ⁺)	C	4367.8 ^{&} 3	(47/2 ⁺)	C	6474.8 ^d 5	(57/2 ⁻)	C
3452.7 ^f 4	(37/2 ⁻)	C	4437.2 3	(43/2 ⁻)	C	6476.5 ^{&} 4	(55/2 ⁺)	C
3455.4 3	(35/2 ⁺)	C	4647.4 ^a 7	(45/2 ⁺)	C	6761.9 ^d 7		C
3574.1 ^g 4	(37/2 ⁻)	C	4686.2 3	(45/2 ⁺)	C	6841.6 ^{&} 5	(57/2 ⁺)	C
3582.3 ^c 3	(37/2 ⁺)	C	4688.1 3	(45/2 ⁻)	C	7272.3 ^{&} 7		C
3640.7 ^{&} 3	(39/2 ⁺)	C	4708.4 3	(47/2 ⁺)	C	7358.0 ^d 9		C
3648.7 3	(39/2 ⁻)	C	4795.3 3	(45/2 ⁻)	C	7582.5 7		C
3672.9 6		C	4848.7 4	(45/2 ⁻)	C	7764.8 ^{&} 9		C
3809.3 3	(41/2 ⁻)	C	4879.3 ^{&} 3	(49/2 ⁺)	C	8135.3 ^d 10		C
3848.6 ^{&} 3	(43/2 ⁺)	C	5042.3 ^d 3	(49/2 ⁻)	C	8843.1 ^d 11		C
3947.0 ^a 5	(41/2 ⁺)	C	5353.7 ^{&} 3	(53/2 ⁺)	C			
3976.0 ^c 6		C	5464.5 ^a 9	(49/2 ⁺)	C			

[†] From least square fit to E_γ values.

[‡] Suggested values from $^{188}\text{Os}(\alpha, 3n\gamma)$, $^{191}\text{Ir}(p, 3n\gamma)$, up to 2865 keV, except where noted. These values are derived from $\gamma\gamma(\theta)$, excitation functions, and Nilsson model assumptions. These are in general agreement with J^π values suggested from multipolarity assignments and yrast arguments from ($^{18}\text{O}, 5n\gamma$), which were used for J^π assignments beyond 2865 keV.

The 6.4 level is populated by an M1+E2 γ from the 88.4 level which is 1/2⁻, 3/2⁻ from L=1 in (p,d). The 172.8 and 493 levels are populated with low log *f_T* (≈ 5) from ^{189}Au ε decay (4.59 min) indicating J^π=9/2⁻, 11/2⁻, 13/2⁻. An E2 γ from 172.6 to 6.2 thus establishes J^π(6.2)=5/2⁻, J^π(88.4)=3/2⁻, and J^π(172.6)=9/2⁻. From $\gamma(\theta)$ on oriented nuclei the 493 level is uniquely determined as 11/2⁻.

@ From $^{176}\text{Yb}(^{18}\text{O}, 5n\gamma)$, using the recoil-distance method (2013He25).

& Band(A): γ cascade based on (39/2⁺). Structure #3 in 2009Hu12.

^a Band(B): 13/2⁺ band, $\alpha=+1/2$.

^b Band(b): 13/2⁺ band, $\alpha=-1/2$.

^c Band(C): Band based on (17/2⁺). Structure #2 in 2009Hu12.

^d Band(D): γ cascade based on (49/2⁻). Structure #4 in 2009Hu12.

^e Band(E): The g.s. band.

^f Band(F): $\Delta J=2$ band based on (25/2⁻). Part of structure #1 in 2009Hu12 interpreted as pair of pseudospin partners with configuration= $\nu i_{13/2}^{-2} \otimes \nu(f_{5/2}/p_{3/2})$.

^g Band(G): $\Delta J=2$ band based on (29/2⁻). Part of structure #1 in 2009Hu12 interpreted as pair of pseudospin partners with configuration= $\nu i_{13/2}^{-2} \otimes \nu(f_{5/2}/p_{3/2})$.

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Pt})$									
$E_i(\text{level})$	J_i^π	E_γ^a	I_γ^c	E_f	J_f^π	Mult. ^{\$}	$\delta^{\S}$	α^b	Comments
6.40	5/2 ⁻	(6.40) ⁺ 4)	100	0.0	3/2 ⁻	[M1]		924 22	
45.78	(1/2) ⁻	39.47 [#] 3	14.4 ^d 23	6.40	5/2 ⁻	E2 [‡]	[‡]	369	
		45.69 [#] 3	100 ^d 25	0.0	3/2 ⁻	M1+E2 [‡]	0.32 [‡] 3	27 3	
88.30	3/2 ⁻	42.75 ^{#f} 5		45.78	(1/2) ⁻	M1+E2 [‡]	0.14 [‡] 2	18.7 14	
		82.2 [#] 5		6.40	5/2 ⁻	M1+E2 [‡]	0.21 [‡] 2	11.6 3	
		88.41 [#] 3		0.0	3/2 ⁻	M1+E2 [‡]	0.21 [‡] 2	9.43	
172.79	9/2 ⁻	166.40 5	100	6.40	5/2 ⁻	E2 [‡]	[‡]	0.684	B(E2)(W.u.)=0.088 5 E _γ : Using the higher precision value from 4.59 min ε decay.
191.4	(13/2 ⁺)	(18.7 ⁺ 9)	100	172.79	9/2 ⁻	[M2]		3.8×10 ⁴ 10	B(M2)(W.u.)=0.08 3
202.2	(11/2 ⁺)	(11.3 ⁺)		191.4	(13/2 ⁺)				
222.30	(3/2,5/2) ⁻	134.26 [#] 4	24 ^d 4	88.30	3/2 ⁻	M1+E2 [‡]	0.8 [‡] 3	2.3 3	
		176.1 [#] 5		45.78	(1/2) ⁻				
		215.68 [#] 5	62 ^d 9	6.40	5/2 ⁻	M1+E2 [‡]	0.9 [‡] 4	0.54 12	
		221.95 [#] 16	100 12	0.0	3/2 ⁻	E2 [‡]	[‡]	0.253	
237.4	(9/2) ⁻	231.0 1	100	6.40	5/2 ⁻	E2 [‡]	[‡]	0.222	E _γ : Weighted average from (¹⁸ O, ⁴ n _γ) and 28.7 min ε decay.
348.45	(5/2,3/2) ⁻	110.8 ^{#f} 5	4 ^d 1	237.4	(9/2) ⁻	(E2) [‡]	[‡]	3.22 8	
		126.31 5	8.8 ^d 12	222.30	(3/2,5/2) ⁻	M1+E2 [‡]	0.54 [‡] 9	3.08 10	
		259.68 [#] 10	13 ^d 4	88.30	3/2 ⁻	M1+E2 [‡]	1.4 [‡] +8-4	0.25 5	
		302.4 ^{#f} 5		45.78	(1/2) ⁻				
		342.0 [#] 5	20 ^d 4	6.40	5/2 ⁻				
		348.15 [#] 15	100 7	0.0	3/2 ⁻	M1(+E2) [‡]	<0.7 [‡]	0.181 24	
356.72	(9/2) ⁻	350.3 3	100	6.40	5/2 ⁻				
447.67	(3/2,5/2) ⁻	225.7 [#] 5	20 ^d 4	222.30	(3/2,5/2) ⁻	M1(+E2) [‡]	<0.8 [‡]	0.58 9	
		359.4 [#] 5	8 3	88.30	3/2 ⁻				
		441.04 [#] 14	69 ^d 8	6.40	5/2 ⁻	M1+E2 [‡]	1.3 [‡] +20-6	0.062 23	
		447.77 [#] 9	100 ^d 13	0.0	3/2 ⁻	M1(+E2) [‡]	<0.7 [‡]	0.092 12	
493.3	11/2 ⁻	321.1 ^a 5	100	172.79	9/2 ⁻	M1+E2	-16.2 +17-21	0.0817	
499.2	(17/2 ⁺)	307.8 1	100	191.4	(13/2 ⁺)	E2 ^{&}		0.0913	B(E2)(W.u.)=13.8 4
529.62	(1/2,3/2,5/2) ⁻	484.2 [#] 5	13 ^d 4	45.78	(1/2) ⁻				
		523.4 [#] 5	13 ^d 7	6.40	5/2 ⁻				
		529.59 [#] 11	100 ^d 18	0.0	3/2 ⁻	M1(+E2) [‡]	<1.4 [‡]	0.052 15	
531.3	(15/2 ⁺)	329.2 5		202.2	(11/2 ⁺)				E _γ : Only in (α,3n _γ).
		339.9 1	100	191.4	(13/2 ⁺)	D+Q ^{&}			

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Pt})$ (continued)									
$E_i(\text{level})$	J_i^π	E_γ @	I_γ^c	E_f	J_f^π	Mult. [§]	α^b	Comments	
608.6	(13/2 ⁻)	251.9 3	11 4	356.72	(9/2 ⁻)				
		371.2 1	100 5	237.4	(9/2 ⁻)	(E2)&	0.0536		
653.8	(15/2 ⁺)	462.4 1	100	191.4	(13/2 ⁺)	D+Q&			
712.0	(13/2 ⁻)	539.5 3	100	172.79	9/2 ⁻	(E2)&	0.0206		
843.7	(13/2 ⁻)	487.0 5	100	356.72	(9/2 ⁻)				
902.9		409.6 5		493.3	11/2 ⁻				
944.0	(17/2 ⁺)	290.2 5		653.8	(15/2 ⁺)				
		412.7 1	100 15	531.3	(15/2 ⁺)	D+Q&			
		444.8 5	30 9	499.2	(17/2 ⁺)	(E2)&	0.0332		
955.0	(21/2 ⁺)	455.8 1	100	499.2	(17/2 ⁺)	(E2)&	0.0312	B(E2)(W.u.)=2.47 7	
983.5	(19/2 ⁺)	452.2 1	100 15	531.3	(15/2 ⁺)	(E2)&	0.0318		
		484.3 3	51 8	499.2	(17/2 ⁺)	D+Q&			
1048.5	(15/2 ⁻)	555.2 5	100	493.3	11/2 ⁻				
1081.1	(17/2 ⁻)	472.4 1	100	608.6	(13/2 ⁻)	(E2)&			
1160.87	(3/2 ⁺)	631.2 [#] 9	12.1 ^d 23	529.62	(1/2,3/2,5/2) ⁻	E1 [‡]	0.00511		
		713.24 [#] 17	100 ^d 14	447.67	(3/2,5/2) ⁻	E1 [‡]	0.00401		
		812.8 [#] 3	63 ^d 9	348.45	(5/2,3/2) ⁻	E1 [‡]	0.00311		
		1071.5 [#] 6	27 ^d 5	88.30	3/2 ⁻	E1 [‡]	0.00187		
		1160.6 [#] 3	35 ^d 5	0.0	3/2 ⁻	E1 [‡]	1.63×10 ⁻³		
1185.31	(19/2 ⁺)	531.5 1	40 6	653.8	(15/2 ⁺)	(E2)&	0.0214		
		686.1 1	100 5	499.2	(17/2 ⁺)	D+Q&			
1361.5	(17/2 ⁻)	280.4 3	17 5	1081.1	(17/2 ⁻)	(E2)&	0.1207		
		649.5 1	56 9	712.0	(13/2 ⁻)	Q&			
		707.7 1	64 10	653.8	(15/2 ⁺)	D			
		862.3 1	100 15	499.2	(17/2 ⁺)	D&			
1414.0		470.0 5		944.0	(17/2 ⁺)				
1415.9	(17/2 ⁻)	572.2 5		843.7	(13/2 ⁻)				
1444.0	(21/2 ⁺)	460.5 3	30 10	983.5	(19/2 ⁺)	D+Q&			
		500.0 1	100 16	944.0	(17/2 ⁺)	(E2)&	0.0248		
		944.8 5	10 4	499.2	(17/2 ⁺)	Q&			
1490.4	(19/2 ⁻)	128.9 1	35 6	1361.5	(17/2 ⁻)	(E2)&	1.77		
		409.3 1	100 5	1081.1	(17/2 ⁻)	(E2)&	0.0412		
		536 1		955.0	(21/2 ⁺)				E _γ : only in (α,3nγ). Uncertainty assumed by evaluators.
1512.1	(21/2 ⁻)	(21.7)		1490.4	(19/2 ⁻)				
		150.6 3	10 4	1361.5	(17/2 ⁻)	(E2)&	0.985 16		
		326.8 1	84 5	1185.31	(19/2 ⁺)	D&			

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Pt})$ (continued)								
$E_i(\text{level})$	J_i^π	E_γ^a	I_γ^c	E_f	J_f^π	Mult. [§]	α^b	Comments
1512.1	(21/2 ⁻)	557.1 1	100 5	955.0	(21/2 ⁺)	D		
1529.3	(25/2 ⁺)	574.3 1	100	955.0	(21/2 ⁺)	(E2)&	0.01780	
1555.7	(23/2 ⁺)	572.2 3	100 16	983.5	(19/2 ⁺)	(E2)&	0.0180	
		600.7 5	22 7	955.0	(21/2 ⁺)	D+Q&		
1695.7	(23/2 ⁻)	183.6 1	100 6	1512.1	(21/2 ⁻)	D+Q&		
		740.7 3	4 2	955.0	(21/2 ⁺)			
1714.3	(25/2 ⁻)	(18.6 [†])		1695.7	(23/2 ⁻)			E_γ : in ($\alpha,3n\gamma$) and the previous evaluation, this γ was placed from a 1530 keV level with (23/2 ⁻). In ($^{18}\text{O},5n\gamma$), coincidence relations found the 740.7 feeding the 945 keV level. This matches the 184 γ feeding the 1512 keV level followed by the 557 γ populating the 954 keV level. The 18.6 keV and and 184 γ 's match and are parallel to the 202 γ feeding the 1512 keV level but with the order of the 18.6 and 184 γ rays now reversed. See 2009Hu12 for further discussion.
		202.2 1	100	1512.1	(21/2 ⁻)	(E2)&	0.346	
1727.4	(23/2 ⁺)	542.1 5		1185.31	(19/2 ⁺)			
		772.4 5		955.0	(21/2 ⁺)			
2009.5	(25/2 ⁺)	565.5 ^e 1	<100 ^e	1444.0	(21/2 ⁺)			
		1054.5 5	14 5	955.0	(21/2 ⁺)	Q&		
2055.2	(27/2 ⁻)	340.9 1	100	1714.3	(25/2 ⁻)	D+Q&		
2189.5	(29/2 ⁺)	660.2 1	100	1529.3	(25/2 ⁺)	Q&		
2219.4	(27/2 ⁺)	663.7 3	100	1555.7	(23/2 ⁺)	Q&		
2291.4	(29/2 ⁻)	236.2 3	15 3	2055.2	(27/2 ⁻)	D+Q&		
		577.1 1	100 6	1714.3	(25/2 ⁻)	(E2)&	0.01760	
2303.7	(29/2 ⁻)	248.5 3	22 4	2055.2	(27/2 ⁻)	D+Q&		
		589.4 1	100 6	1714.3	(25/2 ⁻)	(E2)&	0.01677	
2539.7	(27/2 ⁺)	1010.4 5	100	1529.3	(25/2 ⁺)	D+Q&		
2620.4	(31/2 ⁻)	316.7 1	100 15	2303.7	(29/2 ⁻)	D+Q&		
		329.0 3	42 7	2291.4	(29/2 ⁻)	D+Q&		
		565.2 1	87 13	2055.2	(27/2 ⁻)	(E2)&	0.0185	
2635.5	(29/2 ⁺)	626.0 1	100 5	2009.5	(25/2 ⁺)	Q&		
		1106.2 3	17 6	1529.3	(25/2 ⁺)	Q&		
2688.4	(31/2 ⁻)	397.0 3	63 10	2291.4	(29/2 ⁻)	D+Q&		E_γ : Observed only in $^{176}\text{Yb}(^{18}\text{O},5n\gamma)$.
		633.2 1	100 15	2055.2	(27/2 ⁻)	Q&		
2729.4	(29/2 ⁺)	189.7 5		2539.7	(27/2 ⁺)			
		539.9 ^e 3	100 ^e 32	2189.5	(29/2 ⁺)	(E2)&	0.0206	
		1200.1 5	41 14	1529.3	(25/2 ⁺)	Q&		
2818.6		763.4 5	100	2055.2	(27/2 ⁻)			

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Pt})$ (continued)							
$E_i(\text{level})$	J_i^π	E_γ^a	I_γ^c	E_f	J_f^π	Mult. ^s	α^b
2839.8	(33/2 ⁻)	536.1 1	100 15	2303.7	(29/2 ⁻)	(E2)&	0.0209
		548.4 3	46 8	2291.4	(29/2 ⁻)	(E2)&	0.0198
2864.7	(33/2 ⁺)	675.2 1	100	2189.5	(29/2 ⁺)	Q&	
2874.2	(33/2 ⁻)	582.8 1	100	2291.4	(29/2 ⁻)	(E2)&	0.01721
2931.6	(31/2 ⁺)	712.2 3	100	2219.4	(27/2 ⁺)	Q&	
2979.3	(31/2 ⁺)	249.9 3	<100	2729.4	(29/2 ⁺)		
		439.6 5		2539.7	(27/2 ⁺)		
		759.9 5	19 6	2219.4	(27/2 ⁺)	Q&	
3066.2	(33/2 ⁺)	876.7 3	100	2189.5	(29/2 ⁺)	Q&	
3201.0	(33/2 ⁺)	134.8 5		3066.2	(33/2 ⁺)		
		565.5 ^e 1	100 ^e	2635.5	(29/2 ⁺)	(E2)&	0.0185
3292.4	(35/2 ⁻)	91.4 3	15 5	3201.0	(33/2 ⁺)	D&	
		418.2 3	15 5	2874.2	(33/2 ⁻)	D+Q&	
		452.6 3	20 7	2839.8	(33/2 ⁻)	D+Q&	
		473.8 5		2818.6			
		604.0 1	54 8	2688.4	(31/2 ⁻)	Q&	
		672.0 1	100 5	2620.4	(31/2 ⁻)	Q&	
3376.4	(37/2 ⁺)	511.7 3	100	2864.7	(33/2 ⁺)	(E2)&	0.0234
3420.1	(35/2 ⁺)	219.1 3	100 16	3201.0	(33/2 ⁺)	D+Q&	
		353.9 5	42 14	3066.2	(33/2 ⁺)		
		440.8 5		2979.3	(31/2 ⁺)		
		580.3 3	74 23	2839.8	(33/2 ⁻)	D&	
3452.7	(37/2 ⁻)	612.9 3	100	2839.8	(33/2 ⁻)	Q&	
3455.4	(35/2 ⁺)	163.0 5	37 11	3292.4	(35/2 ⁻)		
		254.4 3	55 16	3201.0	(33/2 ⁺)	D+Q&	
		476.1 3	100 15	2979.3	(31/2 ⁺)		
		523.8 5	27 8	2931.6	(31/2 ⁺)	(E2)&	0.0221
3574.1	(37/2 ⁻)	699.9 3	100	2874.2	(33/2 ⁻)	Q&	
3582.3	(37/2 ⁺)	381.3 1	100 16	3201.0	(33/2 ⁺)	(E2)&	0.0498
		717.6 3	41 13	2864.7	(33/2 ⁺)		
3640.7	(39/2 ⁺)	(58.4)		3582.3	(37/2 ⁺)		
		185.3 1	100 15	3455.4	(35/2 ⁺)	(E2)&	0.467
		188.0 3	25 8	3452.7	(37/2 ⁻)	D&	
		220.6 1	67 11	3420.1	(35/2 ⁺)	(E2)&	0.259
3648.7	(39/2 ⁻)	356.3 1	100	3292.4	(35/2 ⁻)	(E2)&	0.0600
3672.9		808.2 5		2864.7	(33/2 ⁺)		

Adopted Levels, Gammas (continued)

 $\gamma(^{189}\text{Pt})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^a	I_γ^c	E_f	J_f^π	Mult. d	α^b
3809.3	(41/2 ⁻)	160.6 1	100	3648.7	(39/2 ⁻)	D+Q&	
3848.6	(43/2 ⁺)	207.9 1	100	3640.7	(39/2 ⁺)	(E2)&	0.315
3947.0	(41/2 ⁺)	570.6 3	100	3376.4	(37/2 ⁺)	(E2)&	0.0181
3976.0		393.7 5		3582.3	(37/2 ⁺)		
4168.6	(41/2 ⁻)	715.9 5	100	3452.7	(37/2 ⁻)	Q&	
4367.8	(47/2 ⁺)	519.2 1	100	3848.6	(43/2 ⁺)	(E2)&	0.0226
4437.2	(43/2 ⁻)	627.9 1	100 15	3809.3	(41/2 ⁻)	D+Q&	
		788.5 5	16 5	3648.7	(39/2 ⁻)	Q&	
4647.4	(45/2 ⁺)	700.4 5	100	3947.0	(41/2 ⁺)	Q&	
4686.2	(45/2 ⁺)	318.4 3	19 6	4367.8	(47/2 ⁺)		
		837.6 1	100 15	3848.6	(43/2 ⁺)	D+Q&	
4688.1	(45/2 ⁻)	250.9 1	100	4437.2	(43/2 ⁻)	D+Q&	
4708.4	(47/2 ⁺)	340.6 3	49 8	4367.8	(47/2 ⁺)		
		859.8 1	100 16	3848.6	(43/2 ⁺)	Q&	
4795.3	(45/2 ⁻)	986.0 1	100	3809.3	(41/2 ⁻)	Q&	
4848.7	(45/2 ⁻)	1039.4 3	100	3809.3	(41/2 ⁻)	Q&	
4879.3	(49/2 ⁺)	170.9 3	41 13	4708.4	(47/2 ⁺)	D+Q&	
		193.1 1	100 16	4686.2	(45/2 ⁺)	(E2)&	0.405
		511.5 3	58 9	4367.8	(47/2 ⁺)	D+Q&	
5042.3	(49/2 ⁻)	193.6 5	23 7	4848.7	(45/2 ⁻)	(E2)&	0.402 7
		247.0 3	100 15	4795.3	(45/2 ⁻)	(E2)&	0.179
		333.9 3	90 14	4708.4	(47/2 ⁺)	D&	
		354.2 3	98 15	4688.1	(45/2 ⁻)	(E2)&	0.0610
5353.7	(53/2 ⁺)	474.4 1	100	4879.3	(49/2 ⁺)	(E2)&	0.0282
5464.5	(49/2 ⁺)	817.1 5	100	4647.4	(45/2 ⁺)	Q&	
5502.1	(53/2 ⁻)	459.8 1	100	5042.3	(49/2 ⁻)	(E2)&	0.0305
6474.8	(57/2 ⁻)	972.7 3	100	5502.1	(53/2 ⁻)	Q&	
6476.5	(55/2 ⁺)	1122.8 1	100	5353.7	(53/2 ⁺)	D+Q&	
6761.9		287.1 5	100	6474.8	(57/2 ⁻)		
6841.6	(57/2 ⁺)	365.1 3	100	6476.5	(55/2 ⁺)	D+Q&	
7272.3		430.7 5	100	6841.6	(57/2 ⁺)		
7358.0		596.1 5		6761.9			
7582.5		740.9 5		6841.6	(57/2 ⁺)		
7764.8		492.5 5		7272.3			
8135.3		777.3 5		7358.0			
8843.1		707.8 5		8135.3			

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Pt})$ (continued)

[†] Transition unobserved. Energy from energy level differences.

[‡] From Ice data in ^{189}Au ε decay (28.7 min) and ^{189}Au ε decay (4.59 min).

[§] From (^{18}O , $5n\gamma$), except where noted.

[&] From directional correlation of oriented nuclei (DCO) ratios from (^{18}O , $5n\gamma$), assuming quadrupole transitions are E2, stretched dipoles are E1 or M1, and mixed multipolarity are M1+E2. Where J^π values were already tentatively assigned, level scheme placement based on corroborating transitions, was used to distinguish between M1 or E1.

[@] From (^{18}O , $5n\gamma$) (2009Hu12) except where noted.

[#] From ^{189}Au ε decay (28.7 min).

^a From ^{189}Au ε decay (4.59 min).

^b From BrIcc v2.3b (16-Dec-2014) 2008Ki07, “Frozen Orbitals” appr.

^c From ^{176}Yb (^{18}O , $5n\gamma$) unless otherwise noted.

^d From ^{189}Au ε decay (28.7 min).

^e Multiply placed with intensity suitably divided.

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

Adopted Levels, Gammas

Adopted Levels, Gammas (continued)

 ^{189}Au ε decay (28.7 min) [1973Ja16,1970Fi16,1970Jo02](#)

Parent: ^{189}Au : $E=0.0$; $J^\pi=1/2^+$; $T_{1/2}=28.7$ min 4; $Q(\varepsilon)=2887$ 22; $\% \varepsilon + \% \beta^+$ decay=100

^{189}Au - J^π , $T_{1/2}$: From ^{189}Au Adopted Levels.

^{189}Au - $Q(\varepsilon)$: From [2017Wa10](#).

[1973Ja16](#): measured E_γ , I_γ , ce.

[1970Fi16](#): measured E_γ , I_γ .

[1970Jo02](#): measured E_γ , I_γ , I(ce), $T_{1/2}$.

Others: [1967Na02](#), [1965Ki06](#).

 ^{189}Pt Levels

E(level)	J^π [†]	$T_{1/2}$ [†]
0.0	$3/2^-$	10.87 h 12
6.40 4	$5/2^-$	
45.731 23	$(1/2)^-$	
88.334 25	$3/2^-$	
222.29 4	$(3/2, 5/2)^-$	
237.5	$(7/2)^-$	
348.44 5	$(5/2, 3/2)^-$	
447.64 7	$(3/2, 5/2)^-$	
529.62 10	$(1/2, 3/2, 5/2)^-$	
1160.82 14	$3/2^+$	

[†] From Adopted Levels.

γ(¹⁸⁹Pt)

Iγ normalization: Decay scheme is incomplete, thus not normalized.

E _γ [†]	I _γ [‡]	E _i (level)	J _i ^π	E _f	J _f ^π	Mult.&	δ&	α@	Comments
(6.40 4)		6.40	5/2 ⁻	0.0	3/2 ⁻			924 22	E _γ : from Adopted Gammas.
39.47 3	0.13 § 2	45.731	(1/2) ⁻	6.40	5/2 ⁻	E2		369	L2/L3=0.8; M2/M3=0.9; ce(L2)=115 25 α: other values: L1/L2<0.05, L2/L3=0.95 20.
42.75 [#] 5		88.334	3/2 ⁻	45.731	(1/2) ⁻	M1+E2	0.14 2	18.7 14	L1:L2:L3=5.2:1.3:1
^x 45.05 5	0.23 § 9					M1+E2	0.39 +7-4	36 8	L1/L3=0.78 31; ce(L1)=45 12
45.69 3	0.90 § 22	45.731	(1/2) ⁻	0.0	3/2 ⁻	M1+E2	0.32 3	27 3	L1/L2=0.6; L3/L4=1.4; ce(L2)=154 30
82.2 5		88.334	3/2 ⁻	6.40	5/2 ⁻	M1+E2	0.21 2	11.6 3	L2/L3=1.8
88.41 3	10.3 16	88.334	3/2 ⁻	0.0	3/2 ⁻	M1+E2	0.21 2	9.43	L1:L2:L3=9.9:2.2:1; ce(L1)=158 20 α: other value: L1/L2=4.3 11.
^x 92.3 5	6.5 10								
110.8 [#] 5	1.8 4	348.44	(5/2,3/2) ⁻	237.5	(7/2) ⁻	(E2)		3.22 8	α(exp)=3.1 14 α: from intensity balance through 237 level. Transition placed by the evaluators on the basis of energy sums.
126.31 5	3.8 5	348.44	(5/2,3/2) ⁻	222.29	(3/2,5/2) ⁻	M1+E2	0.54 9	3.08 10	α(K)exp=1.2 5; K:L1:L2=12:4:1; ce(L1)=27 5 α: other value: K/L1=5.6 18.
134.26 4	6.5 9	222.29	(3/2,5/2) ⁻	88.334	3/2 ⁻	M1+E2	0.8 3	2.3 3	α(K)exp=1.8 6; K/L1=5; ce(K)=250 40 α: other values: K/L=7.4 16, L1/L2>8.
176.1 5		222.29	(3/2,5/2) ⁻	45.731	(1/2) ⁻	[M1]		1.333 22	
^x 186.5 5									
^x 194.9 3	4.0 8					(E1,E2)			α(K)exp=0.10 5; ce(K)=10 4
215.68 5	16.6 23	222.29	(3/2,5/2) ⁻	6.40	5/2 ⁻	M1+E2	0.9 4	0.54 12	α(K)exp=0.42 10; ce(K)=133 20
^x 218.7 5	9.0 18					E2(+M1)	>3	0.289 24	α(K)exp=0.15 4
221.95 16	27 3	222.29	(3/2,5/2) ⁻	0.0	3/2 ⁻	E2		0.253	α(K)exp=0.13 4; ce(K)=56 15
225.7 5	10.8 22	447.64	(3/2,5/2) ⁻	222.29	(3/2,5/2) ⁻	M1(+E2)	<0.8	0.58 9	α(K)exp=0.55 15
231.2 5	6.0 15	237.5	(7/2) ⁻	6.40	5/2 ⁻	E2		0.222	α(K)exp=0.16 4 ce(K)=31 12
^x 253.67 15									
^x 256.1 5	4.5 12								
259.68 10	5.4 16	348.44	(5/2,3/2) ⁻	88.334	3/2 ⁻	M1+E2	1.4 +8-4	0.25 5	α(K)exp=0.19 5; ce(K)=23 8 ce(K)=4 2
^x 260.61 25									
^x 262.0 5	3.5 10					M1(+E2)	<1.0	0.36 8	α(K)exp=0.31 8
^x 265.7 5	2.5 10					M1		0.425	α(K)exp=0.4 1
^x 297.5 5	14.5 25								
302.4 [#] 5		348.44	(5/2,3/2) ⁻	45.731	(1/2) ⁻	[M1]		0.299	
^x 309.6 5	5.0 18								
^x 329.8 5	9 3								
^x 332.5 5	3.8 12								
342.0 5	8.8 16	348.44	(5/2,3/2) ⁻	6.40	5/2 ⁻	[M1]		0.214	

$\gamma(^{189}\text{Pt})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^\ddagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.&	$\delta\&$	$\alpha^\@$	Comments
348.15 15	43 3	348.44	(5/2,3/2) ⁻	0.0	3/2 ⁻	M1(+E2)	<0.7	0.181 24	$\alpha(\text{K})_{\text{exp}}=0.16$ 3; $\text{ce}(\text{K})=149$ 25
359.4 5	4.3 16	447.64	(3/2,5/2) ⁻	88.334	3/2 ⁻	[M1]		0.187	
441.04 14	38 4	447.64	(3/2,5/2) ⁻	6.40	5/2 ⁻	M1+E2	1.3 +20-6	0.062 23	$\alpha(\text{K})_{\text{exp}}=0.05$ 3; $\text{ce}(\text{K})=44$ 20
447.77 9	55 7	447.64	(3/2,5/2) ⁻	0.0	3/2 ⁻	M1(+E2)	<0.7	0.092 12	$\alpha(\text{K})_{\text{exp}}=0.09$ 2; $\text{ce}(\text{K})=100$
484.2 5	4.3 13	529.62	(1/2,3/2,5/2) ⁻	45.731	(1/2) ⁻				
523.4 5	4.3 22	529.62	(1/2,3/2,5/2) ⁻	6.40	5/2 ⁻				
529.59 11	34 6	529.62	(1/2,3/2,5/2) ⁻	0.0	3/2 ⁻	M1(+E2)	<1.4	0.052 15	$\alpha(\text{K})_{\text{exp}}=0.05$ 2; $\text{ce}(\text{K})=34$ 6
631.2 9	12.1 23	1160.82	3/2 ⁺	529.62	(1/2,3/2,5/2) ⁻	E1		0.00511	$\alpha(\text{K})_{\text{exp}}<0.012$; $\text{ce}(\text{K})<3$ Mult.: both E1 and E2 are consistent with $\alpha(\text{K})_{\text{exp}}$, but $\Delta J\pi$ supports E1.
713.24 17	100 14	1160.82	3/2 ⁺	447.64	(3/2,5/2) ⁻	E1		0.00401	$\alpha(\text{K})_{\text{exp}}=0.0033$ 6; $\text{ce}(\text{K})=7.9$ 13
^x 802 2	5.7 18								
812.8 3	63 9	1160.82	3/2 ⁺	348.44	(5/2,3/2) ⁻	E1		0.00311	$\alpha(\text{K})_{\text{exp}}=0.0024$ 11; $\text{ce}(\text{K})=3.6$ 11
^x 827.7 5	10 3					M1		0.0212	$\alpha(\text{K})_{\text{exp}}=0.033$ 19; $\text{ce}(\text{K})=4.6$ 15
^x 902 2	10 3					(E1,E2)			$\alpha(\text{K})_{\text{exp}}<0.013$
1071.5 6	27 5	1160.82	3/2 ⁺	88.334	3/2 ⁻	E1		0.00187	$\alpha(\text{K})_{\text{exp}}<0.0023$ Mult.: both E1 and E2 are consistent with $\alpha(\text{K})_{\text{exp}}$, but $\Delta J\pi$ supports E1.
^x 1085 2	≈3								
1160.6 3	35 5	1160.82	3/2 ⁺	0.0	3/2 ⁻	E1		1.63×10 ⁻³	$\alpha(\text{K})_{\text{exp}}<0.0015$ Mult.: both E1 and E2 are consistent with $\alpha(\text{K})_{\text{exp}}$, but $\Delta J\pi$ supports E1.
^x 1177.8 10	16 3								$\alpha(\text{K})_{\text{exp}}<0.0075$

[†] Weighted average of 1973Ja16, 1970Fi16, and 1970Jo02. In taking data from 1973Ja16, the evaluators assume 0.05-keV uncertainty when E_γ values reported with 10 eV uncertainty and 0.5-keV uncertainty when reported with uncertainty of 100 eV.

[‡] Weighted average of 1973Ja16 and 1967Na02, except where noted.

[§] Calculated from Ice and theoretical conversion coefficients.

[&] From subshell I(ce) data of 1973Ja16 and 1970Jo02, and I(ce) data of 1970Jo02 combined with the adopted I_γ . An uncertainty of 20% is assumed when not stated. The ce data from 1970Fi16 have been normalized to the 166.4(E2) from ¹⁸⁹Au ε decay (4.59 min), 713.4(E1), and 812.8(E1) transitions. To convert the Ice data to the relative intensity scale of the gammas, multiply by 0.041 5.

[@] From BrIcc v2.3b (16-Dec-2014) 2008Ki07, "Frozen Orbitals" appr.

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

^x γ ray not placed in level scheme.

^{189}Au ϵ decay (28.7 min) 1973Ja16,1970Fi16,1970Jo02

Decay Scheme

Intensities: Relative I_γ

Legend

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

$1/2^+$ 0.0 28.7 min 4
 $Q=2887.22$
 $^{189}\text{Au}_{110}$
 $\% \epsilon = 100$

10.87 h 12

 $^{189}\text{Pt}_{111}$

^{189}Au ε decay (4.59 min) 1973Ja16,1970Fi16,1970ErZX

Parent: ^{189}Au : $E=247.25$ 16; $J^\pi=11/2^-$; $T_{1/2}=4.59$ min 11; $Q(\varepsilon)=2887$ 22; $\% \varepsilon + \% \beta^+$ decay=100

$^{189}\text{Au}-Q(\varepsilon)$: From 2017Wa10.

$^{189}\text{Au}-E, J^\pi, T_{1/2}$: From ^{189}Au Adopted Levels.

^{189}Au -Large decay energy suggests additional γ rays and levels are probably present.

1973Ja16: measured E_γ , I_γ , ce.

1970Fi16: measured E_γ , I_γ .

1970ErZX: measured E_γ , $T_{1/2}$.

Others: 1978DaZC, 1976Pi03, 1967He06, 1967Al17, 1966Fo13.

Level scheme is considered by the evaluators as incomplete.

 ^{189}Pt Levels

E(level)	$J^\pi^\dagger$	$T_{1/2}$	Comments
0.0	$3/2^-$		
6.3 5	$5/2^-$		
172.7 5	$9/2^-$	464 ns 25	$T_{1/2}$: from 1970Fi16 based on $\gamma\gamma(t)$.
191.8 11	$(13/2^+)$		E(level): observed in $^{188}\text{Os}(\alpha, 3n\gamma)$ (1978DaZC), expected to be populated either directly by ε decay or indirectly by γ -ray deexcitation of higher levels.
493.8 7	$11/2^-$		

† From Adopted Levels.

 ε, β^+ radiations

E(decay)	E(level)	$I\beta^+^\dagger$	$I\varepsilon^\dagger$	Log ft	$I(\varepsilon + \beta^+)^\dagger$
(2640 22)	493.8	≈ 1	≈ 12	5.6	≈ 13
(2962 22)	172.7	≈ 9	≈ 78	4.9	≈ 87

† Absolute intensity per 100 decays.

 $\gamma(^{189}\text{Pt})$

I_γ normalization: Assuming $I(\gamma + \text{ce})(166.4\gamma)=100$, and unobserved transition intensity predominantly deexcites through the 173 level.

E_γ	$I_\gamma^\ddagger$	$E_i(\text{level})$	J^π_i	E_f	J^π_f	Mult.	δ	$\alpha^\ddagger$	Comments
(6.3 5)		6.3	$5/2^-$	0.0	$3/2^-$	[M1]		9.7×10^2 27	E_γ : unobserved transition.
(19.1)		191.8	$(13/2^+)$	172.7	$9/2^-$	[M2]		3.39×10^4 99	E_γ : unobserved transition.
166.40 5	100 5	172.7	$9/2^-$	6.3	$5/2^-$	E2		0.684	L1:L2:L3=35 10:115 25:60 20; $\alpha(K)_{\text{exp}}=0.19$ 5 $\%I_\gamma=59$ 3, using the calculated normalization. E_γ : from 1970Fi16. α : from 1970Fi16.
321.1 5	20 4	493.8	$11/2^-$	172.7	$9/2^-$	M1+E2	-16.2 +17-21	0.0813	E_γ : From 1970Fi16. Transition placed by the evaluators on the basis of Adopted Levels, Gammas dataset. I_γ : from 1973Ja16. Mult.: from Adopted Gammas.

Continued on next page (footnotes at end of table)

^{189}Au ε decay (4.59 min) [1973Ja16,1970Fi16,1970ErZX](#) (continued)

$\gamma(^{189}\text{Pt})$ (continued)

[†] From BrIcc v2.3b (16-Dec-2014) [2008Ki07](#), “Frozen Orbitals” appr.

[‡] For absolute intensity per 100 decays, multiply by 0.59 3.

^{189}Au ε decay (4.59 min) 1973Ja16,1970Fi16,1970ErZX

Decay Scheme

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

Legend

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

$^{176}\text{Yb}(^{18}\text{O}, 5n\gamma)$ 2009Hu12

2009Hu12 (also 2009Hu17): ^{18}O beam produced at E=88,95 MeV by the tandem accelerator at the Japan Atomic Energy Agency.

Gamma rays were detected using the GEMINI array, consisting of fourteen HPGe detectors with BGO anti-Compton shields.

Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(\theta)$ (DCO) Results from this experiment were also published in 2009Hu17. There are some differences in the level schemes and DCO ratios. As 2009Hu12 has a more complete level scheme and was submitted for publication after the 2009Hu17 paper, the evaluators take the results from 2009Hu12.

2013He25: ^{18}O beam produced at E=87 MeV by HI-13 tandem accelerator at the China Institute of Atomic Energy (CIAE).

Target=99% enriched ^{176}Yb 0.7 mg/cm² thick on a 2 mg/cm² thick gold foil. The γ rays were detected with an array of eleven Compton suppressed HPGe detectors and two planar HPGe detectors. Measured level lifetimes using RDDS method with a plunger system. Deduced transition quadrupole moments.

 ^{189}Pt Levels

E(level)	$J^{\pi\dagger}$	$T_{1/2}^{\ddagger}$	Comments
0	$3/2^-$		
6.40 ^d 4	$5/2^-$		
172.40 ¹⁰	$9/2^-$	464 ns 25	
191.30 ^{&} 20	$(13/2^+)$	143 μs 5	
237.40 ^d 10	$(9/2^-)$		
356.70 23			
499.10 ^{&} 20	$17/2^+$	211.4 [#] ps 55	Q(transition)=11.05 eb 29 (2013He25).
531.20 ^a 22	$(15/2^+)$		J^{π} : From Adopted Levels.
608.60 ^d 13	$(13/2^-)$		
653.70 20	$15/2^+$		J^{π} : From Adopted Levels and author's assumption of an M1+E2 γ to 13/+ based on the DCO ratio.
711.90 19	$13/2^-$		
943.90 ^b 23	$(17/2^+)$		
954.90 ^{&} 21	$21/2^+$	175.4 [#] ps 49	Q(transition)=2.49 eb 7 (2013He25).
983.40 ^a 23	$19/2^+$		
1081.00 ^d 15	$(17/2^-)$		J^{π} : Assigned $15/2^-$ in $(\alpha, ^3\text{n}\gamma)$.
1185.20 20	$19/2^+$		
1361.40 18	$17/2^-$		
1443.90 ^b 23	$(21/2^+)$		
1490.30 ^d 17	$(21/2^-)$		J^{π} : assigned $19/2^-$ in $(\alpha, ^3\text{n}\gamma)$.
1512.00 21	$21/2^-$		
1529.20 ^{&} 23	$25/2^+$		
1555.6 ^a 3	$23/2^+$		
1695.60 23	$(23/2^-)$		
1714.20 ^e 23	$(25/2^-)$		
2009.40 ^b 24	$(25/2^+)$		
2055.10 24	$(27/2^-)$		
2189.40 ^{&} 24	$29/2^+$		
2219.3 ^a 4	$(27/2^+)$		
2291.30 ^f 24	$(29/2^-)$		
2303.60 ^e 24	$(29/2^-)$		
2539.6 4	$(27/2^+)$		
2620.30 24	$(31/2^-)$		
2635.40 ^b 24	$(29/2^+)$		
2688.30 24	$(31/2^-)$		
2729.3 3	$(29/2^+)$		
2818.5 5			
2839.70 ^e 25	$(33/2^-)$		

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^{18}\text{O},5n\gamma)$ **2009Hu12 (continued)** ^{189}Pt Levels (continued)

E(level)	J^π [†]	E(level)	J^π [†]	E(level)	J^π [†]
2864.6 ^{& 3}	33/2 ⁺	3672.8 6		5042.2 ^{c 3}	(49/2 ⁻)
2874.1 ^{f 3}	(33/2 ⁻)	3809.2 3	(41/2 ⁻)	5353.6 ^{@ 4}	(53/2 ⁺)
2931.5 ^{a 4}	(31/2 ⁺)	3848.5 ^{@ 3}	(43/2 ⁺)	5464.4 ^{& 9}	(49/2 ⁺)
2979.2 3	(31/2 ⁺)	3946.9 ^{& 5}	(41/2 ⁺)	5502.0 ^{c 4}	(53/2 ⁻)
3066.1 4	(33/2 ⁺)	3975.9 ^{b 6}		6474.7 ^{c 5}	(57/2 ⁻)
3200.90 ^{b 24}	(33/2 ⁺)	4168.5 ^{e 6}	(41/2 ⁻)	6476.4 ^{@ 4}	(55/2 ⁺)
3292.30 24	(35/2 ⁻)	4367.7 ^{@ 3}	(47/2 ⁺)	6761.8 ^{c 7}	
3376.3 ^{& 4}	(37/2 ⁺)	4437.1 3	(43/2 ⁻)	6841.5 ^{@ 5}	(57/2 ⁺)
3420.0 3	(35/2 ⁺)	4647.3 ^{& 7}	(45/2 ⁺)	7272.2 ^{@ 7}	
3452.6 ^{e 4}	(37/2 ⁻)	4686.1 3	(45/2 ⁺)	7357.9 ^{c 9}	
3455.3 3	(35/2 ⁺)	4688.0 3	(45/2 ⁻)	7582.4 7	
3574.0 ^{f 4}	(37/2 ⁻)	4708.3 3	(47/2 ⁺)	7764.7 ^{@ 9}	
3582.2 ^{b 3}	(37/2 ⁺)	4795.2 3	(45/2 ⁻)	8135.2 ^{c 10}	
3640.6 ^{@ 3}	(39/2 ⁺)	4848.6 4	(45/2 ⁻)	8843.0 ^{c 11}	
3648.6 3	(39/2 ⁻)	4879.2 ^{@ 3}	(49/2 ⁺)		

[†] The authors based J^π assignments on DCO ratios, assuming stretched quadrupoles to be E2, stretched dipoles to be E1 or M1, with mixed multipolarity to be M1+E2, along with yrast arguments. In addition, assignments were made based on the expectation that spin values increase with excitation energy. These are in general agreement with assignments from (α ,³n γ), with exceptions noted, until 2865 keV, the highest level observed there.

[‡] From Adopted Levels unless otherwise stated.

From **2013He25** using the recoil distance (RDDS) with a plunger system.

@ Band(A): γ cascade based on (39/2⁺). Structure #3 in **2009Hu12**.

& Band(B): 13/2⁺ band, $\alpha=+1/2$.

^a Band(b): 13/2⁺ band, $\alpha=-1/2$.

^b Band(C): Band based on (17/2⁺). Structure #2 in **2009Hu12**.

^c Band(D): γ cascade based on (49/2⁻). Structure #4 in **2009Hu12**.

^d Band(E): Band based on 5/2⁻, $\alpha=+1/2$.

^e Band(F): $\Delta J=2$ band based on (25/2⁻). Part of structure #1 in **2009Hu12** interpreted as pair of pseudospin partners with configuration= $\nu i_{13/2}^{-2} \otimes \nu(f_{5/2}/p_{3/2})$.

^f Band(G): $\Delta J=2$ band based on (29/2⁻). Part of structure #1 in **2009Hu12** interpreted as pair of pseudospin partners with configuration= $\nu i_{13/2}^{-2} \otimes \nu(f_{5/2}/p_{3/2})$.

 $\gamma(^{189}\text{Pt})$

The DCO ratios should be ≈ 1.0 when the gating and measured transitions have the same multipolarity and <1.0 otherwise. Based on authors' DCO ratios and level scheme placements, the evaluators assume E2 transitions were always used as gates.

E_γ [‡]	I_γ [§]	E_i (level)	J_i^π	E_f	J_f^π	Mult. [†]	α ^{&}	Comments
(18.6)		1714.20	(25/2 ⁻)	1695.60	(23/2 ⁻)			
(21.7)		1512.00	21/2 ⁻	1490.30	(21/2 ⁻)			
(58.4)		3640.6	(39/2 ⁺)	3582.2	(37/2 ⁺)			
91.4 3	3.5 11	3292.30	(35/2 ⁻)	3200.90	(33/2 ⁺)	D		DCO=0.57 8
128.9 1	12.6 19	1490.30	(21/2 ⁻)	1361.40	17/2 ⁻	(E2)	1.77	DCO=1.03 18
134.8 5		3200.90	(33/2 ⁺)	3066.1	(33/2 ⁺)			
150.6 3	3.5 11	1512.00	21/2 ⁻	1361.40	17/2 ⁻	(E2)	0.985 16	DCO=1.0 4
160.6 1	13.6 20	3809.2	(41/2 ⁻)	3648.6	(39/2 ⁻)	D+Q		DCO=0.83 7

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^{18}\text{O},5n\gamma)$ 2009Hu12 (continued) $\gamma(^{189}\text{Pt})$ (continued)

E_γ [‡]	I_γ [§]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	α ^{&}	Comments
163.0 5	2.8 8	3455.3	(35/2 ⁺)	3292.30	(35/2 ⁻)			
166.0 1	>3.5	172.40	9/2 ⁻	6.40	5/2 ⁻	E2	0.690	DCO=1.06 13 Mult.: from Adopted Gammas.
170.9 3	4.3 13	4879.2	(49/2 ⁺)	4708.3	(47/2 ⁺)	D+Q		DCO=0.66 13
183.6 1	91 5	1695.60	(23/2 ⁻)	1512.00	21/2 ⁻	D+Q		DCO=0.82 7
185.3 1	17.5 26	3640.6	(39/2 ⁺)	3455.3	(35/2 ⁺)	(E2)	0.467	DCO=1.02 12
188.0 3	4.3 13	3640.6	(39/2 ⁺)	3452.6	(37/2 ⁻)	D	0.0819	DCO=0.66 17
189.7 5		2729.3	(29/2 ⁺)	2539.6	(27/2 ⁺)			
193.1 1	10.6 16	4879.2	(49/2 ⁺)	4686.1	(45/2 ⁺)	(E2)	0.405	DCO=1.02 13
193.6 5	2.0 6	5042.2	(49/2 ⁻)	4848.6	(45/2 ⁻)	(E2)	0.402 7	DCO=1.1 3
202.2 1	24.4 12	1714.20	(25/2 ⁻)	1512.00	21/2 ⁻	(E2)	0.346	DCO=1.06 9
207.9 1	43.5 22	3848.5	(43/2 ⁺)	3640.6	(39/2 ⁺)	(E2)	0.315	DCO=1.08 8
219.1 3	5.3 8	3420.0	(35/2 ⁺)	3200.90	(33/2 ⁺)	D+Q		DCO=0.78 10
220.6 1	11.8 18	3640.6	(39/2 ⁺)	3420.0	(35/2 ⁺)	(E2)	0.259	DCO=1.07 11
231.0 1	17 3	237.40	(9/2 ⁻)	6.40	5/2 ⁻	E2	0.222	DCO=1.19 11 Mult.: from Adopted Gammas; consistent with DCO.
236.2 3	7.7 12	2291.30	(29/2 ⁻)	2055.10	(27/2 ⁻)	D+Q		DCO=0.82 9
247.0 3	8.7 13	5042.2	(49/2 ⁻)	4795.2	(45/2 ⁻)	(E2)	0.179	DCO=1.13 11
248.5 3	7.5 11	2303.60	(29/2 ⁻)	2055.10	(27/2 ⁻)	D+Q		DCO=0.78 10
249.9 3	<7.0	2979.2	(31/2 ⁺)	2729.3	(29/2 ⁺)			
250.9 1	17.2 25	4688.0	(45/2 ⁻)	4437.1	(43/2 ⁻)	D+Q		DCO=0.54 5
251.9 3	3.8 11	608.60	(13/2 ⁻)	356.70				
254.4 3	4.1 12	3455.3	(35/2 ⁺)	3200.90	(33/2 ⁺)	D+Q		DCO=0.56 11
280.4 3	3.4 10	1361.40	17/2 ⁻	1081.00	(17/2 ⁻)	(E2)	0.1207	DCO=1.04 15
287.1 5	1.6 5	6761.8		6474.7	(57/2 ⁻)			
290.2 5		943.90	(17/2 ⁺)	653.70	15/2 ⁺			
307.8 1	144 7	499.10	17/2 ⁺	191.30	(13/2 ⁺)	E2	0.0913	DCO=1.03 8
316.7 1	14.1 21	2620.30	(31/2 ⁻)	2303.60	(29/2 ⁻)	D+Q		DCO=0.40 4
318.4 3	3.4 10	4686.1	(45/2 ⁺)	4367.7	(47/2 ⁺)			
326.8 1	28.9 14	1512.00	21/2 ⁻	1185.20	19/2 ⁺	D		DCO=0.69 5
329.0 3	5.9 9	2620.30	(31/2 ⁻)	2291.30	(29/2 ⁻)	D+Q		DCO=0.84 19
333.9 3	7.8 12	5042.2	(49/2 ⁻)	4708.3	(47/2 ⁺)	D		DCO=0.60 8
339.9 1	>22.9	531.20	(15/2 ⁺)	191.30	(13/2 ⁺)	D+Q		DCO=0.44 8 Mult.: M1+E2 in 2009Hu12.
340.6 3	7.3 11	4708.3	(47/2 ⁺)	4367.7	(47/2 ⁺)			
340.9 1	70 3	2055.10	(27/2 ⁻)	1714.20	(25/2 ⁻)	D+Q		DCO=0.86 4
350.3 3	3.4 10	356.70		6.40	5/2 ⁻			
353.9 5	2.2 7	3420.0	(35/2 ⁺)	3066.1	(33/2 ⁺)			
354.2 3	8.5 13	5042.2	(49/2 ⁻)	4688.0	(45/2 ⁻)	(E2)	0.0610	DCO=1.06 11
356.3 1	35.3 18	3648.6	(39/2 ⁻)	3292.30	(35/2 ⁻)	(E2)	0.0600	DCO=1.06 12
365.1 3	5.3 8	6841.5	(57/2 ⁺)	6476.4	(55/2 ⁺)	D+Q		DCO=0.86 14
371.2 1	34.0 17	608.60	(13/2 ⁻)	237.40	(9/2 ⁻)	(E2)	0.0536	DCO=1.10 8
381.3 1	10.6 16	3582.2	(37/2 ⁺)	3200.90	(33/2 ⁺)	(E2)	0.0498	DCO=1.03 13
393.7 5		3975.9		3582.2	(37/2 ⁺)			
397.0 3	7.7 12	2688.30	(31/2 ⁻)	2291.30	(29/2 ⁻)	D+Q		DCO=0.78 13
409.3 1	36.2 18	1490.30	(21/2 ⁻)	1081.00	(17/2 ⁻)	(E2)	0.0412	DCO=1.13 11
412.7 1	10.1 15	943.90	(17/2 ⁺)	531.20	(15/2 ⁺)	D+Q		DCO=0.55 6
418.2 3	3.5 11	3292.30	(35/2 ⁻)	2874.1	(33/2 ⁻)	D+Q		DCO=0.45 7
430.7 5	2.8 8	7272.2		6841.5	(57/2 ⁺)			
439.6 5		2979.2	(31/2 ⁺)	2539.6	(27/2 ⁺)			
440.8 5		3420.0	(35/2 ⁺)	2979.2	(31/2 ⁺)			
444.8 5	3.0 9	943.90	(17/2 ⁺)	499.10	17/2 ⁺	(E2)	0.0332	DCO=1.05 13
452.2 1	12.8 19	983.40	19/2 ⁺	531.20	(15/2 ⁺)	(E2)	0.0318	DCO=1.04 11

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^{18}\text{O},5n\gamma)$ **2009Hu12** (continued) $\gamma(^{189}\text{Pt})$ (continued)

E_γ ‡	I_γ §	$E_f(\text{level})$	J_i^π	E_f	J_f^π	Mult. †	α &	Comments
452.6 3	4.5 14	3292.30	(35/2 ⁻)	2839.70	(33/2 ⁻)	D+Q		DCO=0.85 11
455.8 1	100 5	954.90	21/2 ⁺	499.10	17/2 ⁺	(E2)	0.0312	DCO=1.10 5
459.8 1	20 3	5502.0	(53/2 ⁻)	5042.2	(49/2 ⁻)	(E2)	0.0305	DCO=1.07 11
460.5 3	4.0 12	1443.90	(21/2 ⁺)	983.40	19/2 ⁺	D+Q		DCO=0.61 11
462.4 1	>25.9	653.70	15/2 ⁺	191.30	(13/2 ⁺)	D+Q		DCO=0.59 10
								Mult.: M1+E2 in 2009Hu12.
472.4 1	41.6 21	1081.00	(17/2 ⁻)	608.60	(13/2 ⁻)	(E2)	0.0285	DCO=1.07 7
473.8 5		3292.30	(35/2 ⁻)	2818.5				
474.4 1	24.9 12	5353.6	(53/2 ⁺)	4879.2	(49/2 ⁺)	(E2)	0.0282	DCO=0.93 8
476.1 3	7.5 11	3455.3	(35/2 ⁺)	2979.2	(31/2 ⁺)			
484.3 3	6.5 10	983.40	19/2 ⁺	499.10	17/2 ⁺	D+Q		DCO=0.47 11
492.5 5		7764.7		7272.2				
500.0 1	13.2 20	1443.90	(21/2 ⁺)	943.90	(17/2 ⁺)	(E2)	0.0248	DCO=1.05 15
511.5 3	6.1 9	4879.2	(49/2 ⁺)	4367.7	(47/2 ⁺)	D+Q		DCO=0.81 15
511.7 3	7.5 11	3376.3	(37/2 ⁺)	2864.6	33/2 ⁺	(E2)	0.0234	DCO=1.17 13
519.2 1	20 3	4367.7	(47/2 ⁺)	3848.5	(43/2 ⁺)	(E2)	0.0226	DCO=1.02 11
523.8 5	2.0 6	3455.3	(35/2 ⁺)	2931.5	(31/2 ⁺)	(E2)	0.0221	DCO=1.03 13
531.5 1	13.0 20	1185.20	19/2 ⁺	653.70	15/2 ⁺	(E2)	0.0214	DCO=0.96 24
536.1 1	17.1 25	2839.70	(33/2 ⁻)	2303.60	(29/2 ⁻)	(E2)	0.0209	DCO=1.05 10
539.5 @ 3	11.5 @ 17	711.90	13/2 ⁻	172.40	9/2 ⁻	(E2)	0.0206	DCO=1.17 12
539.9 @ 3	2.9 @ 9	2729.3	(29/2 ⁺)	2189.40	29/2 ⁺	(E2)	0.0206	DCO=0.97 8
548.4 3	7.8 12	2839.70	(33/2 ⁻)	2291.30	(29/2 ⁻)	(E2)	0.0198	DCO=0.94 11
557.1 1	34.6 17	1512.00	21/2 ⁻	954.90	21/2 ⁺	D		DCO=1.02 6
565.2 1	12.2 18	2620.30	(31/2 ⁻)	2055.10	(27/2 ⁻)	(E2)	0.0185	DCO=0.95 14
565.5 @ 1	<18.5 @	2009.40	(25/2 ⁺)	1443.90	(21/2 ⁺)			
565.5 @ 1	23.4 @ 12	3200.90	(33/2 ⁺)	2635.40	(29/2 ⁺)	(E2)	0.0185	DCO=1.03 11
570.6 3	3.8 11	3946.9	(41/2 ⁺)	3376.3	(37/2 ⁺)	(E2)	0.0181	DCO=1.01 15
572.2 3	7.8 12	1555.6	23/2 ⁺	983.40	19/2 ⁺	(E2)	0.0180	DCO=1.05 9
574.3 1	40.6 20	1529.20	25/2 ⁺	954.90	21/2 ⁺	(E2)	0.01780	DCO=0.94 8
577.1 1	49.8 25	2291.30	(29/2 ⁻)	1714.20	(25/2 ⁻)	(E2)	0.01760	DCO=0.99 7
580.3 3	3.9 12	3420.0	(35/2 ⁺)	2839.70	(33/2 ⁻)	D		DCO=0.50 10
582.8 1	22.6 11	2874.1	(33/2 ⁻)	2291.30	(29/2 ⁻)	(E2)	0.01721	DCO=1.01 11
589.4 1	33.8 17	2303.60	(29/2 ⁻)	1714.20	(25/2 ⁻)	(E2)	0.01677	DCO=1.13 13
596.1 5		7357.9		6761.8				
600.7 5	1.7 5	1555.6	23/2 ⁺	954.90	21/2 ⁺	D+Q		DCO=0.72 21
604.0 1	12.1 18	3292.30	(35/2 ⁻)	2688.30	(31/2 ⁻)	Q		DCO=1.07 15
612.9 3	8.6 13	3452.6	(37/2 ⁻)	2839.70	(33/2 ⁻)	Q		DCO=1.09 13
626.0 1	20.1 10	2635.40	(29/2 ⁺)	2009.40	(25/2 ⁺)	Q		DCO=1.03 9
627.9 1	14.8 22	4437.1	(43/2 ⁻)	3809.2	(41/2 ⁻)	D+Q		DCO=0.87 10
633.2 1	12.2 18	2688.30	(31/2 ⁻)	2055.10	(27/2 ⁻)	Q		DCO=0.95 21
649.5 1	11.3 17	1361.40	17/2 ⁻	711.90	13/2 ⁻	Q		DCO=1.10 11
660.2 1	36.4 18	2189.40	29/2 ⁺	1529.20	25/2 ⁺	Q		DCO=0.97 7
663.7 3	7.5 11	2219.3	(27/2 ⁺)	1555.6	23/2 ⁺	Q		DCO=1.13 13
672.0 1	22.6 11	3292.30	(35/2 ⁻)	2620.30	(31/2 ⁻)	Q		DCO=1.07 16
675.2 1	21.5 11	2864.6	33/2 ⁺	2189.40	29/2 ⁺	Q		DCO=1.09 5
686.1 1	32.9 16	1185.20	19/2 ⁺	499.10	17/2 ⁺	D+Q		DCO=0.45 5
699.9 3	8.4 13	3574.0	(37/2 ⁻)	2874.1	(33/2 ⁻)	Q		DCO=1.09 16
700.4 5	1.7 5	4647.3	(45/2 ⁺)	3946.9	(41/2 ⁺)	Q		DCO=1.3 4
707.7 1	12.9 19	1361.40	17/2 ⁻	653.70	15/2 ⁺	D		DCO=0.72 10
707.8 5		8843.0		8135.2				
712.2 3	4.0 12	2931.5	(31/2 ⁺)	2219.3	(27/2 ⁺)	Q		DCO=1.08 15
715.9 5	2.7 8	4168.5	(41/2 ⁻)	3452.6	(37/2 ⁻)	Q		DCO=1.3 3
717.6 3	4.3 13	3582.2	(37/2 ⁺)	2864.6	33/2 ⁺	Q		DCO=1.02 15

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^{18}\text{O},5n\gamma)$ **2009Hu12** (continued) $\gamma(^{189}\text{Pt})$ (continued)

E_γ [‡]	I_γ [§]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	Comments
740.7 3	3.3 10	1695.60	(23/2 ⁻)	954.90	21/2 ⁺		
740.9 5		7582.4		6841.5	(57/2 ⁺)		
759.9 5	1.3 4	2979.2	(31/2 ⁺)	2219.3	(27/2 ⁺)	Q	DCO=1.3 5
763.4 5	2.1 6	2818.5		2055.10	(27/2 ⁻)		
777.3 5		8135.2		7357.9			
788.5 5	2.3 7	4437.1	(43/2 ⁻)	3648.6	(39/2 ⁻)	Q	DCO=1.26 24
808.2 5		3672.8		2864.6	33/2 ⁺		
817.1 5	1.1 3	5464.4	(49/2 ⁺)	4647.3	(45/2 ⁺)	Q	DCO=1.5 5
837.6 1	17.6 26	4686.1	(45/2 ⁺)	3848.5	(43/2 ⁺)	D+Q	DCO=0.40 5
859.8 1	15.0 23	4708.3	(47/2 ⁺)	3848.5	(43/2 ⁺)	Q	DCO=1.03 10
862.3 1	20 3	1361.40	17/2 ⁻	499.10	17/2 ⁺	D	DCO=1.05 9
876.7 3	4.5 14	3066.1	(33/2 ⁺)	2189.40	29/2 ⁺	Q	DCO=1.25 16
944.8 5	1.3 4	1443.90	(21/2 ⁺)	499.10	17/2 ⁺	Q	DCO=1.14 23
972.7 3	3.1 9	6474.7	(57/2 ⁻)	5502.0	(53/2 ⁻)	Q	DCO=1.2 3
986.0 1	10.9 16	4795.2	(45/2 ⁻)	3809.2	(41/2 ⁻)	Q	DCO=1.01 10
1010.4 5	2.9 9	2539.6	(27/2 ⁺)	1529.20	25/2 ⁺	D+Q	DCO=0.48 11
1039.4 3	6.0 9	4848.6	(45/2 ⁻)	3809.2	(41/2 ⁻)	Q	DCO=1.09 18
1054.5 5	2.6 8	2009.40	(25/2 ⁺)	954.90	21/2 ⁺	Q	DCO=1.1 3
1106.2 3	3.5 11	2635.40	(29/2 ⁺)	1529.20	25/2 ⁺	Q	DCO=0.98 20
1122.8 1	12.7 19	6476.4	(55/2 ⁺)	5353.6	(53/2 ⁺)	D+Q	DCO=0.60 7
1200.1 5	1.2 4	2729.3	(29/2 ⁺)	1529.20	25/2 ⁺	Q	DCO=1.2 4

[†] From DCO ratios and RUL for E2 and M2 when level lifetimes are known. Mult=Q indicated stretched quadrupole (most likely E2); mult=D or D+Q indicates stretched dipole (E1 or M1 with small E2 admixture). For stretched quadrupole transitions, (E2) is assigned here for $E_\gamma < 600$ keV based on assumed level half-life less than 20 ns (typical coincidence resolving time) and RUL for E2 and M2.

[‡] **2009Hu12** state uncertainty as 0.1-0.5 keV. The evaluators assign as follows: 0.1 keV for $I_\gamma > 10$, 0.3 keV for $I_\gamma = 3-10$ and 0.5 keV for $I_\gamma < 3$.

[§] **2009Hu12** state uncertainty as 5-30%. Evaluators assign as follows: 5% for $I_\gamma > 20$, 15% for $I_\gamma = 5-20$ and 30% for $I_\gamma < 5$.

& From BrIcc v2.3b (16-Dec-2014) **2008Ki07**, "Frozen Orbitals" appr.

@ Multiply placed with intensity suitably divided.

$^{188}\text{Os}(\alpha,3n\gamma), ^{191}\text{Ir}(\text{p},3n\gamma)$ [1975Pi02,1978DaZC](#)

[1975Pi02](#), [1976Pi03](#), [1978DaZC](#): $^{188}\text{Os}(\alpha,3n\gamma)$, $^{191}\text{Ir}(\text{p},3n\gamma)$, measured prompt, delayed γ , $\gamma\gamma(\text{t})$, $\sigma(\text{E}\gamma)$, $\gamma(\theta)$, deduced level schemes.

 ^{189}Pt Levels

E(level) [‡]	J ^π [†]	T _{1/2}	Comments
0.0	3/2 ⁻		
6.2 5	5/2 ⁻		
172.6 7	9/2 ⁻		
191.6 7	13/2 ⁺	143 μs 5	T _{1/2} : from 1976Pi03 based on $\alpha,\gamma(\text{t})$.
202.9 8	11/2 ⁺		J ^π : (9/2) ⁻ in Adopted Levels.
237.6 7	7/2 ⁻		
356.6 7	9/2 ⁻		
492.5 8	11/2 ⁻		
499.7 8	17/2 ⁺		
532.1 8	15/2 ⁺		
609.1 7	11/2 ⁻		
654.3 8	15/2 ⁺		
712.5 8	13/2 ⁻		
843.6 8	13/2 ⁻		
902.1 10			
944.9 8	17/2 ⁺		
955.5 8	21/2 ⁺		
984.2 8	19/2 ⁺		
1047.7 10	(15/2 ⁻)		
1081.7 7	15/2 ⁻		
1185.8 8	19/2 ⁺		
1361.9 7	17/2 ⁻		
1414.9 9			
1415.8 10	17/2 ⁻		
1444.8 9	21/2 ⁺		
1491.3 8	19/2 ⁻		
1512.8 8	21/2 ⁻		
1529.8 9	25/2 ⁺		
1530.6 9	(23/2 ⁻)		
1556.4 10	(23/2 ⁺)		
1714.6 9	(25/2 ⁻)		
1727.9 9	(23/2 ⁺)		
2056.0 10	27/2 ⁻		
2189.9 11	29/2 ⁺		
2220.3? 11	(27/2 ⁺)		
2291.9 10	29/2 ⁺		
2689.4? 11	(31/2 ⁻)		
2864.7 12	33/2 ⁺		

[†] J^π are those assigned by [1978DaZC](#) on the basis of $\gamma(\theta)$, excitation functions, and comparison with the Nilsson model. However, the excitation and angular distribution data were not presented in this report and were not published.

[‡] Energies and tentative decay scheme are from [1978DaZC](#). Uncertainties are based on the assumption of 0.5 keV γ -ray energy uncertainty.

$^{188}\text{Os}(\alpha,3n\gamma), ^{191}\text{Ir}(\text{p},3n\gamma)$ **1975Pi02,1978DaZC (continued)** $\gamma(^{189}\text{Pt})$

E_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	E_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π
(6.2) [†]	6.2	5/2 ⁻	0.0	3/2 ⁻	456.0	955.5	21/2 ⁺	499.7	17/2 ⁺
(11.4) [†]	202.9	11/2 ⁺	191.6	13/2 ⁺	460.5	1444.8	21/2 ⁺	984.2	19/2 ⁺
(17.8) [†]	1530.6	(23/2 ⁻)	1512.8	21/2 ⁻	462.7	654.3	15/2 ⁺	191.6	13/2 ⁺
(19.1) [†]	191.6	13/2 ⁺	172.6	9/2 ⁻	470.0	1414.9		944.9	17/2 ⁺
129.2	1491.3	19/2 ⁻	1361.9	17/2 ⁻	472.6	1081.7	15/2 ⁻	609.1	11/2 ⁻
150.9	1512.8	21/2 ⁻	1361.9	17/2 ⁻	484.4	984.2	19/2 ⁺	499.7	17/2 ⁺
166.4	172.6	9/2 ⁻	6.2	5/2 ⁻	487.0	843.6	13/2 ⁻	356.6	9/2 ⁻
184.0	1714.6	(25/2 ⁻)	1530.6	(23/2 ⁻)	500.1	1444.8	21/2 ⁺	944.9	17/2 ⁺
201.8	1714.6	(25/2 ⁻)	1512.8	21/2 ⁻	532.3	1185.8	19/2 ⁺	654.3	15/2 ⁺
231.4	237.6	7/2 ⁻	6.2	5/2 ⁻	536	1491.3	19/2 ⁻	955.5	21/2 ⁺
236.0	2291.9	29/2 ⁺	2056.0	27/2 ⁻	539.7	712.5	13/2 ⁻	172.6	9/2 ⁻
252.5	609.1	11/2 ⁻	356.6	9/2 ⁻	542.1	1727.9	(23/2 ⁺)	1185.8	19/2 ⁺
280.3	1361.9	17/2 ⁻	1081.7	15/2 ⁻	555.2	1047.7	(15/2 ⁻)	492.5	11/2 ⁻
290.6	944.9	17/2 ⁺	654.3	15/2 ⁺	557.2	1512.8	21/2 ⁻	955.5	21/2 ⁺
308.2	499.7	17/2 ⁺	191.6	13/2 ⁺	572.2 [‡]	1415.8	17/2 ⁻	843.6	13/2 ⁻
319.9	492.5	11/2 ⁻	172.6	9/2 ⁻	572.2 [‡]	1556.4	(23/2 ⁺)	984.2	19/2 ⁺
327.1	1512.8	21/2 ⁻	1185.8	19/2 ⁺	574.3	1529.8	25/2 ⁺	955.5	21/2 ⁺
329.2	532.1	15/2 ⁺	202.9	11/2 ⁺	577.1	2291.9	29/2 ⁺	1714.6	(25/2 ⁻)
340.5	532.1	15/2 ⁺	191.6	13/2 ⁺	633.4 [§]	2689.4?	(31/2 ⁻)	2056.0	27/2 ⁻
341.5	2056.0	27/2 ⁻	1714.6	(25/2 ⁻)	649.3	1361.9	17/2 ⁻	712.5	13/2 ⁻
350.4	356.6	9/2 ⁻	6.2	5/2 ⁻	660.1	2189.9	29/2 ⁺	1529.8	25/2 ⁺
371.5	609.1	11/2 ⁻	237.6	7/2 ⁻	663.9 [§]	2220.3?	(27/2 ⁺)	1556.4	(23/2 ⁺)
409.6 [‡]	902.1		492.5	11/2 ⁻	674.8	2864.7	33/2 ⁺	2189.9	29/2 ⁺
409.6 [‡]	1491.3	19/2 ⁻	1081.7	15/2 ⁻	686.2	1185.8	19/2 ⁺	499.7	17/2 ⁺
412.9	944.9	17/2 ⁺	532.1	15/2 ⁺	707.6	1361.9	17/2 ⁻	654.3	15/2 ⁺
445.2	944.9	17/2 ⁺	499.7	17/2 ⁺	772.4	1727.9	(23/2 ⁺)	955.5	21/2 ⁺
452.0	984.2	19/2 ⁺	532.1	15/2 ⁺	862.1	1361.9	17/2 ⁻	499.7	17/2 ⁺

[†] Transition unobserved. Energy from energy level differences.[‡] Multiply placed.[§] Placement of transition in the level scheme is uncertain.

$^{190}\text{Pt}(\text{p},\text{d})$ 1980Ka19

E=25 MeV, resolution FWHM=35 keV, five angles 5° – 55° , DWBA.

 ^{189}Pt Levels

E(level)	L [‡]	C ² S [†]	Comments
0	(1)	1.07	E(level): levels at 0 and 6 keV unresolved. Transition to g.s. dominates L value.
44 7	1	0.42	
93 8	1,(3)	0.35	L: possible doublet. L=1 gives a better fit but L=3 is not excluded. C ² S calculated for L=1.
173 5	[5]	2.7	
193 6	6,5	3.6	C ² S calculated for L=6.
261 5	1	0.38	
285 5	3,1,5		L: if L=3, C ² S=1.5; if L=1, C ² S=0.34; if L=5, C ² S=13.4.
340 5	1,3,4,5		L: if L=1, C ² S=0.15; if L=3, C ² S=0.6; if L=4, C ² S=2, if L=5, C ² S=4.4.
441 6			
491 5	3,1,5		L: if L=3, C ² S=0.47; if L=1, C ² S=0.1; if L=5, C ² S=3.8.
574 5	1	0.33	

[†] Values correspond either to the known $J\pi$ value, or to $3/2^-$ for L=1, $5/2^-$ for L=3, $9/2^+$ for L=4, $9/2^-$ for L=5, and $13/2^+$ for L=6. The alternate value can be deduced from $C^2\text{S}(\text{p}1/2)/C^2\text{S}(\text{p}3/2)\approx 1.08$, $C^2\text{S}(\text{f}7/2)/C^2\text{S}(\text{f}5/2)\approx 0.82$.

[‡] L values given in order of author's preference.

Adopted Levels, Gammas

$Q(\beta^-) = -3960$ 40; $S(n) = 9282$ 20; $S(p) = 3050$ 21; $Q(\alpha) = 4330$ 30 2017Wa10

$S(2n) = 16700$ 30, $S(2p) = 8610$ 30 (2017Wa10).

^{189}Au produced and identified by 1960Po07 and 1960Al20 in proton and deuteron irradiations of ^{189}Pt and ^{189}Hg targets, followed by half-life measurements. Previous assignment of a 42-min activity to ^{189}Au by 1955Sm42 may have belonged to ^{190}Au . Later studies of decay of ^{189}Au : 1973Ja16, 1970Fi16, 1970Jo02, 1967Na02, 1965Ki06.

The level scheme for high-spin structures in 1992Ve05 and 1992Bo23 differ in the ordering of several cascades, and $J\pi$ assignments. Experimental details are not available in either of the two references. The evaluators have adopted the level scheme from 1992Ve05. The level scheme proposed by 1992Bo23 (and 1993Pe17) is in general agreement with that from 1992Ve05, with the exception of a few transitions placed in a different ordering of the γ cascades. The level schemes proposed in $^{191}\text{Ir}(\alpha, 6n\gamma)$ (1979Go15) and $^{181}\text{Ta}(^{12}\text{C}, 4n\gamma)$ (1975De20) differ significantly above ≈ 2.5 MeV excitation, mainly due to either different ordering of the γ cascades or missing transition(s) in a cascade. Observation of a γ ray in 1975De20 and 1979Go15 similar in energy to that in 1992Ve05 is taken here as an evidence of population of a particular level in that study.

 ^{189}Au LevelsCross Reference (XREF) Flags

A	^{189}Hg ε decay (7.6 min)	E	$^{181}\text{Ta}(^{12}\text{C}, 4n\gamma)$
B	^{189}Hg ε decay (8.6 min)	F	$^{191}\text{Ir}(\alpha, 6n\gamma)$
C	$^{174}\text{Yb}(^{19}\text{F}, 4n\gamma)$		
D	$^{176}\text{Yb}(^{19}\text{F}, 6n\gamma)$		

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}$	XREF	Comments
0.0	$1/2^+$	28.7 min 4	AB	$\% \varepsilon + \% \beta^+ = 100$; $\% \alpha < 3 \times 10^{-5}$ $\mu = +0.494$ 14 (1989Wa11, 1987Wa06, 2014StZZ) RMS charge radius $\langle r^2 \rangle^{1/2} = 5.4084$ fm 52 (2013An02 evaluation). μ : laser resonance ionization mass spectroscopy (1989Wa11, 1987Wa06). $\% \alpha$: ionization chamber measurement (1963Ka17). No α decay observed. J^π : spin from atomic beam (1976Ek01). Systematics of ^{191}Au - ^{199}Au predict $1/2^+$, $3/2^+$ ground-state doublet. $T_{1/2}$: weighted average of 28.3 min 5 (1970Fi16), 28.6 min 10 (1970Jo02), 29.7 min 8 (1967Na02), and 28.7 min 4 (1966Fo13). Other values: 30 min (1960Po07, 1960Al20), 42 min 5 (1955Sm42). Activity identified by 1955Sm42 may have belonged to ^{190}Au .
9.94 11	$3/2^+$	30 ns 4	AB	J^π : M1+E2 from $5/2^+$ (248.6), γ to $1/2^+$. Systematics of ^{191}Au - ^{199}Au predict $1/2^+$, $3/2^+$ ground-state doublet. $T_{1/2}$: from 1975Be17.
203.74 12	$3/2^+ \#$		AB	
247.25 & 16	$11/2^- \#$	4.59 min 11	ABCDEF	$\% \varepsilon + \% \beta^+ \approx 100$; $\% \text{IT} = ?$ $\mu = +6.19$ 2 (1989Wa11, 1987Wa06, 2014StZZ) μ : laser resonance ionization mass spectroscopy (1989Wa11, 1987Wa06). Other value: 6.17 15 (1986Va35, 1985Va07, nuclear orientation, NMR). $\% \text{IT}$: on the basis of decay curves, 1970Fi16 suggest a possible IT branch. RUL for a possible 237γ leads to $\% \text{IT} < 5.5$. J^π : spin from atomic beam (1976Ek01), parity from E2 γ from $7/2^-$. $T_{1/2}$: weighted average of 4.55 min 10 (1970Fi16), 4.7 min 1 (1967He06, 1967Al17) and 4.0 min 3 (1966Fo13).
248.56 11	$5/2^+ \#$		AB	
307.76 13	$5/2^+$		AB	J^π : M1+E2 to $3/2^+$ (9.9), E1 from $7/2^-$ (484.0).
325.12 ^a 16	$9/2^- @$	190 ns 15	ABCDEF	$\% \text{IT} = 100$ $T_{1/2}$: from $\gamma(t)$ in ^{189}Hg ε decay (1975Be17).
484.02 16	$7/2^- \#$	0.15 ns 5	AB E	$T_{1/2}$: from $\gamma(t)$ in ^{189}Hg ε decay (1975Be17).
491.53 17	$5/2^- @$	0.30 ns 3	AB E	$T_{1/2}$: from $\gamma(t)$ in ^{189}Hg ε decay (1975Be17).

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Adopted Levels, Gammas (continued) ^{189}Au Levels (continued)

E(level) [†]	J ^π [‡]	XREF	Comments
512.35 15	7/2 ⁺	AB	J ^π : E2 to 3/2 ⁺ (203.7); E2 from 11/2 ⁺ (1112.5).
602.90 16	1/2 ⁺ , 3/2 ⁺	A	J ^π : M1+E2 to 3/2 ⁺ (203.7), M1 to 1/2 ⁺ .
646.17 ^a 17	13/2 ⁻	BCDEF	J ^π : E2 γ to 9/2 ⁻ , band member.
647.20 13	7/2 ⁺	AB	J ^π : M1 to 5/2 ⁺ (248.6), E2 from 11/2 ⁺ .
681.90 ^{&} 19	15/2 ⁻	BCDEF	J ^π : E2 γ to 11/2 ⁻ , band member.
712.70 18	11/2 ⁻	BCDEF	J ^π : M1+E2 to 9/2 ⁻ , strong ε feeding from $^{189\text{m}}\text{Hg}$ (J π =13/2 ⁺).
760.67 18	9/2 ⁺	B	J ^π : E2 to 5/2 ⁺ (248.56), M1 from 11/2 ⁺ .
770.68 18	7/2 ⁻	AB	J ^π : M1+E2 to 9/2 ⁻ , M1+E2 to 5/2 ⁻ .
801.95 18	1/2 ⁺ , 3/2 ⁺	A	J ^π : M1+E2 to 3/2 ⁺ (203.7); M1+E2 to 1/2 ⁺ ; γ to 5/2 ⁺ (248.6), strong ε feeding from $^{189\text{g}}\text{Hg}$ (J π =3/2 ⁻).
811.88 22	(5/2, 3/2, 1/2) ⁺	AB	J ^π : M1 to 3/2 ⁺ ; γ s to 5/2 ⁺ (307.8) and 1/2 ⁺ .
812.67 18	13/2 ⁻	BCDEF	J ^π : M1+E2 to 11/2 ⁻ (247.2), strong ε feeding from $^{189\text{m}}\text{Hg}$ (J π =13/2 ⁺).
814.30 25	1/2 ⁻	A	J ^π : E2 to 5/2 ⁻ , strong ε feeding from $^{189\text{g}}\text{Hg}$ with J π =3/2 ⁻ .
847.89 19	9/2 ⁺	B	J ^π : E2 to 5/2 ⁺ (248.6), E2 from 13/2 ⁺ (1534.8).
862.04 18	9/2 ⁻	AB	J ^π : M1 to 11/2 ⁻ , M1+E2 to 7/2 ⁻ (484.0).
879.64 23	⁺	A	J ^π : E2(+M1) to 3/2 ⁺ (203.7).
880.45 23	9/2 ⁻	B	J ^π : M1+E2 to 11/2 ⁻ , M1+E2 to 7/2 ⁻ (484.0).
887.24 24	(3/2, 5/2) ⁻	A	J ^π : M1+E2 to 5/2 ⁻ , strong ε feeding from $^{189\text{g}}\text{Hg}$ parent with J π =3/2 ⁻ .
911.01 20	7/2 ⁻	AB	J ^π : M1+E2 to 5/2 ⁻ , M1 to 9/2 ⁻ (325.1).
961.22 19	(5/2, 3/2) ⁺	B	J ^π : M1+E2 γ to 5/2 ⁺ (248.6); M1+E2 γ to 3/2 ⁺ .
977.8 10		A	
1058.73 14	3/2 ⁻	A	J ^π : E2 to 7/2 ⁻ (484.0), E1 to 3/2 ⁺ (203.7), E1 to 1/2 ⁺ .
1097.03 21	13/2 ⁻	BCD	J ^π : E2 to 9/2 ⁻ (325.1), strong ε feeding from $^{189\text{m}}\text{Hg}$, J π =13/2 ⁺ .
1098.1 3		A	
1104.80 22	3/2 ⁻ @	A	
1105.35 ^a 10	17/2 ⁻	BCD F	J ^π : E2 γ to 13/2 ⁻ , band member.
1106.56 23	(5/2, 3/2) ⁺	B	J ^π : M1+E2 to 3/2 ⁺ (203.74), ε feeding from $^{189\text{g}}\text{Hg}$, J π =3/2 ⁻ .
1107.4 11		A	
1112.48 20	11/2 ⁺	B	J ^π : M1 to 9/2 ⁺ ; strong ε feeding from $^{189\text{m}}\text{Hg}$ (J π =13/2 ⁺).
1116.05 21	7/2 ⁻ , 5/2 ⁻	A	J ^π : M1 to 7/2 ⁻ (770.67), M1 to 5/2 ⁻ .
1130.10 19	11/2 ⁻	BC	J ^π : M1+E2 to 9/2 ⁻ (325.1), M1+E2 to 13/2 ⁻ (646.2).
1133.52 22	9/2 ⁻	B	J ^π : M1+E2 to 7/2 ⁻ ; E2 to 5/2 ⁻ (491.5).
1133.6 6		A	
1145.70 22	13/2 ⁻ , 15/2 ⁻	BC	J ^π : M1+E2 to 13/2 ⁻ (646.2); strong ε feeding from $^{189\text{m}}\text{Hg}$, J π =13/2 ⁺ ; 11/2 not likely from population in heavy-ion (^{19}F , 4n γ) reaction.
1156.0 3	(5/2, 7/2) ⁻	A	J ^π : M1 to 7/2 ⁻ (770.7), M1+E2 to (3/2, 5/2) ⁻ (887.2); possible γ to 3/2 ⁺ makes 7/2 less likely.
1165.0 10		A	
1165.7 6		A	
1188.60 21	11/2 ⁻	B	J ^π : M1+E2 to 13/2 ⁻ (812.7), M1+E2 to 9/2 ⁻ (862.0).
1193.55 23	-	B	J ^π : M1+E2 to 7/2 ⁻ (911.0).
1247.1 3	(9/2, 7/2) ⁺	B	J ^π : M1+E2 to 9/2 ⁺ (760.7), γ to 5/2 ⁺ (307.8).
1254.24 19	5/2 ⁻ , 7/2 ⁻	A	J ^π : M1 to 7/2 ⁻ (484.0), E2 to 3/2 ⁻ (1058.7).
1260.7 10		A	
1273.14 25	11/2 ⁻	B	J ^π : M1+E2 to 9/2 ⁻ (862.0), M1 to 13/2 ⁻ (646.2).
1286.3 11		A	
1295.5 3	11/2 ⁻	B	J ^π : M1+E2 to 9/2 ⁻ (862.0), populated in ε decay of $^{189\text{m}}\text{Hg}$, J π =13/2 ⁺ .
1298.87 16	11/2 ⁺	B	J ^π : E2 to 647.2 (J $\leq$ 7/2 ⁺), strong ε feeding from $^{189\text{m}}\text{Hg}$ (J π =13/2 ⁺).
1312.96 25	13/2 ⁻	B	J ^π : M1+E2 to 11/2 ⁻ , strong feeding ε from $^{189\text{m}}\text{Hg}$, J π =13/2 ⁺ .
1346.5 5		A	
1352.6 3	(15/2, 13/2, 11/2) ⁻	BCDE	XREF: E(?). J ^π : M1+E2 to 13/2 ⁻ (812.7), E2 to 11/2 ⁻ (247.2).

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Adopted Levels, Gammas (continued) ^{189}Au Levels (continued)

E(level) [†]	J ^π [‡]	XREF	Comments
1358.8 5		A	
1365.3 5		B	
1368.1 3	(17/2,13/2,15/2) ⁻	B	J ^π : (M1) to 15/2 ⁻ (681.9).
1371.3 11		A	
1376.2 11	-	B	J ^π : M1+E2 γ to 13/2 ⁻ .
1383.25 20	13/2 ⁺	BCD	J ^π : E1 to 13/2 ⁻ (646.2), E1 to 11/2 ⁻ (1130.1), strong ε feeding from $^{189\text{m}}\text{Hg}$, J ^π =13/2 ⁺ .
1412.2 & 4	19/2 ⁻	BCDEF	J ^π : ΔJ=2, γ to 15/2 ⁻ , band member.
1419.80 22	(13/2,11/2) ⁺	B	J ^π : E2 to 9/2 ⁺ (760.7), observed in $^{189\text{m}}\text{Hg}$ ε decay, J ^π =13/2 ⁺ .
1431.9 4		A	J ^π : in 1996Wo04 , this level is shown in their Figure 15 with other low lying negative parity levels. However no spin parity was explicitly assigned to this level.
1456.2 10	+	B	J ^π : M1 γ to 647.2, 7/2 ⁺ level.
1459.97 20	11/2 ⁺	B	J ^π : E1 to 9/2 ⁻ (325.1), E1 to 13/2 ⁻ (646.2).
1463.9 5	-	B	J ^π : M1 γ to 712.7, 11/2 ⁻ level.
1476.1 4		A	
1481.6 4	13/2 ⁻	B	J ^π : M1 γ rays to 15/2 ⁻ and 11/2 ⁻ (1188.6).
1483.4 3	(7/2) ⁺	B	J ^π : M1+E2 γ to 760.7, 9/2 ⁺ ; M1+E2 to (5/2,3/2) ⁺ .
1488.9 3	(7/2,11/2) ⁻	B	J ^π : M1+E2 γ to 325.1, 9/2 ⁻ level; (E2) γ to 712.7, 11/2 ⁻ level.
1516.7 11	-	B	J ^π : M1+E2 γ to 812.7, 13/2 ⁻ level.
1523.4 4	(⁻)	B	J ^π : in Figure 10 of 1996Wo04 , the association of the decay of this level with the 11/2 ⁻ isomeric level, indirectly fed via the 841 keV γ leads the authors to assign a negative parity.
1523.9 11	+	B	J ^π : M1+E2 γ to the 847.9, 9/2 ⁺ level.
1525.0 4	-	B	J ^π : M1 γ to 1093.0, 13/2 ⁻ level; M1(+E2) γ to 712.7, 11/2 ⁻ level.
1534.79 19	13/2 ⁺	B	J ^π : E1 to 11/2 ⁻ (247.2), (E1) to 15/2 ⁻ (681.9), strong ε feeding from $^{189\text{m}}\text{Hg}$ (J=13/2 ⁺).
1559.1 4	-	B	J ^π : E2(+M1) γ to 1130.1, 11/2 ⁻ level.
1559.83 22	-	B	J ^π : M1 γ to 712.7, 11/2 ⁻ level.
1580.3 6	-	B	J ^π : M1 γ to 1097.0, 13/2 ⁻ level.
1595.4 11		B	
1597.2 11		B	
1601.19 20	13/2 ⁺ , 15/2 ⁺	BCD	J ^π : E1 to 13/2 ⁻ (812.7), γ to 15/2 ⁻ (681.9), populated by $^{189\text{m}}\text{Hg}$ ε decay.
1654.2 3	13/2 ⁻ , 15/2 ⁻	B	J ^π : M1+E2 to 13/2 ⁻ (812.7), E2 to 15/2 ⁻ (681.9), populated by $^{189\text{m}}\text{Hg}$ ε decay.
1662.4 ^a 4	21/2 ⁻	CD F	J ^π : ΔJ=(2), (E2) γ to 17/2 ⁻ , band member.
1688.1 6		D	
1730.6 4		B	
1739.4 4	13/2 ⁺ , 15/2 ⁺	BC	J ^π : M1+E2 to 13/2 ⁺ (1383.2), γ to 15/2 ⁻ (681.9).
1745.6 11		BCD	
1755.0 11		A	
1756.7 4	-	B	J ^π : M1 γ to 681.9, 15/2 ⁻ level.
1760.2 4		B	
1764.3 4		B	
1767.0 11		A	
1774.5 6		B	
1788.3 8	(⁺)	B	J ^π : (E2) γ to 1112.5, 11/2 ⁺ level.
1800.6 5	(15/2 ⁺)	B	J ^π : (E1) to 17/2 ⁻ (1105.3), observed in $^{189\text{m}}\text{Hg}$ ε decay.
1808.4 4		A	
1822.2 4	-	B	J ^π : M1(+E2) γ to 681.9, 15/2 ⁻ level.
1835.1 3	(13/2 ⁺ , 15/2 ⁺)	B	J ^π : γs to 13/2 ⁻ (646.2, 812.7), 15/2 ⁻ (681.9) and 13/2 ⁺ (1383.2).
1851.0 11		A	
1862.9 8	-	A	J ^π : M1 γ to 911.0, 7/2 ⁻ level.
1863.4 3		A	
1877.1 5	-	B	J ^π : M1+E2 γ to 812.7, 13/2 ⁻ level.
1879.0 3		A	

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Adopted Levels, Gammas (continued) ^{189}Au Levels (continued)

E(level) [†]	J^{π} [‡]	XREF	Comments
1905.2 11		B	
1913.5 5		A	
1935.02 20	+	B	J^{π} : E1 γ to 812.7, 13/2 ⁻ level.
1939.02 20	+	B	J^{π} : M1+E2 γ to 1459.9, 11/2 ⁺ level.
1960.1 4		A	
1970.8 4		A	
2030.87 22		A	
2031.04 25		A	
2034.2 3		A	
2034.7 4		A	
2036.1 6		A	
2045.8 4	+	B	J^{π} : M1+E2 γ to 1298.9, 11/2 ⁺ .
2061.5 11		A	
2062.6 5	(21/2 ⁺)	CDEF	J^{π} : $\Delta J=1$, dipole γ to 19/2 ⁻ .
2066.2 11		A	
2066.47 18	3/2 ⁻ , 5/2 ⁻	A	J^{π} : M1 γ to 1058.7, 3/2 ⁻ ; γ to 5/2 ⁺ .
2074.05 20	-	A	J^{π} : M1 γ to 1058.73, 3/2 ⁻ level.
2074.7 3	-	A	J^{π} : M1+E2 γ to 1156.0, $J^{\pi}=(5/2, 7/2)^{-}$ level.
2092.8 3	-	A	J^{π} : M1 γ to 1156.0, $J^{\pi}=(5/2, 7/2)^{-}$ level.
2093.61 22	-	A	J^{π} : M1 γ to 1116.0, $J^{\pi}=7/2^{-}, 5/2^{-}$ level.
2094.0 4		B	
2099.7 6		A	
2101.47 18		A	
2101.7 3	(-)	A	J^{π} : (M1) γ to 5/2 ⁻ level.
2109.8 10		A	
2113.8 4		B	
2145.0 4		B	
2154.6 4	-	A	J^{π} : M1(+E2) γ to 1254.2, 5/2 ⁻ level.
2155.3 5		A	
2157.4 5		A	
2163.3 6	+	B	J^{π} : M1 γ to 1383.2, 13/2 ⁺ level.
2165.21 24	+	B	J^{π} : M1+E2 γ to 1534.8, 13/2 ⁺ level.
2169.19 21	(+)	B	J^{π} : (M1+E2) γ to 1534.8, 13/2 ⁺ level.
2169.6 3	+	B	J^{π} : M1+E2 γ to 1419.8, $J^{\pi}=(13/2, 11/2)^{+}$ level.
2176.2 8	+	B	J^{π} : E2(+M1) γ to 1459.97, 11/2 ⁺ level.
2176.8 4		B	
2178.0 11		B	
2200.9 11		B	
2205.3 ^{&} 5	23/2 ⁻	C F	J^{π} : $\Delta J=(2)$ to 19/2 ⁻ , band member.
2209.8 10		A	
2211.01 24	+	B	J^{π} : M1(+E2) γ to 1459.9, 11/2 ⁺ level.
2239.9 11		B	
2240.94 20	(+)	B	J^{π} : M1(+E2) γ to 1112.5, 11/2 ⁺ level.
2250.7 5	(25/2 ⁺)	CDEF	J^{π} : γ to (21/2 ⁺); 1997Pe26 proposed 25/2 ⁺ , based on assumed similarity of decay scheme from the (31/2 ⁺) isomers in ^{189}Au and ^{191}Au , which would require 188 γ to be E2, rather than M1+E2, from other studies.
2251.9 5		B	
2255.1 11		B	
2257.18 21	(-)	B	J^{π} : (E1) γ to 1939.0, $\pi=(+)$ level.
2257.53 20	(+)	B	J^{π} : M1+E2 γ to 1419.8, $J^{\pi}=(13/2, 11/2)^{+}$ level.
2258.7 3		A	
2264.0 11		B	
2264.81 22	+	B	J^{π} : M1+E2 γ to 1601.2, 13/2 ⁺ , 15/2 ⁺ level.
2268.0 11		B	

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Adopted Levels, Gammas (continued) ^{189}Au Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	T _{1/2}	XREF	Comments
2268.97 23			B	
2269.7 4			B	
2271.0 4	+		B	J π : M1 γ to 1419.8, J π =(13/2,11/2) ⁺ level.
2272.16 19	+		B	J π : M1(+E2) γ to 1139.0, π =+ level.
2273.1 7			B	
2274.1 3			B	
2274.6 5			B	
2275.6 3	+		B	J π : E2(+M1) γ to 1419.8, J π =(13/2,11/2) ⁺ level.
2276.59 20	+		B	J π : M1(+E2) γ to 1459.9, 11/2 ⁺ level.
2281.00 24			B	
2281.9 8			B	
2293.9 4			B	
2294.99 23	+		B	J π : M1(+E2) γ to 1139.0, π =+ level.
2295.7 6			B	
2299.5 ^a 5	25/2 ⁻		C F	J π : ΔJ =(2) to (21/2 ⁻), band member.
2311.3 3			B	
2316.0 3			B	
2317.1 3	+		B	J π : M1+E2 γ to 1534.8, 13/2 ⁺ level.
2317.5 3	+		B	J π : M1 γ to 1935.0, π =+ level.
2319.4 7			DE	XREF: E(?).
2325.0 11			B	
2330.9 11			B	
2335.1 3	(+)		B	J π : M1+E2 γ to 1601.2, J π =13/2 ⁺ ,15/2 ⁺ level.
2335.7 11			B	
2336.1 11			B	
2338.6 11			B	
2339.7 4			B	
2349.2 11			B	
2370.3 5			B	
2384.7 4			B	
2400.9 6	(25/2 ⁺)		CDEF	J π : ΔJ =0, (M1) to 2250.7, (25/2 ⁺) level.
2405.9 11			B	
2417.1 4			B	
2417.9 11			B	
2436.4 4			B	
2451.0 5	(23/2 ⁻)		CDEF	XREF: E(?). J π : ΔJ =(2) γ to 1412.2, 19/2 ⁻ level.
2483.7 11			B	
2492.1 5			B	
2515.8 6	(27/2 ⁺)		CDEF	J π : ΔJ =1, M1(+E2) γ to (25/2 ⁺).
2542.7 7			C E	XREF: E(?).
2554.2 ^{&} 5	(27/2 ⁻)		CDEF	XREF: E(?). J π : (E2) γ to 2205.3, 23/2 ⁻ level.
2554.2+x ^b	(31/2 ⁻)	9.3 ns 5	CDEF	The 9-ns isomer is populated in all the high-spin studies but its energy is differently interpreted. T _{1/2} : γ (t) method (1975De20) in $^{181}\text{Ta}(^{12}\text{C},4n\gamma)$. Others: 9 ns 2 (1997Pe26) in $^{181}\text{Ta}(^{12}\text{C},4n\gamma)$; 11 ns 4 in $^{191}\text{Ir}(\alpha,6n\gamma)$ (1979Go15).
2554.8 ^h 8	(31/2 ⁺)	242 ns 10	CDEF	%IT=100 μ =6.5 5 (1997Pe26,2014StZZ) E(level): 2515.7+y, y=38.8 keV (2001MaZN, 39 in 1997Pe26). However, y=200 keV from 1975De20. J π : (E2) γ to (27/2 ⁺). T _{1/2} : from γ (t) in $^{181}\text{Ta}(^{12}\text{C},4n\gamma)$ (1997Pe26). Other: 440 ns 50 from

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{189}Au Levels (continued)

<u>E(level)[†]</u>	<u>J^π[‡]</u>	<u>XREF</u>	<u>Comments</u>
			$^{181}\text{Ta}(^{12}\text{C}, 4n\gamma)$ (1975De20) based on $\gamma(t)$ for a 199.6-keV transition which is not confirmed in other studies.
			μ : time dependent perturbed angular distribution (1997Pe26); g factor=0.42 3.
2608.9 6		B	
2862.8+x ^c 3	(33/2 ⁻)	CDEF	J ^π : $\Delta J=1$ γ to (31/2 ⁻), band member.
2928.8? 10		C	E(level): level treated as questionable by the evaluators since 374 γ is not reported in other high-spin studies.
2968.7 ^j 7	(29/2 ⁻)	CD	
2988.8+x ^b 3	(35/2 ⁻)	CDEF	
3003.9 ^a 7	29/2 ⁻	CD	J ^π : γ to 25/2 ⁻ ; band member.
3062.3 ^h 9	(35/2 ⁺)	CDEF	
3160.5+x ^e 5	(37/2 ⁻)	CD	
3222.1 ^j 8	(31/2 ⁻)	CDE	XREF: E(?).
3359.2+x ^c 4	(37/2 ⁻)	CDEF	
3377.4 ^j 8	(33/2 ⁻)	D	
3559.6+x ^b 4	(39/2 ⁻)	C F	
3562.9 9	(37/2 ⁺)	CD	
3709.7 ^j 9		CD	
3838.2+x ^e 5	(39/2 ⁻)	CD	
3845.6 ^h 9	(39/2 ⁺)	CDEF	
3921.4 ^j 9	(37/2 ⁻)	D	
3965.0+x 5	(39/2 ⁻)	CD	
3980.2 11		D	
4102.7+x ^c 5	(41/2 ⁻)	CD	
4253.5+x ^b 5	(43/2 ⁻)	CD	
4290.7+x 6	(41/2 ⁻)	CD	
4305.6+x ^d 6	(43/2 ⁻)	D	
4325.7 10	(41/2 ⁺)	CD	
4352.5 ⁱ 10	(41/2 ⁺)	D	
4480.1 ^h 10	(43/2 ⁺)	CD	
4527.0+x ^e 6	(43/2 ⁻)	CD	
4639.0 ⁱ 10	(43/2 ⁺)	D	
4674.4+x ^e 6	(45/2 ⁻)	CD	
4694.7+x ^c 7	(45/2 ⁻)	D	
4698.7 ^h 11	(47/2 ⁺)	CDE	
4796.5+x 7		C	
4879.7 10		CD	
4903.5+x ^b 7	(47/2 ⁻)	CD	
4916.2 11		D	
5085.0 12		D	
5103.1 ⁱ 10	(47/2 ⁺)	CD	
5124.6+x ^d 8	(47/2 ⁻)	D	
5166.5 11		D	
5174.5 12	(49/2 ⁺)	CD	
5263.3+x ^e 8	(49/2 ⁻)	D	
5315.6 ^h 12	(51/2 ⁺)	CD	
5368.1+x ^c 7	(49/2 ⁻)	CD	XREF: C(?).
5428.5+x 8	(47/2 ⁻)	CD	
5602.5 13		C	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{189}Au Levels (continued)

$E(\text{level})^{\dagger}$	$J\pi^{\ddagger}$	XREF	Comments
5634.9 ^g 13	(53/2 ⁺)	CD	
5665.5 13		C	
5707.4+x ^b 8	(51/2 ⁻)	CD	
5734.2+x ^e 10	(53/2 ⁻)	D	
5861.2 13		D	
5923.8 12	(55/2 ⁺)	D	
5964.1+x ^d 9	(51/2 ⁻)	D	
6096.7+x ^c 8	(53/2 ⁻)	D	
6179.8 14		CD	XREF: C(?).
6202.3 13		D	
6234.8 ^g 14	(57/2 ⁺)	D	
6305.5+x ^b 9	(55/2 ⁻)	D	
6305.6+x 10		CD	
6316.1+x ^e 11	(57/2 ⁻)	D	
6359.5 ^f 13	(57/2)	D	
6379.4 13		D	
6394.9+x 10		D	
6881.2 ^f 14	(61/2)	D	
7092.1 ^g 15	(61/2 ⁺)	CD	
7284.7 14	(61/2 ⁻)	D	
7601.0 ^f 14	(65/2)	D	
7849.4 15	(65/2)	D	
7956.2 ^g 15	(65/2 ⁺)	CD	
8182.3 15		D	
8261.8 15		D	
8433.9 ^f 15	(69/2)	D	
8680.6 ^g 16	(69/2 ⁺)	D	
8804.3 16		D	
9141.0 17		D	
9314.1 ^f 16	(73/2)	D	
9580.9 ^g 17	(73/2 ⁺)	D	

[†] From least-squares fit to E_{γ} values with assumed 0.5 keV uncertainty for E_{γ} value when not stated.

[‡] For high-spin ($J > 17/2$ or so) levels, assignments are essentially as proposed in the most extensive (yet not reported in adequate detail) by 1992Ve05 in $^{176}\text{Yb}(^{19}\text{F}, 6n\gamma)$ study, corroborated by similar but limited studies by 1992Bo23 (also 1993Pe17), 1979Go15 and 1975De20. Except for levels in a well-defined band built on $\pi h_{11/2}$ orbital, all other $J\pi$ assignments are considered as tentative since detailed angular distribution or correlation data are available for only a few transitions, and no polarization or internal conversion data are available.

[#] The 248.56 state M1+E2 decays to the 203.74 state, and then M1+E2 to the ground state ($J=1/2^{+}$) imply $J(248.56) \leq 5/2^{+}$; E1 transition from the 484.02 state to the 248.56 state implies $J(248.56) \leq 7/2^{-}$; On the other hand, an E2 transition from the 484.02 level to the 247.23 state, with $J=11/2$ determined from atomic beam (1976Ek01), uniquely determines the assignments as $J(247.23)=11/2^{-}$, therefore, $J(484.02)=7/2^{-}$; $J(248.56)=5/2^{+}$; $J(203.74)=3/2^{+}$.

[@] The 1104.78 state has strong ε feeding from ^{189}Hg ($J=3/2^{+}$). It cascades via 491.51 and 325.11 to the 247.23 state ($J=11/2^{-}$) with M1+E2, E2, and M1+E2 transitions. This implies $J(1104.78) \geq 3/2^{-}$. Therefore, $J(1104.78)=3/2^{-}$; $J(491.51)=5/2^{-}$; $J(325.11)=9/2^{-}$.

[&] Band(A): $\pi h_{11/2}$ band.

^a Band(B): $\pi h_{9/2}$ band.

^b Band(C): $\pi h_{11/2} \otimes \nu i_{13/2}^2, \alpha = -1/2$.

^c Band(c): $\pi h_{11/2} \otimes \nu i_{13/2}^2, \alpha = +1/2$.

Adopted Levels, Gammas (continued)

 ^{189}Au Levels (continued)

^d Band(D): γ cascade based on $(43/2^-)$.

^e Band(E): γ cascade based on $(37/2^-)$.

^f Band(F): Band based on $(57/2)$.

^g Band(G): Band based on $(53/2^+)$.

^h Band(H): γ cascade based on $(31/2^+)$.

ⁱ Band(I): γ cascade based on $(41/2^+)$.

^j Band(J): γ cascade based on $(29/2^-)$.

Adopted Levels, Gammas (continued)

$E_i(\text{level})$	J_i^π	$\gamma(^{189}\text{Au})$							Comments
		$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult.&	$\delta^\&$	$\alpha^\ddagger$	
9.94	3/2 ⁺	9.9 2	100	0.0	1/2 ⁺	[M1]		278 18	B(M1)(W.u.)=0.0027 5 E _γ : observed as M-conversion line in singles and ce-γ coin by 1975Be17. Mult.: from the systematics of analogous transitions in heavier odd-A Au isotopes, a 15-20% E2 admixture in this transition is expected.
203.74	3/2 ⁺	203.9 2	100	0.0	1/2 ⁺	M1+E2	0.63 +14-15	0.79 6	
248.56	5/2 ⁺	44.7 2		203.74	3/2 ⁺	M1+E2	0.15 2	18.2 13	δ: average value from the two decays.
		238.7 2	99 8	9.94	3/2 ⁺	M1+E2	2.3 3	0.274 18	
		248.7 2	100 8	0.0	1/2 ⁺	E2		0.182	
307.76	5/2 ⁺	59.2 2		248.56	5/2 ⁺				
		104 1		203.74	3/2 ⁺				
		297.9 2	100 7	9.94	3/2 ⁺	M1(+E2)	<0.8	0.29 5	δ: from ε decay (7.6 min).
325.12	9/2 ⁻	77.9 2	100	247.25	11/2 ⁻	M1+E2	0.3 2	3.7 15	B(M1)(W.u.)=4.8×10 ⁻⁵ 17; B(E2)(W.u.)=0.3 +4-3 E _γ : weighted average of values from ¹⁸⁹ Hg ε decay (7.6 m) (1996Wo04) and ¹⁸⁹ Hg ε decay (7.6 m+8.6 m) (1975Be17). δ: From ε decay (8.6 min).
484.02	7/2 ⁻	176.3 2	20 4	307.76	5/2 ⁺	E1		0.0988	B(E1)(W.u.)=3.0×10 ⁻⁵ +15-7
		235 1	32 5	248.56	5/2 ⁺	E1		0.0484 9	B(E1)(W.u.)=2.1×10 ⁻⁵ +11-5
		236 1	100 11	247.25	11/2 ⁻	E2		0.216 5	B(E2)(W.u.)=43 +22-10
491.53	5/2 ⁻	166.5 2	100	325.12	9/2 ⁻	E2		0.714	B(E2)(W.u.)=133 14
512.35	7/2 ⁺	264.0 2	43 4	248.56	5/2 ⁺	M1+E2	0.4 +2-3	0.43 5	δ: From ε decay (7.6 min).
		308 1	9 2	203.74	3/2 ⁺	E2		0.0947 16	
		502.3 2	100 8	9.94	3/2 ⁺	E2		0.0255	
602.90	1/2 ⁺ , 3/2 ⁺	399 1	29 10	203.74	3/2 ⁺	M1+E2	1.0 +5-4	0.100 26	
		603.0 2	100 14	0.0	1/2 ⁺	M1		0.0518	
646.17	13/2 ⁻	321.2 2	100	325.12	9/2 ⁻	E2		0.0837	
647.20	7/2 ⁺	135 1		512.35	7/2 ⁺	M1+E2	0.7 +4-5	2.6 5	δ: From ε decay (7.6 min).
		339.7 3	6.5 10	307.76	5/2 ⁺	E2(+M1)	>1.3	0.102 31	δ: from ε decay (8.6 min).
		398.9 3	100 [#] 25	248.56	5/2 ⁺	M1		0.1539	Mult.: from ε decay (8.6 min).
		443.4 3	13 [#] 5	203.74	3/2 ⁺				
		637.2 1	27 [#] 3	9.94	3/2 ⁺	E2		0.01469	
681.90	15/2 ⁻	434.6 2	100	247.25	11/2 ⁻	E2		0.0367	
712.70	11/2 ⁻	387.7 2	100	325.12	9/2 ⁻	M1+E2	2.0 +14-6	0.073 17	
760.67	9/2 ⁺	113 1	1.5 4	647.20	7/2 ⁺	M1+E2	1.2 3	4.0 4	
		453 1	6.4 18	307.76	5/2 ⁺	E2		0.0330	
		512 1	100 18	248.56	5/2 ⁺	E2		0.0244	
770.68	7/2 ⁻	279.3 2	99 8	491.53	5/2 ⁻	M1+E2	0.9 2	0.28 4	δ: From ε decay (8.6 min).
		445.6 2	100 8	325.12	9/2 ⁻	M1+E2	0.8 3	0.083 16	δ: From ε decay (7.6 min).
801.95	1/2 ⁺ , 3/2 ⁺	553 1	21 10	248.56	5/2 ⁺				

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Au})$ (continued)									Comments
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult. &	$\delta^\&$	$\alpha^\ddagger$	
801.95	1/2 ⁺ , 3/2 ⁺	598.4 3	100 17	203.74	3/2 ⁺	M1+E2	≈1.0	≈0.0349	
		791.7 3	29 8	9.94	3/2 ⁺				
		802.1 3	92 17	0.0	1/2 ⁺	M1(+E2)	<0.8	0.022 4	
811.88	(5/2, 3/2, 1/2) ⁺	504 1	86 25	307.76	5/2 ⁺				
		608.5 5	100 35	203.74	3/2 ⁺	E2(+M1)	>2	0.020 4	
		802.4 4	73 19	9.94	3/2 ⁺	M1		0.0248	
		811.5 3	96 @ 32	0.0	1/2 ⁺				
812.67	13/2 ⁻	565.4 2	100	247.25	11/2 ⁻	M1+E2	0.6 +4-3	0.050 10	
814.30	1/2 ⁻	322.9 3	100	491.53	5/2 ⁻	E2		0.0825	
847.89	9/2 ⁺	200.7 2	45 # 5	647.20	7/2 ⁺	M1+E2	1.1 +3-2	0.66 8	
		335.5 4	24 # 7	512.35	7/2 ⁺	M1		0.245	
		540.0 5	100 # 18	307.76	5/2 ⁺	E2		0.0215	
		600 1	36 # 9	248.56	5/2 ⁺	E2		0.01682	
862.04	9/2 ⁻	378.3 2	100 10	484.02	7/2 ⁻	M1(+E2)	<0.5	0.165 13	δ: From ε decay (7.6 min).
		614.8 2	75 6	247.25	11/2 ⁻	M1		0.0492	
879.64	+	571 1	22 @ 11	307.76	5/2 ⁺				
		675.9 2	100 @ 18	203.74	3/2 ⁺	E2(+M1)			
880.45	9/2 ⁻	389 1	60 # 19	491.53	5/2 ⁻	E2		0.0491 8	
		395.8 3	49 # 6	484.02	7/2 ⁻	M1(+E2)	<0.4	0.150 8	
		555.7 3	100 # 10	325.12	9/2 ⁻	M1+E2	0.5 +3-4	0.055 9	
		634 1	59 # 9	247.25	11/2 ⁻	(M1+E2)	1.0 2	0.030 4	
887.24	(3/2, 5/2) ⁻	395.7 2	100	491.53	5/2 ⁻	M1+E2	1.1 +4-3	0.097 18	
911.01	7/2 ⁻	419.5 2	100 9	491.53	5/2 ⁻	M1+E2	0.8 +5-4	0.098 24	δ: From ε decay (8.6 min).
		585.9 2	41 6	325.12	9/2 ⁻	M1		0.0558	
961.22	(5/2, 3/2) ⁺	653.3 3	23 # 5	307.76	5/2 ⁺	M1+E2	1.7 +25-7	0.0211 69	
		713.0 5	69 # 15	248.56	5/2 ⁺	E2		0.01150	
		757.5 2	100 # 11	203.74	3/2 ⁺	M1+E2	2.6 +12-6	0.0125 14	
		952 1	12 # 6	9.94	3/2 ⁺	(E2)		0.00634	
977.8		670 1	100	307.76	5/2 ⁺				
1058.73	3/2 ⁻	456 1	7.9 @ 24	602.90	1/2 ⁺ , 3/2 ⁺				
		574.8 3	100 @ 14	484.02	7/2 ⁻	E2		0.0186	
		751.1 3	7.9 @ 24	307.76	5/2 ⁺				
		809.6 3	12 @ 3	248.56	5/2 ⁺				
		855.5 4	17 @ 3	203.74	3/2 ⁺	E1		0.00295	
		1048 1	4.8 @ 17	9.94	3/2 ⁺				
		1058.5 3	33 @ 3	0.0	1/2 ⁺	E1		0.00199	
1097.03	13/2 ⁻	384.4 3	100 # 8	712.70	11/2 ⁻	M1+E2	0.7 3	0.131 23	

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Au})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult. &	$\delta^\&$	$\alpha^\ddagger$
1097.03	$13/2^-$	451 1	15 [#] 5	646.17	$13/2^-$	M1(+E2)	<0.5	0.103 8
		771.9 3	31 [#] 3	325.12	$9/2^-$	E2		0.00972
		894.9 5	41 [@] 15	203.74	$3/2^+$			
1098.1		1087.9 3	100 [@] 24	9.94	$3/2^+$			
		217 1	22 [@] 6	887.24	$(3/2,5/2)^-$	M1(+E2)	<1.3	0.64 17
1104.80	$3/2^-$	290 1	31 [@] 12	814.30	$1/2^-$	M1		0.364 7
		613.2 2	100 [@] 19	491.53	$5/2^-$	M1(+E2)	<0.8	0.043 7
1105.35	$17/2^-$	459.3 3	100	646.17	$13/2^-$	E2		0.0319
1106.56	$(5/2,3/2)^+$	799 1	73 [#] 20	307.76	$5/2^+$			
		857.7 3	100 [#] 20	248.56	$5/2^+$	M1+E2	1.4 +23-6	0.0122 36
		903.1 3	80 [#] 20	203.74	$3/2^+$	M1(+E2)	<2.6	0.0134 50
1107.4		595 1	100	512.35	$7/2^+$			
1112.48	$11/2^+$	351.9 2	41 [#] 4	760.67	$9/2^+$	M1		0.215
		600 1	100 [#] 13	512.35	$7/2^+$	E2		0.01682
		229 1	55 [@] 22	887.24	$(3/2,5/2)^-$	M1+E2	0.8 3	0.52 9
1116.05	$7/2^-,5/2^-$	345.2 3	100 [@] 18	770.68	$7/2^-$	M1		0.227
		624.6 2	80 [@] 30	491.53	$5/2^-$	M1		0.0473
		249 1	48 [#] 9	880.45	$9/2^-$	M1+E2	1.4 +8-4	0.31 7
		360 1	47 [#] 9	770.68	$7/2^-$	E2		0.0606 10
		417.6 3	15 [#] 2	712.70	$11/2^-$	M1		0.1362
1130.10	$11/2^-$	484.0 2	100 [#] 10	646.17	$13/2^-$	M1		0.0921
		805.0 3	17 [#] 6	325.12	$9/2^-$	E2(+M1)	>0.8	0.0137 48
		882.4 3	11 [#] 3	247.25	$11/2^-$	M1		0.0194
		363.0 2	100 [#] 10	770.68	$7/2^-$	M1+E2	2.5 +16-6	0.078 12
		420.7 4	27 [#] 12	712.70	$11/2^-$	M1(+E2)	<1.7	0.099 35
1133.52	$9/2^-$	641.7 3	31 [#] 5	491.53	$5/2^-$	E2		0.01447
		825.8 5	100	307.76	$5/2^+$			
1133.6								
1145.70	$13/2^-,15/2^-$	433.0 3	23 [#] 4	712.70	$11/2^-$	M1+E2	1.8 +43-7	0.057 19
		499.6 2	100 [#] 8	646.17	$13/2^-$	M1+E2	0.9 4	0.058 15
		898.1 4	5.8 [#] 13	247.25	$11/2^-$	E2(+M1)	>0.8	0.0106 35
1156.0	$(5/2,7/2)^-$	268.8 3	97 [@] 19	887.24	$(3/2,5/2)^-$	M1+E2	1.7 +12-8	0.221 91
		385 1	65 [@] 14	770.68	$7/2^-$	M1		0.169 3
		664 1	100 [@] 20	491.53	$5/2^-$	M1+E2	≈ 0.4	≈ 0.0366
		848 ^a 1	41 ^{a@} 14	307.76	$5/2^+$	[E1]		
		952 ^b 1	27 [@] 9	203.74	$3/2^+$			

Adopted Levels, Gammas (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	$\gamma(^{189}\text{Au})$ (continued)		
						Mult.&	$\delta^\&$	$\alpha^\ddagger$
1165.0		1165 <i>I</i>	100	0.0	1/2 ⁺			
1165.7		917.1 <i>5</i>	100	248.56	5/2 ⁺			
1188.60	11/2 ⁻	326.4 <i>3</i>	32 [#] <i>4</i>	862.04	9/2 ⁻	M1+E2	1.3 +14-6	0.148 <i>56</i>
		376.1 <i>4</i>	13 [#] <i>3</i>	812.67	13/2 ⁻	M1(+E2)	<1.3	0.140 <i>40</i>
		704 <i>I</i>	18 [#] <i>2</i>	484.02	7/2 ⁻			
		941.4 <i>2</i>	100 [#] <i>10</i>	247.25	11/2 ⁻	M1+E2	1.3 +5-4	0.0102 <i>19</i>
1193.55	-	282.6 <i>3</i>	54 [#] <i>7</i>	911.01	7/2 ⁻	M1+E2	1.1 +14-6	0.244 <i>94</i>
		868.4 <i>2</i>	100 [#] <i>11</i>	325.12	9/2 ⁻	(E2)		0.00762
		486.3 <i>3</i>	100 [#] <i>27</i>	760.67	9/2 ⁺	M1+E2	0.8 +6-5	0.066 <i>20</i>
1247.1	(9/2,7/2) ⁺	600 <i>I</i>	43 [#] <i>13</i>	647.20	7/2 ⁺			
		735 <i>I</i>	83 [#] <i>27</i>	512.35	7/2 ⁺			
		939.8 <i>6</i>	27 [#] <i>10</i>	307.76	5/2 ⁺			
		195.6 <i>4</i>	10 [@] <i>4</i>	1058.73	3/2 ⁻	E2		0.404 <i>7</i>
1254.24	5/2 ⁻ , 7/2 ⁻	770.2 <i>2</i>	100 [@] <i>15</i>	484.02	7/2 ⁻	M1		0.0275
		946.3 <i>3</i>	19 [@] <i>7</i>	307.76	5/2 ⁺			
		1057 <i>I</i>	100 [@]	203.74	3/2 ⁺			
1260.7		393 ^b <i>I</i>	40 [#] <i>20</i>	880.45	9/2 ⁻			
1273.14	11/2 ⁻	411.4 <i>3</i>	100 [#] <i>12</i>	862.04	9/2 ⁻	M1+E2	0.6 <i>3</i>	0.115 <i>19</i>
		459 <i>I</i>	48 [#] <i>24</i>	812.67	13/2 ⁻	M1(+E2)	<6	0.070 <i>36</i>
		626.7 <i>3</i>	40 [#] <i>12</i>	646.17	13/2 ⁻	M1		0.0469
		1026.2 <i>5</i>	72 [#] <i>12</i>	247.25	11/2 ⁻	M1+E2	1.2 +20-6	0.0086 <i>26</i>
1286.3		472 <i>I</i>	100	814.30	1/2 ⁻			
1295.5	11/2 ⁻	433.5 <i>3</i>	100 [#] <i>16</i>	862.04	9/2 ⁻	M1+E2	0.8 +6-5	0.090 <i>27</i>
		483 <i>I</i>	23 [#] <i>7</i>	812.67	13/2 ⁻			
		612 <i>I</i>	18 [#] <i>5</i>	681.90	15/2 ⁻			
		811 <i>I</i>	23 [#] <i>9</i>	484.02	7/2 ⁻			
		1048.4 <i>3</i>	46 [#] <i>14</i>	247.25	11/2 ⁻	M1+E2	1.1 +16-6	0.0085 <i>26</i>
1298.87	11/2 ⁺	186.6 <i>3</i>	8 [#] <i>2</i>	1112.48	11/2 ⁺	E2		0.476
		538.2 <i>2</i>	100 [#] <i>10</i>	760.67	9/2 ⁺	M1		0.0697
		651.6 <i>2</i>	92 [#] <i>9</i>	647.20	7/2 ⁺	E2		0.01398
		786.6 <i>2</i>	32 [#] <i>3</i>	512.35	7/2 ⁺	E2		0.00934
1312.96	13/2 ⁻	432.3 <i>4</i>	27 [#] <i>8</i>	880.45	9/2 ⁻	E2		0.0372
		600.1 <i>5</i>	100 [#] <i>23</i>	712.70	11/2 ⁻	M1+E2	1.3 +11-5	0.0301 <i>85</i>
		667.0 <i>3</i>	18 [#] <i>4</i>	646.17	13/2 ⁻	M1(+E2)	<0.9	0.034 <i>6</i>
		987.8 <i>4</i>	8 [#] <i>2</i>	325.12	9/2 ⁻			

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Au})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult.&	$\delta\&$	$\alpha^\ddagger$	Comments
1346.5		1142.8 4	100	203.74	3/2 ⁺				
1352.6	(15/2,13/2,11/2) ⁻	540.0 5	100 [#] 20	812.67	13/2 ⁻	M1+E2	1.2 +7-4	0.041 10	E_γ : doublet.
		670 1	19 [#] 7	681.90	15/2 ⁻	M1		0.0394	
		1105.4 3	27 [#] 4	247.25	11/2 ⁻	E2		0.00473	
1358.8		1155.1 4	100	203.74	3/2 ⁺				
1365.3		683.4 ^b 4	100	681.90	15/2 ⁻				
1368.1	(17/2,13/2,15/2) ⁻	686.2 2	100	681.90	15/2 ⁻	(M1)		0.0370	
1371.3		557 1	100	814.30	1/2 ⁻				
1376.2	-	730 1	100	646.17	13/2 ⁻	M1+E2	≈ 1.7	≈ 0.01624	
1383.25	13/2 ⁺	253.2 2	39 [#] 4	1130.10	11/2 ⁻	E1		0.0404	
		670 1	2.6 [#] 12	712.70	11/2 ⁻	[E1]		0.00471	
		737.0 2	100 [#] 9	646.17	13/2 ⁻	E1		0.00391	
1412.2	19/2 ⁻	730.3 3	100	681.90	15/2 ⁻	Q			$E_\gamma, \text{Mult.}$: from $^{191}\text{Ir}(\alpha, 6n\gamma)$.
1419.80	(13/2,11/2) ⁺	659.0 2	100	760.67	9/2 ⁺	E2		0.01364	
1431.9		544.7 3	100	887.24	(3/2,5/2) ⁻				
1456.2	+	809 1	100	647.20	7/2 ⁺	M1		0.0243	
1459.97	11/2 ⁺	813 1	23 [#] 6	646.17	13/2 ⁻	E1		0.00324	
		1134.8 2	100 [#] 10	325.12	9/2 ⁻	E1		1.76×10^{-3}	
		1213 1	22 [#] 7	247.25	11/2 ⁻				
1463.9	-	751.4 5	76 [#] 41	712.70	11/2 ⁻	M1		0.0293	
		817 1	100 [#] 29	646.17	13/2 ⁻				
1476.1		1272.1 5	100 [@] 28	203.74	3/2 ⁺				
		1466.3 4	97 [@] 28	9.94	3/2 ⁺				
1481.6	13/2 ⁻	293.0 3	48 [#] 7	1188.60	11/2 ⁻	M1		0.354	
		800 1	100 [#] 14	681.90	15/2 ⁻	M1		0.0250	
1483.4	(7/2) ⁺	522.2 2	100 [#] 11	961.22	(5/2,3/2) ⁺	M1+E2	2.2 +11-5	0.032 5	
		722 1	44 [#] 7	760.67	9/2 ⁺	M1+E2	1.1 +5-4	0.021 5	
1488.9	(7/2,11/2) ⁻	578 1	39 [#] 14	911.01	7/2 ⁻				
		776.0 3	71 [#] 14	712.70	11/2 ⁻	(E2)		0.00961	
		1164.3 5	100 11	325.12	9/2 ⁻	M1+E2	1.4 +14-6	0.0061 15	
1516.7	-	704 1	100	812.67	13/2 ⁻	M1+E2	2.0 +11-5	0.0164 25	
1523.4	(⁻)	841 1	100 [#] 17	681.90	15/2 ⁻				
		1276.2 3	61 [#] 13	247.25	11/2 ⁻				
1523.9	+	676 1	100	847.89	9/2 ⁺	M1+E2	1.6 +9-5	0.020 5	
1525.0	-	429 1	100 [#] 27	1097.03	13/2 ⁻	M1		0.1268 20	
		812.1 4	50 [#] 14	712.70	11/2 ⁻	M1(+E2)	<0.7	0.022 3	

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Au})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult.&	$\delta^\&$	$\alpha^\ddagger$	Comments
1534.79	13/2 ⁺	151.4 2	24 [#] 2	1383.25	13/2 ⁺	M1(+E2)	<0.4	2.14 9	
		404.5 3	17 [#] 6	1130.10	11/2 ⁻	E1		0.01358	
		686 1	31 [#] 10	847.89	9/2 ⁺	[E2]		0.01250	
		722 1	11 [#] 4	812.67	13/2 ⁻				
		821.9 3	47 [#] 5	712.70	11/2 ⁻	E1		0.00318	
		853 1	13 [#] 4	681.90	15/2 ⁻	(E1)		0.00296	
		888.5 3	33 [#] 4	646.17	13/2 ⁻	(E1)		0.00275	
		1287.7 2	100 [#] 10	247.25	11/2 ⁻	E1		1.46×10 ⁻³	
		429 1	100 [#] 20	1130.10	11/2 ⁻	E2		0.0379	
		912.9 3	30 [#] 10	646.17	13/2 ⁻	M1(+E2)	<0.24	0.0175 4	
		847.2 3	50 [#] 15	712.70	11/2 ⁻	M1		0.0216	
		1234.3 3	100 [#] 15	325.12	9/2 ⁻				
		1312.9 3	90 [#] 15	247.25	11/2 ⁻				
		483 1	100 [#] 40	1097.03	13/2 ⁻	M1		0.0926	
		934.2 6	79 [#] 17	646.17	13/2 ⁻				
		1083 1	100	512.35	7/2 ⁺				
		951 1	100	646.17	13/2 ⁻				
		218.1 2	100 [#] 10	1383.25	13/2 ⁺	E2(+M1)	>1.1	0.40 12	
		455 1	13 [#] 5	1145.70	13/2 ⁻ , 15/2 ⁻				
		788.5 2	40 [#] 7	812.67	13/2 ⁻	E1		0.00344	
		919.0 4	11 [#] 3	681.90	15/2 ⁻				
		954.9 3	36 [#] 4	646.17	13/2 ⁻	E1		0.00240	
		286 1	15 [#] 6	1368.1	(17/2, 13/2, 15/2) ⁻				
		841 1	39 [#] 12	812.67	13/2 ⁻	E2		0.00814	
		972.1 3	100 [#] 9	681.90	15/2 ⁻	M1+E2	0.7 5	0.012 3	
		1407.2 3	42 [#] 9	247.25	11/2 ⁻				
		557.0 3	100	1105.35	17/2 ⁻	(E2)			E _γ , Mult.: from $\gamma(\theta)$ in ($\alpha, 6n\gamma$).
		582.7		1105.35	17/2 ⁻				
		1049 1	41 [#] 14	681.90	15/2 ⁻				
		1483.3 4	100 [#] 23	247.25	11/2 ⁻				
		356 1	100 [#] 15	1383.25	13/2 ⁺	M1+E2	0.9 +6-4	0.143 37	
		926.8 3	25 [#] 8	812.67	13/2 ⁻	[E1]		0.00254	
		1057.0 10	15 [#] 6	681.90	15/2 ⁻				
		1093 1	48 [#] 12	646.17	13/2 ⁻	[E1]		0.00188	
1745.6		393 1	100	1352.6	(15/2, 13/2, 11/2) ⁻				
1755.0		844 1	100	911.01	7/2 ⁻				

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Au})$ (continued)								
$E_f(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult. &	$\delta^\&$	$\alpha^\ddagger$
1756.7	-	1074.8 3	100	681.90	15/2 ⁻	M1		0.01177
1760.2		999.5 3	100	760.67	9/2 ⁺			
1764.3		1003.6 3	100	760.67	9/2 ⁺			
1767.0		1283 ^b 1	100	484.02	7/2 ⁻			
1774.5		1013.8 5	100	760.67	9/2 ⁺			
1788.3	(+)	676 1	100	1112.48	11/2 ⁺	(E2)		0.01290
1800.6	(15/2 ⁺)	417 1	85 [#] 15	1383.25	13/2 ⁺			
		695.3 5	100 [#] 12	1105.35	17/2 ⁻	(E1)		0.00438
1808.4		1559.8 3	100	248.56	5/2 ⁺			
1822.2	-	1140.3 3	100 [#]	681.90	15/2 ⁻	M1(+E2)	<1.6	0.0081 2/
1835.1	(13/2 ⁺ , 15/2 ⁺)	451 1	80 [#] 29	1383.25	13/2 ⁺			
		1022.6 3	17 [#] 9	812.67	13/2 ⁻			
		1153 1	29 [#] 9	681.90	15/2 ⁻			
		1188.9 5	100 [#] 11	646.17	13/2 ⁻			
1851.0		1367 1	100	484.02	7/2 ⁻			
1862.9	-	952 1	100 [@] 11	911.01	7/2 ⁻	M1		0.01601
		1555 1	47 [@] 15	307.76	5/2 ⁺			
1863.4		1379.4 2	100	484.02	7/2 ⁻			
1877.1	-	1064.4 4	100	812.67	13/2 ⁻	M1+E2	≈0.7	
1879.0		1571.3 5	70 [@] 19	307.76	5/2 ⁺			
		1675.2 3	100 [@] 23	203.74	3/2 ⁺			
1905.2		1259 1	100	646.17	13/2 ⁻			
1913.5		1664.9 4	100	248.56	5/2 ⁺			
1935.02	+	400 1	35 [#] 5	1534.79	13/2 ⁺			
		1122.2 2	100 [#] 10	812.67	13/2 ⁻	E1		
		1253.3 2	69 [#] 8	681.90	15/2 ⁻			
		1289 1	27 [#] 4	646.17	13/2 ⁻			
		1687.8 3	22 [#] 3	247.25	11/2 ⁻			
1939.02	+	479.1 3	19 [#] 4	1459.97	11/2 ⁺	M1+E2	0.6 2	0.077 9
		1126.4 3	19 [#] 4	812.67	13/2 ⁻	(E1)		
		1257.3 3	15 [#] 2	681.90	15/2 ⁻			
		1292.7 3	15 [#] 3	646.17	13/2 ⁻			
		1691.7 3	100 [#] 8	247.25	11/2 ⁻			
1960.1		1476.1 3	100	484.02	7/2 ⁻			
1970.8		1487 1	44 [@] 26	484.02	7/2 ⁻			
		1663.0 4	100 [@] 23	307.76	5/2 ⁺			
2030.87		926 1	33 [@] 11	1104.80	3/2 ⁻			

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Au})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult.&	$\delta^\&$	$\alpha^\ddagger$	Comments
2030.87		933.4 ^b 4	38 [@] 8	1098.1					
		972 1	24 [@] 10	1058.73	3/2 ⁻				
		1428.1 2	100 [@] 19	602.90	1/2 ⁺ , 3/2 ⁺				
		1826.6 4	38 [@] 13	203.74	3/2 ⁺				
2031.04		2021.5 3	100 [@] 10	9.94	3/2 ⁺				
		2030.3 4	30 [@] 7	0.0	1/2 ⁺				
2034.2		2034.2 3	100	0.0	1/2 ⁺				
2034.7		1221 1	100 [@] 35	814.30	1/2 ⁻				
		1431.7 3	100 [@] 35	602.90	1/2 ⁺ , 3/2 ⁺				
2036.1		1787.5 5	100	248.56	5/2 ⁺				
2045.8	+	746.9 3	100 [#] 11	1298.87	11/2 ⁺	M1+E2	1.2 +6-4	0.018 4	
		1364 1	59 [#] 15	681.90	15/2 ⁻				
2061.5		1570 1	100	491.53	5/2 ⁻				
2062.6	(21/2 ⁺)	650.3 3	100	1412.2	19/2 ⁻	D			$E_\gamma, \text{Mult.}: \text{from } (\alpha, 6n\gamma).$
2066.2		1179 1	100	887.24	(3/2, 5/2) ⁻				
2066.47	3/2 ⁻ , 5/2 ⁻	1007.7 2	100 [@] 11	1058.73	3/2 ⁻	M1		0.01386	
		1463.5 3	41 [@] 9	602.90	1/2 ⁺ , 3/2 ⁺				
		1818.3 5	23 [@] 9	248.56	5/2 ⁺				
		1862.7 3	40 [@] 9	203.74	3/2 ⁺				
2074.05	-	969.0 3	28 [@] 7	1104.80	3/2 ⁻				
		1015.3 3	63 [@] 7	1058.73	3/2 ⁻	M1		0.01360	
		1259.9 3	31 [@] 7	814.30	1/2 ⁻				
		1471 1	19 [@] 10	602.90	1/2 ⁺ , 3/2 ⁺				
		1766.4 3	100 [@] 10	307.76	5/2 ⁺				
2074.7	-	918.8 3	98 [@] 11	1156.0	(5/2, 7/2) ⁻	M1+E2	0.8 +8-6	0.0133 38	
		958.6 3	100 [@] 11	1116.05	7/2 ⁻ , 5/2 ⁻	M1		0.01573	
2092.8	-	936.6 3	100 [@] 11	1156.0	(5/2, 7/2) ⁻	M1		0.01669	
		1278 1	41 [@] 11	814.30	1/2 ⁻				
		2093.2 4	61 [@] 13	0.0	1/2 ⁺				
2093.61	-	977.7 3	45 [@] 4	1116.05	7/2 ⁻ , 5/2 ⁻	M1		0.01496	
		1034.6 3	100 [@] 11	1058.73	3/2 ⁻	M1		0.01296	
		1786.0 5	61 [@] 13	307.76	5/2 ⁺				
		1845.3 5	27 [@] 8	248.56	5/2 ⁺				
2094.0		1447.8 3	100	646.17	13/2 ⁻				
2099.7		1895.9 5	100	203.74	3/2 ⁺				
2101.47		995.5 ^b 4	36 [@] 18	1107.4					

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Au})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult. &	$\delta^\&$	$\alpha^\ddagger$
2101.47		1221 ^a 1	36 ^a 16	879.64	+			
		1299.5 6	33 [@] 18	801.95	1/2 ⁺ , 3/2 ⁺			
		1331.0 3	47 [@] 15	770.68	7/2 ⁻			
		1454.4 3	100 [@] 22	647.20	7/2 ⁺			
		2091.3 4	87 [@] 18	9.94	3/2 ⁺			
		2101.3 3	76 [@] 18	0.0	1/2 ⁺			
2101.7	(⁻)	848 ^a 1	100 ^{a@} 33	1254.24	5/2 ⁻ , 7/2 ⁻	(M1)		0.0215
		1589.4 4	90 [@] 27	512.35	7/2 ⁺			
		1793.8 4	100 [@] 33	307.76	5/2 ⁺			
2109.8		1802 1	100	307.76	5/2 ⁺			
2113.8		925.2 3	64 [#] 12	1188.60	11/2 ⁻			
		1301.1 5	100 [#] 20	812.67	13/2 ⁻			
2145.0		1039 1	14 [#] 7	1105.35	17/2 ⁻			
		1498.9 3	100 [#] 14	646.17	13/2 ⁻			
2154.6	-	900.4 3	100	1254.24	5/2 ⁻ , 7/2 ⁻	M1(+E2)		
2155.3		1096.6 4	100	1058.73	3/2 ⁻			
2157.4		1908.8 4	100	248.56	5/2 ⁺			
2163.3	+	780.1 5	100	1383.25	13/2 ⁺	M1		0.0266
2165.21	+	630.3 2	100 [#] 11	1534.79	13/2 ⁺	M1+E2	1.2 +4-3	0.028 5
		1352.8 3	18 [#] 7	812.67	13/2 ⁻			
		1519 1	18 [#] 7	646.17	13/2 ⁻			
2169.19	(⁺)	634 1	37 [#] 5	1534.79	13/2 ⁺	(M1+E2)	1.0 2	0.030 4
		709.1 4	10 [#] 3	1459.97	11/2 ⁺	E2(+M1)	>1.2	0.0162 46
		1356.4 3	8 [#] 3	812.67	13/2 ⁻			
		1487.4 4	12 [#] 4	681.90	15/2 ⁻			
		1523 1	21 [#] 5	646.17	13/2 ⁻			
		1922.0 2	100 [#] 9	247.25	11/2 ⁻			
2169.6	+	749.7 3	100 [#] 11	1419.80	(13/2, 11/2) ⁺	M1+E2	0.6 3	0.024 4
		981.2 4	33 [#] 11	1188.60	11/2 ⁻			
		1409 ^b 1	22 [#] 11	760.67	9/2 ⁺			
2176.2	+	437 1	67 [#] 44	1739.4	13/2 ⁺ , 15/2 ⁺			
		716 1	100 [#] 44	1459.97	11/2 ⁺	E2		0.01139
2176.8		1364 1	18 [#] 6	812.67	13/2 ⁻			
		1495 1	15 [#] 4	681.90	15/2 ⁻			
		1929.5 3	100 [#] 10	247.25	11/2 ⁻			
2178.0		239 1	100	1939.02	+			

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Au})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult.&	$\delta^\&$	$\alpha^\ddagger$	Comments
2200.9		1519 <i>I</i>	100	681.90	15/2 ⁻				
2205.3	23/2 ⁻	793.2 <i>3</i>	100	1412.2	19/2 ⁻	(Q)			$E_\gamma, \text{Mult.}$: from $(\alpha, 6n\gamma)$.
2209.8		2006 <i>I</i>	100	203.74	3/2 ⁺				
2211.01	+	751.0 <i>5</i>	76 [#] <i>29</i>	1459.97	11/2 ⁺	M1(+E2)	<2.2	0.0215 <i>79</i>	
		1398.5 <i>3</i>	65 [#] <i>18</i>	812.67	13/2 ⁻				
		1528.9 <i>4</i>	65 [#] <i>18</i>	681.90	15/2 ⁻				
		1963.7 <i>3</i>	100 [#] <i>12</i>	247.25	11/2 ⁻				
2239.9		751 <i>I</i>	100	1488.9	(7/2, 11/2) ⁻				
2240.94	(+)	1128.7 <i>3</i>	24 [#] <i>7</i>	1112.48	11/2 ⁺	M1(+E2)	<0.9	0.0091 <i>14</i>	
		1379.0 <i>2</i>	86 [#] <i>24</i>	862.04	9/2 ⁻				
		1594.8 <i>3</i>	100 [#] <i>10</i>	646.17	13/2 ⁻				
		1915.8 <i>3</i>	60 [#] <i>7</i>	325.12	9/2 ⁻				
		1993.2 <i>3</i>	38 [#] <i>5</i>	247.25	11/2 ⁻				
2250.7	(25/2 ⁺)	188.0 <i>3</i>	100	2062.6	(21/2 ⁺)	[E2]		0.464	E_γ : from $^{191}\text{Ir}(\alpha, 6n\gamma)$. Mult.: $\Delta J=1$ γ from $\gamma(\theta)$, and M1(+E2), $\delta < 1.1$ from $\alpha(\text{exp})$ in $(^{12}\text{C}, 4n\gamma)$, but $\Delta J\pi$ requires E2.
2251.9		1605.7 <i>4</i>	100	646.17	13/2 ⁻				
2255.1		1125 ^b <i>I</i>	100	1130.10	11/2 ⁻				
2257.18	(-)	318 <i>I</i>	27 [#] <i>10</i>	1939.02	+	(E1)		0.0862 <i>15</i>	
		697.3 <i>4</i>	20 [#] <i>4</i>	1559.83	-				
		1395.4 <i>3</i>	12 [#] <i>4</i>	862.04	9/2 ⁻				
		1610 <i>I</i>	6 [#] <i>2</i>	647.20	7/2 ⁺				
		1744.7 <i>5</i>	16 [#] <i>4</i>	512.35	7/2 ⁺				
		1931.9 <i>3</i>	100 [#] <i>10</i>	325.12	9/2 ⁻				
		2009.9 <i>3</i>	74 [#] <i>7</i>	247.25	11/2 ⁻				
2257.53	(+)	837.8 <i>3</i>	73 [#] <i>13</i>	1419.80	(13/2, 11/2) ⁺	M1+E2	1.1 +9-5	0.0145 <i>40</i>	
		958.7 <i>3</i>	57 [#] <i>10</i>	1298.87	11/2 ⁺	M1(+E2)	<1.1	0.013 <i>3</i>	
		1145 <i>I</i>	80 [#] <i>17</i>	1112.48	11/2 ⁺	M1(+E2)	<1.0	0.0086 <i>14</i>	
		1444.9 <i>3</i>	73 [#] <i>10</i>	812.67	13/2 ⁻				
		1496.8 <i>3</i>	100 [#] <i>33</i>	760.67	9/2 ⁺				
		1544.7 <i>3</i>	60 [#] <i>10</i>	712.70	11/2 ⁻				
2258.7		1004.2 <i>3</i>	100 [@] <i>26</i>	1254.24	5/2 ⁻ , 7/2 ⁻				
		1200 <i>I</i>	65 [@] <i>23</i>	1058.73	3/2 ⁻				
		2249.1 <i>4</i>	68 [@] <i>23</i>	9.94	3/2 ⁺				
2264.0		951 <i>I</i>	100	1312.96	13/2 ⁻				
2264.81	+	326 <i>I</i>	35 [#] <i>8</i>	1939.02	+	M1+E2	1.2 +16-6	0.156 <i>61</i>	

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Au})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult.&	$\delta^\&$	$\alpha^\ddagger$
2264.81	+	663.6 2	84 [#] 8	1601.19	13/2 ⁺ , 15/2 ⁺	M1+E2 (E1)	0.5 +3-4	0.035 6
		1159.7 5	100 [#] 9	1105.35	17/2 ⁻			
		1167.8 3	24 [#] 4	1097.03	13/2 ⁻			
		1451.9 3	39 [#] 7	812.67	13/2 ⁻			
		1618.9 4	14 [#] 3	646.17	13/2 ⁻			
2268.0		808 1	100	1459.97	11/2 ⁺			
2268.97		1421.4 ^b 3	8 [#] 2	847.89	9/2 ⁺			
		1943.8 2	100 [#] 10	325.12	9/2 ⁻			
		2021.8 3	68 [#] 7	247.25	11/2 ⁻			
2269.7		1557.0 3	100	712.70	11/2 ⁻			
2271.0	+	851.2 4	79 [#] 21	1419.80	(13/2, 11/2) ⁺	M1		0.0213
		1945.9 4	100 [#] 14	325.12	9/2 ⁻			
2272.16	+	333.3 4	9.7 [#] 23	1939.02	+	M1(+E2)	<1.1	0.20 5
		484 1	7 [#] 3	1788.3	(⁺)			
		1083 1	3.3 [#] 17	1188.60	11/2 ⁻			
		1511.5 3	13.3 [#] 13	760.67	9/2 ⁺			
		1559.6 2	11.3 [#] 23	712.70	11/2 ⁻			
		1626.0 2	29 [#] 5	646.17	13/2 ⁻			
		2024.7 2	100 [#] 10	247.25	11/2 ⁻			
2273.1		853 1	83 [#] 17	1419.80	(13/2, 11/2) ⁺			
		1460.6 8	100 [#] 33	812.67	13/2 ⁻			
2274.1		1161.0 4	100 [#] 29	1112.48	11/2 ⁺			
		1513.7 3	88 [#] 29	760.67	9/2 ⁺			
2274.6		1592.7 4	100	681.90	15/2 ⁻			
2275.6	+	716 1	100 [#] 36	1559.83	-			
		855.6 3	79 [#] 21	1419.80	(13/2, 11/2) ⁺	E2(+M1)	>0.7	0.0123 45
		2029.0 5	86 [#] 21	247.25	11/2 ⁻			
2276.59	+	816.5 3	38 [#] 11	1459.97	11/2 ⁺	M1(+E2)	<1.5	0.0185 53
		977.9 3	60 [#] 6	1298.87	11/2 ⁺			
		1428.8 3	34 [#] 11	847.89	9/2 ⁺			
		1630.5 3	100 [#] 13	646.17	13/2 ⁻			
		1951.2 3	32 [#] 4	325.12	9/2 ⁻			
2281.00		1568.4 5	9.5 [#] 14	712.70	11/2 ⁻			
		1599.4 8	10.5 [#] 19	681.90	15/2 ⁻			
		2033.7 2	100 [#] 27	247.25	11/2 ⁻			

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Au})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult.&	$\delta^\&$	$\alpha^\ddagger$	Comments
2281.9		1093 1	73 [#] 36	1188.60	11/2 ⁻				
		1636 1	100 [#] 27	646.17	13/2 ⁻				
2293.9		981 1	100 [#] 40	1312.96	13/2 ⁻				
		1431.8 3	100 [#] 50	862.04	9/2 ⁻				
2294.99	+	356 1	34 [#] 9	1939.02	+	M1(+E2)	<1.3	0.163 46	
		360 1	37 [#] 9	1935.02	+	M1(+E2)	<1.1	0.16 4	
		1198.0 2	33 [#] 4	1097.03	13/2 ⁻				
		1482.0 4	26 [#] 5	812.67	13/2 ⁻				
		1613 1	8 [#] 4	681.90	15/2 ⁻				
		1648.9 3	100 [#] 9	646.17	13/2 ⁻				
2295.7		1583.0 5	100	712.70	11/2 ⁻				
2299.5	25/2 ⁻	637.1 3	100	1662.4	21/2 ⁻	(Q)			$E_\gamma, \text{Mult.}: \text{from } (\alpha, 6n\gamma).$
2311.3		1986.3 3	100 [#] 11	325.12	9/2 ⁻				
		2063.8 5	22 [#] 6	247.25	11/2 ⁻				
2316.0		1503.6 4	57 [#] 17	812.67	13/2 ⁻				
		1634.0 3	100 [#] 13	681.90	15/2 ⁻				
2317.1	+	716 1	26 [#] 14	1601.19	13/2 ⁺ , 15/2 ⁺				
		782.2 3	48 [#] 5	1534.79	13/2 ⁺	M1+E2	0.7 4	0.021 5	
		1671.1 3	100 [#] 12	646.17	13/2 ⁻				
2317.5	+	382.5 3	27 [#] 4	1935.02	+	M1		0.1722	
		1171.8 2	100 [#] 10	1145.70	13/2 ⁻ , 15/2 ⁻	(E1)			
		1212 1	18 [#] 6	1105.35	17/2 ⁻				
2319.4		256.8	100	2062.6	(21/2 ⁺)				
2325.0		386 1	100	1939.02	+				
2330.9		1649 1	100	681.90	15/2 ⁻				
2335.1	(⁺)	401 1	69 [#] 14	1935.02	+				
		734 1	42 [#] 22	1601.19	13/2 ⁺ , 15/2 ⁺	M1+E2	0.8 +9-6	0.0232 72	
		800 1	100 [#] 17	1534.79	13/2 ⁺	[E2]		0.00902	
		1222.7 4	28 [#] 8	1112.48	11/2 ⁺				
		1238.0 3	33 [#] 8	1097.03	13/2 ⁻				
2335.7		1523 1	100	812.67	13/2 ⁻				
2336.1		777 1	100	1559.1	-				
2338.6		1150 1	100	1188.60	11/2 ⁻				
2339.7		1657.8 3	100	681.90	15/2 ⁻				
2349.2		1703 1	100	646.17	13/2 ⁻				
2370.3		1264.9 4	100	1105.35	17/2 ⁻				

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Au})$ (continued)									
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult.&	$\delta^\&$	$\alpha^\ddagger$	Comments
2384.7		1703 1	90 [#] 30	681.90	15/2 ⁻				
		2137.4 3	100 [#] 20	247.25	11/2 ⁻				
2400.9	(25/2 ⁺)	150.1 3	100	2250.7	(25/2 ⁺)	(M1)		2.26	$E_\gamma, \text{Mult.}: \text{from } (\alpha, 6n\gamma).$
2405.9		1724 1	100	681.90	15/2 ⁻				
2417.1		1771.1 4	100 [#] 17	646.17	13/2 ⁻				
		2169.6 5	50 [#] 17	247.25	11/2 ⁻				
2417.9		1736 1	100	681.90	15/2 ⁻				
2436.4		1331.0 3	100	1105.35	17/2 ⁻				
2451.0	(23/2 ⁻)	1038.8 3	100	1412.2	19/2 ⁻	(Q)			$E_\gamma, \text{Mult.}: \text{from } ^{191}\text{Ir}(\alpha, 6n\gamma).$
2483.7		1671 1	100	812.67	13/2 ⁻				
2492.1		1845.9 4	100	646.17	13/2 ⁻				
2515.8	(27/2 ⁺)	265.1 3	100	2250.7	(25/2 ⁺)	M1(+E2)	<1.0	0.32 17	$E_\gamma: \text{from } ^{191}\text{Ir}(\alpha, 6n\gamma).$ Mult., δ : M1(+E2), $\delta < 1.0$ from ($^{12}\text{C}, 4n\gamma$).
2542.7		292	100	2250.7	(25/2 ⁺)				$E_\gamma: \text{from } (^{12}\text{C}, 4n\gamma).$
2554.2	(27/2 ⁻)	104 ^b		2451.0	(23/2 ⁻)				$E_\gamma: \text{from } (^{19}\text{F}, 4n\gamma).$ Other: 103.5 for an unplaced γ in ($^{12}\text{C}, 4n\gamma$). Not reported in the other two high-spin studies. $I_\gamma: 260 10$ for 103.5-keV unplaced γ in ($^{12}\text{C}, 4n\gamma$).
		153.2 3	90 9	2400.9	(25/2 ⁺)	(E1)		0.1409 21	$I_\gamma: \text{from } (^{12}\text{C}, 4n\gamma).$
		349.0 3	100 10	2205.3	23/2 ⁻	(E2)		0.0661	$E_\gamma, \text{Mult.}: \text{from } (\alpha, 6n\gamma).$ $I_\gamma: \text{from } (^{12}\text{C}, 4n\gamma).$ $E_\gamma, \text{Mult.}: \text{from } (\alpha, 6n\gamma).$
2554.2+x	(31/2 ⁻)	x		2554.2	(27/2 ⁻)				
2554.8	(31/2 ⁺)	38.8 3	100	2515.8	(27/2 ⁺)	(E2)		435 18	B(E2)(W.u.)=0.95 13 $E_\gamma, \text{Mult.}: \text{from } ^{174}\text{Yb}(^{19}\text{F}, 4n\gamma) \text{ dataset}$ (1997Pe26,2001MaZN).
2608.9		1796.2 5	100	812.67	13/2 ⁻				
2862.8+x	(33/2 ⁻)	308.6 3	100	2554.2+x	(31/2 ⁻)	D			$E_\gamma, \text{Mult.}: \text{from } ^{191}\text{Ir}(\alpha, 6n\gamma).$
2928.8?		374 ^b		2554.8	(31/2 ⁺)				
2968.7	(29/2 ⁻)	669.2		2299.5	25/2 ⁻				
2988.8+x	(35/2 ⁻)	125.6 3		2862.8+x	(33/2 ⁻)	D			$E_\gamma, \text{Mult.}: \text{from } (\alpha, 6n\gamma).$
		435.2		2554.2+x	(31/2 ⁻)				$E_\gamma: \text{from } (^{19}\text{F}, 6n\gamma).$
3003.9	29/2 ⁻	704.4		2299.5	25/2 ⁻				
3062.3	(35/2 ⁺)	507.5 3	100	2554.8	(31/2 ⁺)	(Q)			$E_\gamma, \text{Mult.}: \text{from } (\alpha, 6n\gamma) \text{ where this } \gamma \text{ is placed from a } 3023.1+x \text{ level.}$
3160.5+x	(37/2 ⁻)	297.7		2862.8+x	(33/2 ⁻)				
3222.1	(31/2 ⁻)	253.3		2968.7	(29/2 ⁻)				
3359.2+x	(37/2 ⁻)	370.3 3		2988.8+x	(35/2 ⁻)	D			$E_\gamma, \text{Mult.}: \text{from } (\alpha, 6n\gamma) \text{ where this } \gamma \text{ is placed from a } 3233.0 \text{ level.}$
		496.4		2862.8+x	(33/2 ⁻)				
3377.4	(33/2 ⁻)	155.2		3222.1	(31/2 ⁻)				

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Au})$ (continued)						
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult. & Comments
3377.4	(33/2 ⁻)	408.9		2968.7	(29/2 ⁻)	
3559.6+x	(39/2 ⁻)	200.2 ³		3359.2+x	(37/2 ⁻)	E_γ : from ($\alpha,6n\gamma$) where this γ is shown from a 3433.2 level.
		571.2		2988.8+x	(35/2 ⁻)	
3562.9	(37/2 ⁺)	500.4		3062.3	(35/2 ⁺)	
3709.7		332.1		3377.4	(33/2 ⁻)	
3838.2+x	(39/2 ⁻)	677.8		3160.5+x	(37/2 ⁻)	
		848.8		2988.8+x	(35/2 ⁻)	
3845.6	(39/2 ⁺)	283.0		3562.9	(37/2 ⁺)	
		783.4 ³		3062.3	(35/2 ⁺)	Q $E_{\gamma,\text{Mult.}}$: from ($\alpha,6n\gamma$) where this γ is shown from a 3806.6+x level.
3921.4	(37/2 ⁻)	211.5		3709.7		
		544.1		3377.4	(33/2 ⁻)	
3965.0+x	(39/2 ⁻)	606.3		3359.2+x	(37/2 ⁻)	
		975.8		2988.8+x	(35/2 ⁻)	
3980.2		417.3		3562.9	(37/2 ⁺)	
4102.7+x	(41/2 ⁻)	542.9		3559.6+x	(39/2 ⁻)	
		743.6		3359.2+x	(37/2 ⁻)	
4253.5+x	(43/2 ⁻)	150.7		4102.7+x	(41/2 ⁻)	
		288.6		3965.0+x	(39/2 ⁻)	
		693.9		3559.6+x	(39/2 ⁻)	
4290.7+x	(41/2 ⁻)	325.9		3965.0+x	(39/2 ⁻)	
4305.6+x	(43/2 ⁻)	746.3		3559.6+x	(39/2 ⁻)	
4325.7	(41/2 ⁺)	480.0		3845.6	(39/2 ⁺)	
		762.8		3562.9	(37/2 ⁺)	
4352.5	(41/2 ⁺)	507.3		3845.6	(39/2 ⁺)	
		789.2		3562.9	(37/2 ⁺)	
4480.1	(43/2 ⁺)	154.2		4325.7	(41/2 ⁺)	
		634.5		3845.6	(39/2 ⁺)	
4527.0+x	(43/2 ⁻)	236.1		4290.7+x	(41/2 ⁻)	
		688.1		3838.2+x	(39/2 ⁻)	
4639.0	(43/2 ⁺)	286.6		4352.5	(41/2 ⁺)	
		313.3		4325.7	(41/2 ⁺)	
4674.4+x	(45/2 ⁻)	147.5		4527.0+x	(43/2 ⁻)	
		369.0		4305.6+x	(43/2 ⁻)	
4694.7+x	(45/2 ⁻)	441.4		4253.5+x	(43/2 ⁻)	
4698.7	(47/2 ⁺)	218.6	100	4480.1	(43/2 ⁺)	(Q) Mult., I_γ : from ($^{12}\text{C},4n\gamma$), assuming 217.8 γ in that reaction is the same as 218.6 γ from ($^{19}\text{F},6n\gamma$) and 219 or 218 in ($^{19}\text{F},4n\gamma$).
4796.5+x		543		4253.5+x	(43/2 ⁻)	
4879.7		240.6		4639.0	(43/2 ⁺)	
		399.5		4480.1	(43/2 ⁺)	
4903.5+x	(47/2 ⁻)	649.8		4253.5+x	(43/2 ⁻)	
4916.2		277.3		4639.0	(43/2 ⁺)	
5085.0		386.3		4698.7	(47/2 ⁺)	

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Au})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	E_f	J_f^π
5103.1	(47/2 ⁺)	187.0	4916.2	
		223.3	4879.7	
		464.1	4639.0	(43/2 ⁺)
5124.6+x	(47/2 ⁻)	819.0	4305.6+x	(43/2 ⁻)
5166.5		286.8	4879.7	
5174.5	(49/2 ⁺)	475.7	4698.7	(47/2 ⁺)
5263.3+x	(49/2 ⁻)	588.9	4674.4+x	(45/2 ⁻)
5315.6	(51/2 ⁺)	141.0	5174.5	(49/2 ⁺)
		617.1	4698.7	(47/2 ⁺)
5368.1+x	(49/2 ⁻)	464.7	4903.5+x	(47/2 ⁻)
		673.6	4694.7+x	(45/2 ⁻)
5428.5+x	(47/2 ⁻)	754.1	4674.4+x	(45/2 ⁻)
5602.5		428	5174.5	(49/2 ⁺)
5634.9	(53/2 ⁺)	319.3	5315.6	(51/2 ⁺)
5665.5		491	5174.5	(49/2 ⁺)
5707.4+x	(51/2 ⁻)	803.8	4903.5+x	(47/2 ⁻)
5734.2+x	(53/2 ⁻)	470.9	5263.3+x	(49/2 ⁻)
5861.2		686.7	5174.5	(49/2 ⁺)
5923.8	(55/2 ⁺)	608.2	5315.6	(51/2 ⁺)
		838.7	5085.0	
5964.1+x	(51/2 ⁻)	839.4	5124.6+x	(47/2 ⁻)
6096.7+x	(53/2 ⁻)	389.1	5707.4+x	(51/2 ⁻)
		728.8	5368.1+x	(49/2 ⁻)
6179.8		544.9	5634.9	(53/2 ⁺)
6202.3		886.7	5315.6	(51/2 ⁺)
6234.8	(57/2 ⁺)	599.9	5634.9	(53/2 ⁺)
6305.5+x	(55/2 ⁻)	598.0	5707.4+x	(51/2 ⁻)
6305.6+x		877.1	5428.5+x	(47/2 ⁻)
6316.1+x	(57/2 ⁻)	581.9	5734.2+x	(53/2 ⁻)
6359.5	(57/2)	435.7	5923.8	(55/2 ⁺)
6379.4		1063.8	5315.6	(51/2 ⁺)
6394.9+x		966.4	5428.5+x	(47/2 ⁻)
6881.2	(61/2)	522.1	6359.5	(57/2)
7092.1	(61/2 ⁺)	857.3	6234.8	(57/2 ⁺)
7284.7	(61/2 ⁻)	924.9	6359.5	(57/2)
7601.0	(65/2)	315.9	7284.7	(61/2 ⁻)
		720.2	6881.2	(61/2)
7849.4	(65/2)	968.2	6881.2	(61/2)
7956.2	(65/2 ⁺)	864.1	7092.1	(61/2 ⁺)
8182.3		1090.2	7092.1	(61/2 ⁺)
8261.8		1169.7	7092.1	(61/2 ⁺)
8433.9	(69/2)	832.9	7601.0	(65/2)

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Au})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	E_f	J_f^π
8680.6	(69/2 ⁺)	724.4	7956.2	(65/2 ⁺)
8804.3		848.1	7956.2	(65/2 ⁺)
9141.0		460.4	8680.6	(69/2 ⁺)
9314.1	(73/2)	880.2	8433.9	(69/2)
9580.9	(73/2 ⁺)	900.3	8680.6	(69/2 ⁺)

[†] From ^{189}Hg ε decay for gamma rays from low-spin ($J \leq 15/2$) levels. Gammas from high-spin ($J > 15/2$ or so) levels, values are from $^{176}\text{Yb}(^{19}\text{F}, 6n\gamma)$, unless otherwise stated.

[‡] From BrIcc v2.3b (16-Dec-2014) [2008Ki07](#), “Frozen Orbitals” appr.

[§] From ^{189}Hg ε decay for gamma rays from low-spin ($J \leq 15/2$) levels. For gamma rays from high-spin ($J > 15/2$ or so) levels, values are from $^{191}\text{Ir}(\alpha, 6n\gamma)$ and/or from $^{181}\text{Ta}(^{12}\text{C}, 4n\gamma)$. Intensities from $^{176}\text{Yb}(^{19}\text{F}, 6n\gamma)$ and $^{174}\text{Yb}(^{19}\text{F}, 4n\gamma)$ are not available.

[&] From ^{189}Hg ε decay (7.6 m) and ^{189}Hg ε decay (8.6 m), except as noted. For gammas from high-spin ($J > 15/2$ or so) levels, assignments are from $\gamma(\theta)$ data in $^{191}\text{Ir}(\alpha, 6n\gamma)$ and/or in $^{181}\text{Ta}(^{12}\text{C}, 4n\gamma)$. No such assignments are available from $^{176}\text{Yb}(^{19}\text{F}, 6n\gamma)$ and $^{174}\text{Yb}(^{19}\text{F}, 4n\gamma)$.

[@] From ^{189}Hg ε decay (7.6 m).

[#] From ^{189}Hg ε decay (8.6 m).

^a Multiply placed with intensity suitably divided.

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

Adopted Levels, Gammas

Adopted Levels, Gammas (continued)

^{189}Hg ε decay (7.6 min) 1996Wo04

Parent: ^{189}Hg : $E=0$; $J^\pi=3/2^-$; $T_{1/2}=7.6$ min 2; $Q(\varepsilon)=3960$ 40; $\% \varepsilon + \% \beta^+$ decay=100

^{189}Hg - J^π , $T_{1/2}$: From ^{189}Hg Adopted Levels.

^{189}Hg - $Q(\varepsilon)$: From 2017Wa10.

1996Wo04: mass separated ^{189g}Hg samples from the decay of ^{189}Tl following $^{181}\text{Ta}(^{16}\text{O},8n)$ reaction. Measured E_γ , I_γ , I_{ce} , $\gamma\gamma$, $ce\gamma$, $\gamma(x\text{ ray})$ and $e(x\text{ ray})$ coincidences. Deduced levels, J^π . Ge(Li), Si(Li) detectors. See also 1976Wo10 where several authors are the same as in 1996Wo04.

1988Ko22: ^{189}Au structure from ε decay of ^{189g}Hg and ^{189m}Hg produced by heavy ion induced reaction. Measured $\gamma\gamma$, $\gamma(x\text{ rays})$, $\gamma(ce)$, and $ce(x\text{ rays})$ coincidences. Ge(Li) and Si(Li) detectors. Deduced band structure. Several authors in 1988Ko22 are the same as in 1996Wo04.

1975Be17: ^{189g}Hg , ^{189m}Hg from $\text{Pb}(p,xn3p)$, mass separated; Measured E_γ , I_γ , I_{ce} , $\gamma\gamma$, $(ce)\gamma$. Deduced levels, J^π , $T_{1/2}$.

Ge(Li), Si(Li) and magnetic spectrometer.

 ^{189}Au Levels

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$T_{1/2}^\ddagger$	Comments
0.0 [#]	1/2 ⁺	28.7 min 4	
9.93 [#] 12	3/2 ⁺	30 ns 4	$T_{1/2}$: from $ce(x\text{ ray})(t)$ and $ce-ce(t)$ (1975Be17).
203.77 [#] 12	3/2 ⁺		
247.25 [@] 16	11/2 ⁻	4.59 min 11	$\%IT=?$; $\% \varepsilon + \% \beta^+ \approx 100$ $E(\text{level})$: from Adopted Levels.
248.59 [#] 12	5/2 ⁺		
307.77 [#] 14	5/2 ⁺		
325.10 ^{&} 22	9/2 ⁻	190 ns 15	$T_{1/2}$: from $ce(x\text{ ray})(t)$ (1975Be17).
483.99 [@] 18	7/2 ⁻	0.15 ns 5	$T_{1/2}$: from $ce(\gamma)(t)$ (1975Be17).
491.51 ^{&} 21	5/2 ⁻	0.30 ns 3	$T_{1/2}$: from $ce(\text{Compton continuum in } 120\text{-}300\text{ keV region})(t)$ (1975Be17).
512.43 [#] 19	7/2 ⁺		
602.92 16	1/2 ⁺ , 3/2 ⁺		
647.13 [#] 14	7/2 ⁺		
770.73 ^{&} 21	7/2 ⁻		
801.96 18	1/2 ⁺ , 3/2 ⁺		
811.79 24	(5/2, 3/2, 1/2) ⁺		
814.3 3	1/2 ⁻		
862.2 [@] 3	9/2 ⁻		
879.67 23	⁺		
887.2 3	(3/2, 5/2) ⁻		
911.0 3	7/2 ⁻		
977.8 10			
1058.73 [@] 14	3/2 ⁻		
1098.1 3			
1104.79 ^{&} 24	3/2 ⁻		
1107.4 11			
1116.05 23	7/2 ⁻ , 5/2 ⁻		
1133.6 6			
1156.0 3	(5/2 ⁻ , 7/2 ⁻)		
1165.0 10			
1165.7 6			
1254.23 [@] 20	5/2 ⁻ , 7/2 ⁻		
1260.8 10			
1286.3 11			
1346.6 5			
1358.9 5			
1371.3 11			

Continued on next page (footnotes at end of table)

^{189}Hg ε decay (7.6 min) **1996Wo04** (continued) ^{189}Au Levels (continued)

E(level) [†]	$J\pi^{\ddagger}$	Comments
1431.9 4		J^π : in 1996Wo04 , this level is shown in their Figure 15 with other low-lying negative parity levels. However no $J\pi$ was assigned to this level.
1476.1 4		
1755.0 11		
1767.0 11		
1808.4 4		
1851.0 11		
1862.9 8	–	
1863.4 3		
1879.0 3		
1913.5 5		
1960.1 4		
1970.8 4		
2030.88 22		
2031.0 3		
2034.2 3		
2034.7 4		
2036.1 6		
2061.5 11		
2066.2 11		
2066.48 18	$3/2^-, 5/2^-$	
2074.05 21	–	
2074.7 3	(–)	
2092.8 3	–	
2093.62 23	–	
2099.7 6		
2101.46 18		
2101.8 3	(–)	
2109.8 10		
2154.6 4	–	
2155.3 5		
2157.4 5		
2209.8 10		
2258.7 3		

[†] From least-squares fit to E_γ values.[‡] From Adopted Levels unless otherwise stated.# $\pi(s_{1/2}, d_{3/2}, d_{5/2})^{-1}$ structure.@ $\pi h_{11/2}^{-1}$ structure.& $\pi h_{9/2}$ structure.

γ(¹⁸⁹Au)

Annihilation intensity $I_{\gamma}(\gamma^{\pm})=50.5$.

In the absence of unknown $\varepsilon+\beta^+$ feeding to the g.s., the decay scheme has not been normalized.

The experimental subshell ratios and conversion coefficients are from 1996Wo04. When specified as 'other', those values are from 1975Be17.

$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\ddagger}$	$E_i(\text{level})$	J_i^{π}	E_f	J_f^{π}	Mult. [§]	$\delta^{\S}$	$\alpha^@$	$I_{(\gamma+ce)}$	Comments
9.9 2		9.93	3/2 ⁺	0.0	1/2 ⁺	[M1]		278 18	>250	E_{γ} : observed as M-conversion line in singles and ce-γ coin by 1975Be17. $I_{(\gamma+ce)}$: from intensity balance by evaluators.
44.7 2		248.59	5/2 ⁺	203.77	3/2 ⁺	M1+E2	0.15 2	18.2 13	5	L3/L12=0.14 3; M/L12=0.37 7 $I_{(\gamma+ce)}$: from intensity balance (1996Wo04). $\delta=0.14$ 2 from ce data in the present experiment.
59.2 2		307.77	5/2 ⁺	248.59	5/2 ⁺	M1+E2	0.3 2	3.7 15	3	$I_{(\gamma+ce)}$: from 1996Wo04.
77.9 2		325.10	9/2 ⁻	247.25	11/2 ⁻				>140	M/L12=0.29 7; L3/L12≤0.15; L/M=4.2 4 $I_{(\gamma+ce)}$: from intensity balance. $\delta<0.6$ from ce data in the present experiment.
104 1		307.77	5/2 ⁺	203.77	3/2 ⁺	M1+E2	0.7 +4-5	2.6 5		L12/K=0.25 9; M/K=0.09 9; L3/K≤0.06
135 1		647.13	7/2 ⁺	512.43	7/2 ⁺					$\alpha(K)\text{exp}=0.26$ 7; L12/K=1.00 24;
166.5 2	70 15	491.51	5/2 ⁻	325.10	9/2 ⁻	E2		0.714		L3/K=0.56 15; M/K=0.50 14; n/K=0.17 6 $\alpha(K)\text{exp}=0.14$ 5
176.3 2	9.8 25	483.99	7/2 ⁻	307.77	5/2 ⁺	E1		0.0988		
(194)	<0.7	203.77	3/2 ⁺	9.93	3/2 ⁺					
195.6 4	1.4 5	1254.23	5/2 ⁻ , 7/2 ⁻	1058.73	3/2 ⁻	E2		0.404 7		$\alpha(K)\text{exp}=0.79$ 25; L12/K=0.67 19
203.9 2	89 10	203.77	3/2 ⁺	0.0	1/2 ⁺	M1+E2	0.63 +14-15	0.79 6		$\alpha(K)\text{exp}=0.63$ 9; L12/K=0.18 3; L3/K=0.041 6; K/L=6.1 6; M/K=0.042 7 L3/K taken from Table 2 of 1996Wo04 as the value listed in authors' Table 3 seems a misprint. $\delta=0.67$ +14-15 from ce data in the present experiment.
217 1	2.9 8	1104.79	3/2 ⁻	887.2	(3/2, 5/2) ⁻	M1(+E2)	<1.3	0.64 17		$\alpha(K)\text{exp}=0.52$ 18
229 1	3.7 15	1116.05	7/2 ⁻ , 5/2 ⁻	887.2	(3/2, 5/2) ⁻	M1+E2	0.8 3	0.52 9		$\alpha(K)\text{exp}=0.41$ 8
235 1	15 5	483.99	7/2 ⁻	248.59	5/2 ⁺	E1		0.0484 9		Mult.: $\alpha(K)\text{exp}\leq 0.04$ from ^{189m} Hg ε decay; ≈ 0.03 from ^{189g} Hg ε decay (1996Wo04).
236 1	48 7	483.99	7/2 ⁻	247.25	11/2 ⁻	E2		0.216 5		$\alpha(K)\text{exp}=0.19$ 6; L12/K=0.69 26; M/K=0.33 16
238.7 2	47 6	248.59	5/2 ⁺	9.93	3/2 ⁺	M1+E2	2.3 3	0.274 18		$\alpha(K)\text{exp}=0.20$ 3; L12/K=0.33 6; L3/K=0.11 2

$\gamma(^{189}\text{Au})$ (continued)

E_γ †	I_γ ‡	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. §	δ §	α @	Comments
248.7 2	49 6	248.59	5/2 ⁺	0.0	1/2 ⁺	E2		0.182	Other: $\alpha(\text{K})_{\text{exp}}=0.21$ 2.
264.0 2	4.9 10	512.43	7/2 ⁺	248.59	5/2 ⁺	M1+E2	0.4 +2–3	0.43 5	$\delta=2.2$ +5–4 from ce data in the present experiment.
268.8 3	7.2 14	1156.0	(5/2 [–] , 7/2 [–])	887.2	(3/2, 5/2) [–]	M1+E2	1.7 +12–8	0.221 91	$\alpha(\text{K})_{\text{exp}}=0.11$ 2; L3/K=0.20 4; M/K=0.23 5
279.3 2	13.4 20	770.73	7/2 [–]	491.51	5/2 [–]	M1+E2	0.9 2	0.28 4	$\alpha(\text{K})_{\text{exp}}=0.37$ 9; L12/K=0.20 5; L3/K<0.02; M/K=0.031 4
290 1	4.0 15	1104.79	3/2 [–]	814.3	1/2 [–]	M1		0.364 7	$\delta<0.3$ from ce data in the present experiment.
295 ^a	<0.7	602.92	1/2 ⁺ , 3/2 ⁺	307.77	5/2 ⁺				$\alpha(\text{K})_{\text{exp}}=0.26$ 6; L12/K=0.27 5; L3/K=0.15 5
297.9 2	100 10	307.77	5/2 ⁺	9.93	3/2 ⁺	M1(+E2)	<0.8	0.29 5	$\alpha(\text{K})_{\text{exp}}=0.22$ 4
(308)	<3	307.77	5/2 ⁺	0.0	1/2 ⁺				$\alpha(\text{K})_{\text{exp}}=0.35$ 8
308 1	1.0 & 5	512.43	7/2 ⁺	203.77	3/2 ⁺	E2		0.0947 16	E_γ : from level scheme Fig. 13 in 1996Wo04.
322.9 3	40 6	814.3	1/2 [–]	491.51	5/2 [–]	E2		0.0825	$\alpha(\text{K})_{\text{exp}}=0.24$ 3; K/L=6.8 15; L12/K=0.175 25; M/K=0.048 8; L3/K<0.03
(334)	<0.6	1104.79	3/2 [–]	770.73	7/2 [–]				$\alpha(\text{K})_{\text{exp}}\leq 0.17$
345.2 3	6.7 12	1116.05	7/2 [–] , 5/2 [–]	770.73	7/2 [–]	M1		0.227	Mult.: E2(+M1), $\delta>0.9$ from 1996Wo04, but $\Delta J=2$ requires pure E2.
356 ^a	<0.3	602.92	1/2 ⁺ , 3/2 ⁺	248.59	5/2 ⁺				$\alpha(\text{K})_{\text{exp}}=0.050$ 13; L12/K=0.50 2; L3/K=0.2 1; M/K=0.15 10
378.3 3	2.3 7	862.2	9/2 [–]	483.99	7/2 [–]	M1(+E2)	<0.5	0.165 13	$\alpha(\text{K})_{\text{exp}}=0.19$ 6
385 1	4.8 10	1156.0	(5/2 [–] , 7/2 [–])	770.73	7/2 [–]	M1		0.169 3	E_γ : from level scheme Fig. 13 in 1996Wo04.
(392)	<0.5	1254.23	5/2 [–] , 7/2 [–]	862.2	9/2 [–]				$\alpha(\text{K})_{\text{exp}}=0.14$ 1; L12/K=0.22 4; M/K=0.058 20; L3/K<0.007
395.7 2	34 5	887.2	(3/2, 5/2) [–]	491.51	5/2 [–]	M1+E2	1.1 +4–3	0.097 18	$\alpha(\text{K})_{\text{exp}}=0.15$ 6
399 [#] 1	6.0 [#] 20	602.92	1/2 ⁺ , 3/2 ⁺	203.77	3/2 ⁺	M1+E2	1.0 +5–4	0.100 26	$\alpha(\text{K})_{\text{exp}}=0.074$ 14; L12/K=0.15 8; L3/K $\approx$ 0.05
399 [#] 1	7.6 [#] 20	647.13	7/2 ⁺	248.59	5/2 ⁺	M1		0.1539	$\alpha(\text{K})_{\text{exp}}=0.08$ 2
419.5 3	12.4 25	911.0	7/2 [–]	491.51	5/2 [–]	M1+E2	0.8 +5–4	0.098 24	$\alpha(\text{K})_{\text{exp}}=0.09$ 4
443.4 4	1.0 & 5	647.13	7/2 ⁺	203.77	3/2 ⁺				$\delta<2.1$ from ce data in the present experiment.
445.6 2	14.8 20	770.73	7/2 [–]	325.10	9/2 [–]	M1+E2	0.8 3	0.083 16	$\alpha(\text{K})_{\text{exp}}=0.11$ 3; L12/K=0.23 8
456 1	2.3 7	1058.73	3/2 [–]	602.92	1/2 ⁺ , 3/2 ⁺				$\delta<0.9$ from ce data in the present experiment.
472 1	2.7 8	1286.3		814.3	1/2 [–]				$\alpha(\text{K})_{\text{exp}}=0.068$ 11; L12/K=0.22 5
502.3 3	12 2	512.43	7/2 ⁺	9.93	3/2 ⁺	E2		0.0255	
504 1	2.9 9	811.79	(5/2, 3/2, 1/2) ⁺	307.77	5/2 ⁺				$\alpha(\text{K})_{\text{exp}}\approx 0.025$
544.7 ^a 3	3.6 9	1431.9		887.2	(3/2, 5/2) [–]				
553 1	1.8 9	801.96	1/2 ⁺ , 3/2 ⁺	248.59	5/2 ⁺				
557 1	2.7 8	1371.3		814.3	1/2 [–]				

$\gamma(^{189}\text{Au})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^\ddagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [§]	$\delta^\S$	$\alpha^@$	Comments
571 1	2.5 12	879.67	+	307.77	5/2 ⁺				
574.8 3	29 4	1058.73	3/2 ⁻	483.99	7/2 ⁻	E2		0.0186	$\alpha(\text{K})\text{exp}=0.019$ 3
585.9 3	5.5 12	911.0	7/2 ⁻	325.10	9/2 ⁻	M1		0.0558	$\alpha(\text{K})\text{exp}=0.047$ 12
593 ^a	<0.4	602.92	1/2 ⁺ , 3/2 ⁺	9.93	3/2 ⁺				E_γ : from level scheme Fig. 13 in 1996Wo04.
595 1	2.0 10	1107.4		512.43	7/2 ⁺				
598.4 3	8.7 15	801.96	1/2 ⁺ , 3/2 ⁺	203.77	3/2 ⁺	M1+E2	≈1.0	≈0.0349	$\alpha(\text{K})\text{exp}\approx 0.03$
603.0 2	21 3	602.92	1/2 ⁺ , 3/2 ⁺	0.0	1/2 ⁺	M1		0.0518	$\alpha(\text{K})\text{exp}=0.050$ 9; M/K=0.07 3; L3/K<0.03
608.5 4	2.5 12	811.79	(5/2, 3/2, 1/2) ⁺	203.77	3/2 ⁺	E2(+M1)	>2	0.020 4	$\alpha(\text{K})\text{exp}=0.013$ 5
613.2 2	12.9 25	1104.79	3/2 ⁻	491.51	5/2 ⁻	M1(+E2)	<0.8	0.043 7	$\alpha(\text{K})\text{exp}=0.04$ 1
614.8 3	1.7& 6	862.2	9/2 ⁻	247.25	11/2 ⁻	M1		0.0492	$\alpha(\text{K})\text{exp}=0.041$ 5; L12/K=0.19 3
624.6 2	5.5 20	1116.05	7/2 ⁻ , 5/2 ⁻	491.51	5/2 ⁻	M1		0.0473	Mult.: $\alpha(\text{K})\text{exp}=0.055$ 1 from ^{189g} Hg ε decay (1996Wo04). Other: $\alpha(\text{K})\text{exp}=0.019$ 5 from ¹⁸⁹ Hg ε decay (7.6 min+8.6 min) (1975Be17), implies a M1+E2 transition of $\delta\approx 1.8$.
637.2 1	1.0& 5	647.13	7/2 ⁺	9.93	3/2 ⁺	E2		0.01469	$\alpha(\text{K})\text{exp}=0.008$ 2
664 1	7.4 15	1156.0	(5/2 ⁻ , 7/2 ⁻)	491.51	5/2 ⁻	M1+E2	≈0.4	≈0.0366	$\alpha(\text{K})\text{exp}\approx 0.03$
670 1	3.3 9	977.8		307.77	5/2 ⁺				
675.9 2	11.2 20	879.67	+	203.77	3/2 ⁺	E2(+M1)			$\alpha(\text{K})\text{exp}\approx 0.01$
751.1 3	2.3 7	1058.73	3/2 ⁻	307.77	5/2 ⁺				
770.2 2	13.5 20	1254.23	5/2 ⁻ , 7/2 ⁻	483.99	7/2 ⁻	M1		0.0275	$\alpha(\text{K})\text{exp}=0.027$ 4 Other: $\alpha(\text{K})\text{exp}=0.007$ 2 from ¹⁸⁹ Hg ε decay (7.6 min+8.6 min) (1975Be17), implies a pure E2 transition.
791.7 3	2.5 7	801.96	1/2 ⁺ , 3/2 ⁺	9.93	3/2 ⁺				
802 1	2.0 10	811.79	(5/2, 3/2, 1/2) ⁺	9.93	3/2 ⁺				
802.1 3	8.0 15	801.96	1/2 ⁺ , 3/2 ⁺	0.0	1/2 ⁺	M1(+E2)	<0.8	0.022 4	$\alpha(\text{K})\text{exp}=0.021$ 5
809.6 3	3.6 9	1058.73	3/2 ⁻	248.59	5/2 ⁺				
811.5 3	2.4 8	811.79	(5/2, 3/2, 1/2) ⁺	0.0	1/2 ⁺				
825.8 5	1.8 6	1133.6		307.77	5/2 ⁺				
844 1	2.0 10	1755.0		911.0	7/2 ⁻				
848 [#] 1	3.0 [#] 10	1156.0	(5/2 ⁻ , 7/2 ⁻)	307.77	5/2 ⁺	[E1]		0.00299	Mult.: M1 in 2003Wu02 evaluation is inconsistent with $\Delta J\pi$; $\alpha(\text{K})\text{exp}=0.037$ 12 is consistent with M1 for the second component from the 2101.8 level.
848 [#] 1	3.0 [#] 10	2101.8	(⁻)	1254.23	5/2 ⁻ , 7/2 ⁻	(M1)		0.0215	$\alpha(\text{K})\text{exp}=0.037$ 12
855.5 4	4.8 10	1058.73	3/2 ⁻	203.77	3/2 ⁺	E1		0.00295	$\alpha(\text{K})\text{exp}<0.004$
894.9 5	1.7 6	1098.1		203.77	3/2 ⁺				
900.4 3	4.5 5	2154.6	-	1254.23	5/2 ⁻ , 7/2 ⁻	M1(+E2)			I_γ : from table 3 of 1996Wo04. Mult.: $\alpha(\text{K})\text{exp}=0.020$ 8 if $I_\gamma=2.5$ 10 is used. However, if $I_\gamma=4.5$ 5 from table 4 is used, $\alpha(\text{K})\text{exp}=0.011$ 4 and $\delta=0.9+16-8$.
^x 912.0 7	2.1 15								
917.1 5	1.8 5	1165.7		248.59	5/2 ⁺				

$\gamma(^{189}\text{Au})$ (continued)

E_γ †	I_γ ‡	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. §	δ §	α @	Comments
918.8 3	5.3 6	2074.7	(⁻)	1156.0	(5/2 ⁻ , 7/2 ⁻)	M1+E2	0.8 +8-6	0.0133 38	$\alpha(\text{K})\text{exp}=0.011$ 3
926 1	2.1 7	2030.88		1104.79	3/2 ⁻				
933.4 ^a 4	2.4 5	2030.88		1098.1					
936.6 3	7.5 8	2092.8	-	1156.0	(5/2 ⁻ , 7/2 ⁻)	M1		0.01669	$\alpha(\text{K})\text{exp}=0.016$ 3
946.3 3	2.5 10	1254.23	5/2 ⁻ , 7/2 ⁻	307.77	5/2 ⁺				
952 ^a 1	2.0 7	1156.0	(5/2 ⁻ , 7/2 ⁻)	203.77	3/2 ⁺				
952 1	5.3 6	1862.9	-	911.0	7/2 ⁻	M1		0.01601	$\alpha(\text{K})\text{exp}=0.017$ 4
958.6 3	5.4 6	2074.7	(⁻)	1116.05	7/2 ⁻ , 5/2 ⁻	M1		0.01573	$\alpha(\text{K})\text{exp}=0.015$ 4
969.0 3	4.1 10	2074.05	-	1104.79	3/2 ⁻				
972 1	1.5 6	2030.88		1058.73	3/2 ⁻				
977.7 3	3.4 3	2093.62	-	1116.05	7/2 ⁻ , 5/2 ⁻	M1		0.01496	$\alpha(\text{K})\text{exp}=0.026$ 6
995.5 ^a 4	2.0 10	2101.46		1104.79	3/2 ⁻				
1004.2 3	3.1 8	2258.7		1254.23	5/2 ⁻ , 7/2 ⁻				
1007.7 2	11.0 11	2066.48	3/2 ⁻ , 5/2 ⁻	1058.73	3/2 ⁻	M1		0.01386	$\alpha(\text{K})\text{exp}=0.013$ 2
1015.3 3	9.2 10	2074.05	-	1058.73	3/2 ⁻	M1		0.01360	$\alpha(\text{K})\text{exp}=0.011$ 3
1034.6 3	7.5 8	2093.62	-	1058.73	3/2 ⁻	M1		0.01296	$\alpha(\text{K})\text{exp}=0.016$ 3
1048 1	1.4 5	1058.73	3/2 ⁻	9.93	3/2 ⁺				
1057 1	1.8 5	1260.8		203.77	3/2 ⁺				
1058.5 3	9.7 10	1058.73	3/2 ⁻	0.0	1/2 ⁺	E1		0.00199	$\alpha(\text{K})\text{exp}\leq 0.0016$
1087.9 3	4.1 10	1098.1		9.93	3/2 ⁺				
1096.6 4	2.3 7	2155.3		1058.73	3/2 ⁻				
1142.8 4	1.9 6	1346.6		203.77	3/2 ⁺				
1155.1 4	3.0 8	1358.9		203.77	3/2 ⁺				
1165 1	2.4 8	1165.0		0.0	1/2 ⁺				
1179 1	1.0 5	2066.2		887.2	(3/2, 5/2) ⁻				
1200 1	2.0 7	2258.7		1058.73	3/2 ⁻				
1221 [#] 1	2.0 [#] 7	2034.7		814.3	1/2 ⁻				
1221 [#] 1	2.0 [#] 9	2101.46		879.67	+				
1259.9 3	4.5 10	2074.05	-	814.3	1/2 ⁻				
1272.1 5	2.9 8	1476.1		203.77	3/2 ⁺				
1278 1	3.1 8	2092.8	-	814.3	1/2 ⁻				
1283 ^a 1	2.0 12	1767.0		483.99	7/2 ⁻				
1299.5 6	1.8 10	2101.46		801.96	1/2 ⁺ , 3/2 ⁺				
1331.0 3	2.6 8	2101.46		770.73	7/2 ⁻				
1367 1	2.0 10	1851.0		483.99	7/2 ⁻				
1379.4 2	8.6 20	1863.4		483.99	7/2 ⁻				
1428.1 2	6.3 12	2030.88		602.92	1/2 ⁺ , 3/2 ⁺				
1431.7 3	2.0 7	2034.7		602.92	1/2 ⁺ , 3/2 ⁺				
1454.4 3	5.5 12	2101.46		647.13	7/2 ⁺				
1463.5 3	4.5 10	2066.48	3/2 ⁻ , 5/2 ⁻	602.92	1/2 ⁺ , 3/2 ⁺				

γ(¹⁸⁹Au) (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>
1466.3 4	2.8 8	1476.1		9.93	3/2 ⁺
1471 1	2.8 15	2074.05	–	602.92	1/2 ⁺ , 3/2 ⁺
1476.1 3	3.5 9	1960.1		483.99	7/2 [–]
1487 1	1.7 10	1970.8		483.99	7/2 [–]
1555 1	2.5 8	1862.9	–	307.77	5/2 ⁺
1559.8 3	2.7 8	1808.4		248.59	5/2 ⁺
1570 1	3.2 11	2061.5		491.51	5/2 [–]
1571.3 5	3.0 8	1879.0		307.77	5/2 ⁺
1589.4 4	2.7 8	2101.8	(–)	512.43	7/2 ⁺
1663.0 4	3.9 9	1970.8		307.77	5/2 ⁺
1664.9 4	2.7 8	1913.5		248.59	5/2 ⁺
1675.2 3	4.3 10	1879.0		203.77	3/2 ⁺
1766.4 3	14.5 15	2074.05	–	307.77	5/2 ⁺
1786.0 5	4.6 10	2093.62	–	307.77	5/2 ⁺
1787.5 5	2.5 10	2036.1		248.59	5/2 ⁺
1793.8 4	3.0 10	2101.8	(–)	307.77	5/2 ⁺
1802 1	2.0 10	2109.8		307.77	5/2 ⁺
1818.3 5	2.5 10	2066.48	3/2 [–] , 5/2 [–]	248.59	5/2 ⁺
1826.6 4	2.4 8	2030.88		203.77	3/2 ⁺
1845.3 5	2.0 6	2093.62	–	248.59	5/2 ⁺
1862.7 3	4.4 10	2066.48	3/2 [–] , 5/2 [–]	203.77	3/2 ⁺
1895.9 5	3.5 12	2099.7		203.77	3/2 ⁺
1908.8 4	2.0 7	2157.4		248.59	5/2 ⁺
2006 1	1.8 9	2209.8		203.77	3/2 ⁺
2021.5 3	15.3 15	2031.0		9.93	3/2 ⁺
2030.3 4	4.6 10	2031.0		0.0	1/2 ⁺
2034.2 3	16.2 16	2034.2		0.0	1/2 ⁺
2091.3 4	4.8 10	2101.46		9.93	3/2 ⁺
2093.2 4	4.6 10	2092.8	–	0.0	1/2 ⁺
2101.3 3	4.2 10	2101.46		0.0	1/2 ⁺
^x 2181.6 4	2.6 8				
2249.1 4	2.1 7	2258.7		9.93	3/2 ⁺

[†] From 1996Wo04, except as noted.[‡] Values are from table 3 of 1996Wo04 except for E_γ=900.4, 918.8, 936.6, 952, 958.6, 977.7, 1007.7, 1015.3, 1034.6, 1058.5, which are taken from more precise values quoted in authors' table 4, and in Sept. 5, 2003 communication with J. Wood, as noted by S. -C. Wu in 2003-NDS.[§] From Adopted Gammas, where the multipolarity and mixing ratios are based mainly on the conversion electron measurements in 1996Wo04.[&] Estimated from ^{189m}Hg ε decay.[@] From BrIcc v2.3b (16-Dec-2014) 2008Ki07, “Frozen Orbitals” appr.[#] Multiply placed with intensity suitably divided.^a Placement of transition in the level scheme is uncertain.^x γ ray not placed in level scheme.

^{189}Hg ε decay (7.6 min) 1996Wo04

Decay Scheme

Intensities: Relative I_γ

@ 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)

$3/2^-$ 0 7.6 min 2
 $Q=3960$ 40
 $^{189}_{80}\text{Hg}_{109}$
 $\% \varepsilon=100$

30 ns 4
28.7 min 4

 $^{189}_{79}\text{Au}_{110}$

^{189}Hg ε decay (7.6 min) 1996Wo04

Decay Scheme (continued)

Intensities: Relative I_γ

@ Multiply placed: intensity suitably divided

Legend

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

$3/2^-$ 0 7.6 min 2
 $Q=3960.40$
 $^{189}\text{Hg}_{109}$
 80

0.30 ns 3
 0.15 ns 5

30 ns 4
 28.7 min 4

 $^{189}_{79}\text{Au}_{110}$

^{189}Hg ϵ decay (7.6 min) 1996Wo04

Decay Scheme (continued)

Intensities: Relative I_γ

@ 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)

$3/2^-$ 0 7.6 min 2
 $Q=3960.40$
 $^{189}_{80}\text{Hg}_{109}$
 $\% \epsilon = 100$

0.30 ns 3
0.15 ns 5

30 ns 4
28.7 min 4

^{189}Hg ε decay (7.6 min) 1996Wo04

Decay Scheme (continued)

Intensities: Relative I_γ

@ Multiplied: intensity suitably divided

Legend

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

$^{189}\text{Au}_{110}$

^{189}Hg ε decay (7.6 min) 1996Wo04

Decay Scheme (continued)

Legend

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

Intensities: Relative I_γ
 @ Multiply placed: intensity suitably divided

$3/2^-$ 0 7.6 min 2
 $Q=3960$ 40
 $^{189}\text{Hg}_{109}$
 $\% \varepsilon=100$

^{189}Hg ε decay (8.6 min) 1996Wo04

Parent: ^{189}Hg : $E=0.0+x$; $J^\pi=13/2^+$; $T_{1/2}=8.6$ min 2; $Q(\varepsilon)=3960$ 40; $\% \varepsilon + \% \beta^+$ decay=100

^{189}Hg -E, J^π , $T_{1/2}$: From ^{189}Hg Adopted Levels. From mass doublet, energy of the isomer is 80 30 (2017Au03), which is used in obtaining log ft values.

^{189}Hg -Q(ε): From 2017Wa10.

1996Wo04: $^{180}\text{Hf}(^{16}\text{O},7n)$, mass separated ^{189m}Hg samples. Measured $E\gamma$, $I\gamma$, I_{ce} , $\gamma\gamma$, $ce\gamma$, $\gamma(x$ ray) and $e(x$ ray) coincidences.

Deduced levels, $J\pi$. Ge(Li) and Si(Li) detectors. See also, 1976Wo10 from several of the same authors as in 1996Wo04.

1988Ko22: ^{189}Au structure from ε decay of ^{189g}Hg and ^{189m}Hg produced by heavy ion induced reaction. Measured $\gamma\gamma$, $\gamma(x$ ray), $\gamma(ce)$, and $ce(x$ ray) coincidences. Ge(Li), Si(Li) detectors. Deduced band structure. Several authors on this paper are the same as in 1996Wo04.

1975Be17: ^{189g}Hg , ^{189m}Hg from $\text{Pb}(p,xn3p)$, mass separated. Measured $E\gamma$, $I\gamma$, I_{ce} , $\gamma\gamma$, $ce-\gamma$. Deduced levels, $J\pi$, $T_{1/2}$. Ge(Li), Si(Li) and magnetic spectrometer.

 ^{189}Au Levels

E(level) [†]	J^π [‡]	$T_{1/2}$ [‡]	Comments
0.0 [#]	1/2 ⁺	28.7 min 4	
9.95 [#] 12	3/2 ⁺	30 ns 4	$T_{1/2}$: from $ce(x$ ray)(t) and $ce-ce(t)$ (1975Be17).
203.81 [#] 14	3/2 ⁺		
247.25 [@] 16	11/2 ⁻	4.59 min 11	$\%IT=?$; $\% \varepsilon + \% \beta^+ \approx 100$ E(level): from Adopted Levels.
248.57 [#] 12	5/2 ⁺		
307.78 [#] 13	5/2 ⁺		
325.13 ^{&} 10	9/2 ⁻	190 ns 15	$T_{1/2}$: from $ce(x$ ray)(t) (1975Be17).
484.04 [@] 15	7/2 ⁻	0.15 ns 5	$T_{1/2}$: from $ce(\gamma)(t)$ (1975Be17).
491.58 ^{&} 17	5/2 ⁻	0.30 ns 3	$T_{1/2}$: from $ce(\text{Compton continuum in } 120\text{-}300 \text{ keV region})(t)$ (1975Be17).
512.39 [#] 14	7/2 ⁺		
646.18 ^{&} 10	13/2 ⁻		
647.29 [#] 14	7/2 ⁺		
681.89 [@] 11	15/2 ⁻		
712.73 ^{&} 11	11/2 ⁻		
760.70 [#] 14	9/2 ⁺		
770.72 ^{&} 17	7/2 ⁻		
812.3 4	(5/2,3/2,1/2) ⁺		
812.67 [@] 10	13/2 ⁻		
847.94 [#] 18	9/2 ⁺		
862.06 [@] 12	9/2 ⁻		
880.46 20	9/2 ⁻		
911.02 21	7/2 ⁻		
961.28 19	(5/2,3/2) ⁺		
1097.04 16	13/2 ⁻		
1105.28 ^{&} 20	17/2 ⁻		
1106.60 24	(5/2 ⁺ ,3/2 ⁺)		
1112.51 [#] 17	11/2 ⁺		
1130.11 13	11/2 ⁻		
1133.58 21	9/2 ⁻		
1145.71 ^{&} 16	13/2 ⁻ ,15/2 ⁻		
1188.60 [@] 14	11/2 ⁻		
1193.56 20	-		
1247.2 3	(9/2,7/2) ⁺		
1273.21 20	11/2 ⁻		
1295.52 21	11/2 ⁻		

Continued on next page (footnotes at end of table)

^{189}Hg ε decay (8.6 min) [1996Wo04](#) (continued) ^{189}Au Levels (continued)

E(level) [†]	J^{π} [‡]	Comments
1298.92 [#] 14	11/2 ⁺	
1312.98 21	13/2 ⁻	
1352.6 3	(15/2,13/2,11/2) ⁻	
1365.3 5		
1368.08 [@] 22	(17/2,13/2,15/2) ⁻	
1376.2 10	-	
1383.25 ^{&} 13	13/2 ⁺	
1411.9 [@] 10	19/2 ⁻	
1419.83 [#] 18	(13/2,11/2) ⁺	
1456.3 10	+	
1460.00 17	11/2 ⁺	
1463.9 5	-	
1481.6 3	13/2 ⁻	
1483.4 3	(7/2) ⁺	
1488.9 3	(7/2,11/2) ⁻	
1516.7 10	-	
1523.4 3	(⁻)	J^{π} : in Figure 10 of 1996Wo04 , the association of the decay of this level with the 11/2 ⁻ isomeric level, indirectly fed via the 841 keV γ leads the authors to assign a negative parity.
1523.8 8	+	
1525.0 4	-	
1534.79 12	13/2 ⁺	
1559.1 3	-	
1559.85 17	-	
1580.4 5	-	
1595.4 10		
1597.2 10		
1601.20 14	13/2 ⁺ ,15/2 ⁺	
1654.20 21	13/2 ⁻ ,15/2 ⁻	
1730.6 4		
1739.4 3	13/2 ⁺ ,15/2 ⁺	
1745.6 11		
1756.7 4	-	
1760.2 4		
1764.3 4		
1774.5 6		
1788.3 8	(⁺)	
1800.5 5	15/2 ⁺	
1822.2 4	-	
1835.1 3	(13/2 ⁺ ,15/2 ⁺)	
1877.1 5	-	
1905.2 10		
1935.02 14	+	
1939.01 15	+	
2045.8 4	+	
2094.0 4		
2113.8 3		
2145.0 3		
2163.4 6	+	
2165.21 19	+	
2169.19 15	(⁺)	
2169.6 3	(⁺)	
2176.2 8	+	
2176.8 3		

Continued on next page (footnotes at end of table)

^{189}Hg ε decay (8.6 min) **1996Wo04** (continued) ^{189}Au Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$
2178.0 11		2273.1 7		2335.14 25	(⁺)
2200.9 10		2274.1 3		2335.7 10	
2211.01 19	+	2274.6 5		2336.1 11	
2239.9 11		2275.7 3	+	2338.6 10	
2240.96 14	(⁺)	2276.62 16	+	2339.7 4	
2251.9 5		2281.00 19		2349.2 10	
2255.1 10		2281.9 8		2370.2 5	
2257.20 16	(⁻)	2293.9 3		2384.7 3	
2257.55 16	(⁺)	2295.00 18	+	2405.9 10	
2264.0 11		2295.7 6		2417.1 4	
2264.81 16	(⁺)	2311.3 3		2417.9 10	
2268.0 11		2316.0 3		2436.3 4	
2268.98 18		2317.14 23	+	2483.7 10	
2269.7 4		2317.51 21	+	2492.1 5	
2271.0 3	+	2325.0 11		2608.9 5	
2272.17 12	+	2330.9 10			

[†] From least-squares fit to $E\gamma$ values.[‡] From Adopted Levels unless otherwise stated.# $\pi(s_{1/2}, d_{3/2}, d_{5/2})$ structure.@ $\pi h_{11/2}^{-1}$ structure.& $\pi(h_{9/2}, i_{13/2})$ structure. ε, β^+ radiations

ε and β^+ branching ratios are not available experimentally. The evaluators use a similar case of ^{191}Hg ε decay to estimate the decay branching ratios and $\log ft$ values. The branching ratio for ^{191}Hg ε decay to the ^{191}Au isomeric state of $J\pi=11/2^-$ at 266 keV is 9% 5. It is assumed that the $\varepsilon+\beta^+$ feeding to the 247.4 keV state is $\approx 10\%$. Other $\varepsilon+\beta^+$ feedings are from intensity balances.

The γ transition intensity balance gives following apparent $\varepsilon+\beta^+$ feedings for low-spin ($J \leq 7/2$) levels in ^{189}Au , but $\Delta J\pi$ implied for β transitions does not allow any such feedings: $\approx 0.7\%$ for 203.8, $3/2^+$; $\approx 1.3\%$ for 248.6, $5/2^+$; $\approx 1.0\%$ for 307.8, $5/2^+$; $\approx 0.7\%$ for 484.0, $7/2^-$; $\approx 1.4\%$ for 491.6, $5/2^-$; $\approx 1.7\%$ for 512.4, $7/2^+$; $\approx 0.8\%$ for 770.7, $7/2^-$; $\approx 0.2\%$ for 812.3, $<5/2$; $\approx 0.3\%$ for 911.0, $7/2^-$; $\approx 0.6\%$ for 961.3, $(5/2, 7/2)$; $\approx 0.3\%$ for 1106.6, $(3/2^+, 5/2^+)$. All these feedings, which add to a total of $\approx 9\%$, are set to zero in the decay scheme. Note that there are still 25 unplaced γ rays with a total absolute intensity of $\approx 3\%$ which may be responsible for some of the above imbalances.

E(decay)	E(level)	$I\beta^+$ [†]	$I\varepsilon$ [†]	Log ft	$I(\varepsilon+\beta^+)$ [†]
(1.35×10^3 4)	2608.9		≈ 0.06	≈ 7.7	≈ 0.06
(1.47×10^3 4)	2492.1	≈ 0.0001	≈ 0.10	≈ 7.5	≈ 0.1
(1.48×10^3 4)	2483.7	$\approx 7. \times 10^{-5}$	≈ 0.06	≈ 7.7	≈ 0.06
(1.52×10^3 4)	2436.3	$\approx 9. \times 10^{-5}$	≈ 0.06	≈ 7.8	≈ 0.06
(1.54×10^3 4)	2417.9	$\approx 9. \times 10^{-5}$	≈ 0.05	≈ 7.9	≈ 0.05
(1.54×10^3 4)	2417.1	≈ 0.0002	≈ 0.10	≈ 7.6	≈ 0.1
(1.55×10^3 4)	2405.9	$\approx 8. \times 10^{-5}$	≈ 0.04	≈ 8.0	≈ 0.04
(1.58×10^3 4)	2384.7	≈ 0.0004	≈ 0.2	≈ 7.3	≈ 0.2
(1.59×10^3 4)	2370.2	≈ 0.0001	≈ 0.06	≈ 7.8	≈ 0.06
(1.61×10^3 4)	2349.2	≈ 0.0003	≈ 0.10	≈ 7.6	≈ 0.1
(1.62×10^3 4)	2339.7	≈ 0.0003	≈ 0.10	≈ 7.6	≈ 0.1
(1.62×10^3 4)	2338.6	≈ 0.0002	≈ 0.07	≈ 7.7	≈ 0.07
(1.62×10^3 4)	2336.1	≈ 0.0003	≈ 0.10	≈ 7.6	≈ 0.1

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^{189}Hg ε decay (8.6 min) 1996Wo04 (continued) ε, β^+ radiations (continued)

E(decay)	E(level)	$I\beta^+ \uparrow$	$I\varepsilon \uparrow$	Log ft	$I(\varepsilon + \beta^+) \uparrow$
(1.62×10^3 4)	2335.7	≈ 0.0003	≈ 0.10	≈ 7.6	≈ 0.1
(1.62×10^3 4)	2335.14	≈ 0.002	≈ 0.8	≈ 6.7	≈ 0.8
(1.63×10^3 4)	2330.9	≈ 0.0002	≈ 0.06	≈ 7.8	≈ 0.06
(1.64×10^3 4)	2325.0	≈ 0.0003	≈ 0.10	≈ 7.6	≈ 0.1
(1.64×10^3 4)	2317.51	≈ 0.0038	≈ 1.2	≈ 6.5	≈ 1.2
(1.64×10^3 4)	2317.14	≈ 0.003	≈ 0.8	≈ 6.7	≈ 0.8
(1.64×10^3 4)	2316.0	≈ 0.0010	≈ 0.3	≈ 7.1	≈ 0.3
(1.65×10^3 4)	2311.3	≈ 0.0010	≈ 0.3	≈ 7.1	≈ 0.3
(1.66×10^3 4)	2295.7	≈ 0.0002	≈ 0.06	≈ 7.8	≈ 0.06
(1.67×10^3 4)	2295.00	≈ 0.0079	≈ 2.2	≈ 6.3	≈ 2.2
(1.67×10^3 4)	2293.9	≈ 0.0007	≈ 0.2	≈ 7.3	≈ 0.2
(1.68×10^3 4)	2281.9	≈ 0.0008	≈ 0.2	≈ 7.3	≈ 0.2
(1.68×10^3 4)	2281.00	≈ 0.0077	≈ 2.0	≈ 6.3	≈ 2.0
(1.68×10^3 4)	2276.62	≈ 0.0039	≈ 1.00	≈ 6.6	≈ 1.0
(1.68×10^3 4)	2275.7	≈ 0.001	≈ 0.3	≈ 7.2	≈ 0.3
(1.69×10^3 4)	2274.6	≈ 0.0004	≈ 0.10	≈ 7.6	≈ 0.1
(1.69×10^3 4)	2274.1	≈ 0.001	≈ 0.3	≈ 7.2	≈ 0.3
(1.69×10^3 4)	2273.1	≈ 0.001	≈ 0.3	≈ 7.2	≈ 0.3
(1.69×10^3 4)	2272.17	≈ 0.017	≈ 4.1	≈ 6.0	≈ 4.1
(1.69×10^3 4)	2271.0	≈ 0.0008	≈ 0.2	≈ 7.3	≈ 0.2
(1.69×10^3 4)	2269.7	≈ 0.0004	≈ 0.10	≈ 7.6	≈ 0.1
(1.69×10^3 4)	2268.98	≈ 0.0090	≈ 2.2	≈ 6.3	≈ 2.2
(1.69×10^3 4)	2268.0	≈ 0.0003	≈ 0.07	≈ 7.8	≈ 0.07
(1.70×10^3 4)	2264.81	≈ 0.0075	≈ 1.8	≈ 6.4	≈ 1.8
(1.70×10^3 4)	2264.0	≈ 0.0008	≈ 0.2	≈ 7.3	≈ 0.2
(1.70×10^3 4)	2257.55	≈ 0.0043	≈ 1.00	≈ 6.6	≈ 1.0
(1.70×10^3 4)	2257.20	≈ 0.0069	≈ 1.6	≈ 6.4	≈ 1.6
(1.70×10^3 4)	2255.1	≈ 0.0002	≈ 0.05	≈ 7.9	≈ 0.05
(1.71×10^3 4)	2251.9	≈ 0.0004	≈ 0.10	≈ 7.6	≈ 0.1
(1.72×10^3 4)	2240.96	≈ 0.0047	≈ 1.00	≈ 6.6	≈ 1.0
(1.72×10^3 4)	2239.9	≈ 0.0005	≈ 0.10	≈ 7.6	≈ 0.1
(1.75×10^3 4)	2211.01	≈ 0.002	≈ 0.4	≈ 7.1	≈ 0.4
(1.76×10^3 4)	2200.9	≈ 0.0003	≈ 0.05	≈ 8.0	≈ 0.05
(1.78×10^3 4)	2178.0	≈ 0.0006	≈ 0.10	≈ 7.7	≈ 0.1
(1.78×10^3 4)	2176.8	≈ 0.005	≈ 0.8	≈ 6.8	≈ 0.8
(1.78×10^3 4)	2176.2	≈ 0.0006	≈ 0.10	≈ 7.7	≈ 0.1
(1.79×10^3 4)	2169.6	≈ 0.003	≈ 0.4	≈ 7.1	≈ 0.4
(1.79×10^3 4)	2169.19	≈ 0.010	≈ 1.6	≈ 6.5	≈ 1.6
(1.79×10^3 4)	2165.21	≈ 0.003	≈ 0.5	≈ 7.0	≈ 0.5
(1.80×10^3 4)	2163.4	≈ 0.0007	≈ 0.10	≈ 7.7	≈ 0.1
(1.82×10^3 4)	2145.0	≈ 0.003	≈ 0.4	≈ 7.1	≈ 0.4
(1.85×10^3 4)	2113.8	≈ 0.002	≈ 0.3	≈ 7.2	≈ 0.3
(1.87×10^3 4)	2094.0	≈ 0.003	≈ 0.3	≈ 7.2	≈ 0.3
(1.91×10^3 4)	2045.8	≈ 0.003	≈ 0.3	≈ 7.3	≈ 0.3
(2.02×10^3 4)	1939.01	≈ 0.003	≈ 0.2	≈ 7.5	≈ 0.2
(2.02×10^3 4)	1935.02	≈ 0.01	≈ 0.7	≈ 6.9	≈ 0.7
(2.05×10^3 4)	1905.2	≈ 0.002	≈ 0.10	≈ 7.8	≈ 0.1
(2.08×10^3 4)	1877.1	≈ 0.002	≈ 0.10	≈ 7.8	≈ 0.1
(2.12×10^3 4)	1835.1	≈ 0.01	≈ 0.6	≈ 7.1	≈ 0.6
(2.14×10^3 4)	1822.2	≈ 0.002	≈ 0.10	≈ 7.8	≈ 0.1
(2.16×10^3 4)	1800.5	≈ 0.009	≈ 0.4	≈ 7.2	≈ 0.4
(2.17×10^3 4)	1788.3	≈ 0.005	≈ 0.2	≈ 7.6	≈ 0.2
(2.19×10^3 4)	1774.5	≈ 0.002	≈ 0.10	≈ 7.9	≈ 0.1

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^{189}Hg ε decay (8.6 min) 1996Wo04 (continued) ε, β^+ radiations (continued)

E(decay)	E(level)	$I\beta^+ \dagger$	$I\varepsilon \dagger$	Log ft	$I(\varepsilon + \beta^+) \dagger$	Comments
$(2.20 \times 10^3 \text{ keV})$	1764.3	≈ 0.002	≈ 0.06	≈ 8.1	≈ 0.06	
$(2.20 \times 10^3 \text{ keV})$	1760.2	≈ 0.003	≈ 0.10	≈ 7.9	≈ 0.1	
$(2.20 \times 10^3 \text{ keV})$	1756.7	≈ 0.005	≈ 0.2	≈ 7.6	≈ 0.2	
$(2.21 \times 10^3 \text{ keV})$	1745.6	≈ 0.002	≈ 0.08	≈ 8.0	≈ 0.08	
$(2.22 \times 10^3 \text{ keV})$	1739.4	≈ 0.027	≈ 0.97	≈ 6.9	≈ 1.0	
$(2.23 \times 10^3 \text{ keV})$	1730.6	≈ 0.006	≈ 0.2	≈ 7.6	≈ 0.2	
$(2.31 \times 10^3 \text{ keV})$	1654.20	≈ 0.02	≈ 0.5	≈ 7.2	≈ 0.5	
$(2.36 \times 10^3 \text{ keV})$	1601.20	≈ 0.041	≈ 1.1	≈ 6.9	≈ 1.1	
$(2.36 \times 10^3 \text{ keV})$	1597.2	≈ 0.004	≈ 0.10	≈ 7.9	≈ 0.1	
$(2.36 \times 10^3 \text{ keV})$	1595.4	≈ 0.004	≈ 0.10	≈ 7.9	≈ 0.1	
$(2.38 \times 10^3 \text{ keV})$	1580.4	≈ 0.02	≈ 0.4	≈ 7.3	≈ 0.4	
$(2.40 \times 10^3 \text{ keV})$	1559.85	≈ 0.004	≈ 0.10	≈ 7.9	≈ 0.1	
$(2.40 \times 10^3 \text{ keV})$	1559.1	≈ 0.02	≈ 0.4	≈ 7.3	≈ 0.4	
$(2.43 \times 10^3 \text{ keV})$	1534.79	≈ 0.03	≈ 0.8	≈ 7.1	≈ 0.8	
$(2.44 \times 10^3 \text{ keV})$	1525.0	≈ 0.01	≈ 0.3	≈ 7.5	≈ 0.3	
$(2.44 \times 10^3 \text{ keV})$	1523.8	≈ 0.02	≈ 0.4	≈ 7.4	≈ 0.4	
$(2.44 \times 10^3 \text{ keV})$	1523.4	≈ 0.01	≈ 0.3	≈ 7.5	≈ 0.3	
$(2.44 \times 10^3 \text{ keV})$	1516.7	≈ 0.004	≈ 0.10	≈ 8.0	≈ 0.1	
$(2.47 \times 10^3 \text{ keV})$	1488.9	≈ 0.02	≈ 0.4	≈ 7.4	≈ 0.4	
$(2.48 \times 10^3 \text{ keV})$	1483.4	≈ 0.03	≈ 0.6	≈ 7.2	≈ 0.6	
$(2.48 \times 10^3 \text{ keV})$	1481.6	≈ 0.03	≈ 0.6	≈ 7.2	≈ 0.6	
$(2.50 \times 10^3 \text{ keV})$	1463.9	≈ 0.01	≈ 0.2	≈ 7.7	≈ 0.2	
$(2.50 \times 10^3 \text{ keV})$	1460.00	≈ 0.04	≈ 0.7	≈ 7.1	≈ 0.7	
$(2.50 \times 10^3 \text{ keV})$	1456.3	≈ 0.01	≈ 0.2	≈ 7.7	≈ 0.2	
$(2.54 \times 10^3 \text{ keV})$	1419.83	≈ 0.03	≈ 0.5	≈ 7.3	≈ 0.5	
$(2.55 \times 10^3 \text{ keV})$	1411.9	≈ 0.006	≈ 0.09	≈ 8.0	≈ 0.1	
$(2.58 \times 10^3 \text{ keV})$	1383.25	≈ 0.070	≈ 1.1	≈ 6.9	≈ 1.2	
$(2.58 \times 10^3 \text{ keV})$	1376.2	≈ 0.006	≈ 0.09	≈ 8.0	≈ 0.1	
$(2.59 \times 10^3 \text{ keV})$	1368.08	≈ 0.02	≈ 0.4	≈ 7.4	≈ 0.4	
$(2.59 \times 10^3 \text{ keV})$	1365.3	≈ 0.006	≈ 0.09	≈ 8.0	≈ 0.1	
$(2.61 \times 10^3 \text{ keV})$	1352.6	≈ 0.04	≈ 0.7	≈ 7.2	≈ 0.7	
$(2.65 \times 10^3 \text{ keV})$	1312.98	≈ 0.093	≈ 1.3	≈ 6.9	≈ 1.4	
$(2.66 \times 10^3 \text{ keV})$	1298.92	≈ 0.095	≈ 1.3	≈ 6.9	≈ 1.4	
$(2.66 \times 10^3 \text{ keV})$	1295.52	≈ 0.068	≈ 0.93	≈ 7.1	≈ 1.0	
$(2.69 \times 10^3 \text{ keV})$	1273.21	≈ 0.04	≈ 0.6	≈ 7.3	≈ 0.6	
$(2.71 \times 10^3 \text{ keV})$	1247.2	≈ 0.05	≈ 0.6	≈ 7.2	≈ 0.7	
$(2.77 \times 10^3 \text{ keV})$	1193.56	≈ 0.06	≈ 0.7	≈ 7.2	≈ 0.8	
$(2.77 \times 10^3 \text{ keV})$	1188.60	≈ 0.098	≈ 1.1	≈ 7.0	≈ 1.2	
$(2.81 \times 10^3 \text{ keV})$	1145.71	≈ 0.15	≈ 1.6	≈ 6.9	≈ 1.7	
$(2.83 \times 10^3 \text{ keV})$	1133.58	≈ 0.02	≈ 0.8	≈ 8.7	≈ 0.8	
$(2.83 \times 10^3 \text{ keV})$	1130.11	≈ 0.07	≈ 0.7	≈ 7.2	≈ 0.8	
$(2.85 \times 10^3 \text{ keV})$	1112.51	≈ 0.17	≈ 1.7	≈ 6.8	≈ 1.9	
$(2.85 \times 10^3 \text{ keV})$	1105.28	≈ 0.029	≈ 0.97	≈ 8.6	≈ 1.0	
$(2.86 \times 10^3 \text{ keV})$	1097.04	≈ 0.21	≈ 2.0	≈ 6.8	≈ 2.2	
$(3.08 \times 10^3 \text{ keV})$	880.46	≈ 0.03	≈ 0.7	≈ 8.9	≈ 0.7	
$(3.10 \times 10^3 \text{ keV})$	862.06	≈ 0.03	≈ 0.7	≈ 8.9	≈ 0.7	
$(3.11 \times 10^3 \text{ keV})$	847.94	≈ 0.20	≈ 1.3	≈ 7.0	≈ 1.5	
$(3.15 \times 10^3 \text{ keV})$	812.67	≈ 0.55	≈ 3.5	≈ 6.6	≈ 4.0	
$(3.25 \times 10^3 \text{ keV})$	712.73	≈ 0.48	≈ 2.6	≈ 6.8	≈ 3.1	
$(3.28 \times 10^3 \text{ keV})$	681.89	≈ 0.76	≈ 4.0	≈ 6.6	≈ 4.8	
$(3.31 \times 10^3 \text{ keV})$	646.18	≈ 0.94	≈ 4.8	≈ 6.5	≈ 5.7	

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 ^{189}Hg ε decay (8.6 min) 1996Wo04 (continued)

 ϵ, β^+ radiations (continued)

<u>E(level)</u>	<u>Comments</u>
247.25	$I(\varepsilon + \beta^+)$: assumed as $\approx 10\%$ based on branching ratio for ^{191}Hg ε decay to the ^{191}Au isomeric state of $J\pi=11/2^-$ at 266 keV, which is 9% 5.

[†] Absolute intensity per 100 decays.

[‡] Existence of this branch is questionable.

γ(¹⁸⁹Au)

Annihilation intensity $I_\gamma(\gamma^\pm)=70$ 10 (**1996Wo04**). This value seems too high in comparison to the deduced value of ≈ 14 from the present decay scheme.

The experimental subshell ratios and conversion coefficients are from **1996Wo04**. When specified as 'other', those values are from **1975Be17**.

I_γ normalization: From summed gamma transition intensity to the g.s. (except the 9.9-keV transition), 9.9-keV level, and the 247.25, 11/2⁻ isomer of ¹⁸⁹Au ≈ 90 , assuming $\approx 10\%$ $\varepsilon+\beta^+$ feeding to the 247.25, 11/2⁻ isomer, the latter based on branching ratio for ¹⁹¹Hg ε decay to the ¹⁹¹Au isomeric state of $J\pi=11/2^-$ at 266 keV, which is 9% 5.

$I(\gamma+ce)$ normalization: From summed gamma transition intensity to the g.s. (except the 9.9-keV transition), 9.9-keV level, and the 247.25, 11/2⁻ isomer of ¹⁸⁹Au ≈ 90 , assuming $\approx 10\%$ $\varepsilon+\beta^+$ feeding to the 247.25, 11/2⁻ isomer, the latter based on branching ratio for ¹⁹¹Hg ε decay to the ¹⁹¹Au isomeric state of $J\pi=11/2^-$ at 266 keV, which is 9% 5.

$E_\gamma^\dagger$	$I_\gamma^{\ddagger\&}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [‡]	$\delta^\ddagger$	$\alpha^\S$	$I_{(\gamma+ce)}^\&$	Comments
9.9 2		9.95	3/2 ⁺	0.0	1/2 ⁺	[M1]		278 18	>150	E_γ : observed as M-conversion line in singles and ce-γ coin by 1975Be17 . $I_{(\gamma+ce)}$: deduced by evaluators from intensity balance argument.
44.7 2		248.57	5/2 ⁺	203.81	3/2 ⁺	M1+E2	0.15 2	18.2 13	5	L3/L12=0.16 5; M/L12=0.37 6 $I_{(\gamma+ce)}$: from intensity balance (1996Wo04). $\delta=0.16$ 3 from ce data in the present experiment.
59.2 2		307.78	5/2 ⁺	248.57	5/2 ⁺				1	$I_{(\gamma+ce)}$: from 1996Wo04 .
77.9 2		325.13	9/2 ⁻	247.25	11/2 ⁻	M1+E2	0.3 2	3.7 15	500	M/L12=0.28 4; L/M=4.2 4; L3/L12≤0.15 $I_{(\gamma+ce)}$: from intensity balance (1996Wo04). $I_{(\gamma+ce)}$: from 1996Wo04 .
(104)		307.78	5/2 ⁺	203.81	3/2 ⁺				<2	$I_{(\gamma+ce)}$: from 1996Wo04 .
113 1	0.8 2	760.70	9/2 ⁺	647.29	7/2 ⁺	M1+E2	1.2 3	4.0 4		$\alpha(K)\text{exp}=1.8$ 6; L12/K=0.41 12; M/K=0.21 7; L3/K≤0.09
135 1		647.29	7/2 ⁺	512.39	7/2 ⁺	M1+E2	0.7 +4-5	2.6 5		L12/K=0.25 6; L3/K≤0.06 $\delta=1.8 +15-14$ from ce data in the present experiment.
151.4 2	2.0 2	1534.79	13/2 ⁺	1383.25	13/2 ⁺	M1(+E2)	<0.4	2.14 9		$\alpha(K)\text{exp}=2.3$ 3; L3/K≤0.03; M/K=0.10 3
166.5 2	25 3	491.58	5/2 ⁻	325.13	9/2 ⁻	E2		0.714		$\alpha(K)\text{exp}=0.22$ 4; L12/K=1.25 32; L3/K=0.77 25; M/K=0.52 18; n/K=0.12 4
176.3 2	3.9 10	484.04	7/2 ⁻	307.78	5/2 ⁺	E1		0.0988		$\alpha(K)\text{exp}=0.12$ 4
186.6 3	0.8 2	1298.92	11/2 ⁺	1112.51	11/2 ⁺	E2		0.476		$\alpha(K)\text{exp}=0.23$ 6
(194)	<0.2	203.81	3/2 ⁺	9.95	3/2 ⁺					
200.7 2	5.0 5	847.94	9/2 ⁺	647.29	7/2 ⁺	M1+E2	1.1 +3-2	0.66 8		$\alpha(K)\text{exp}=0.38$ 6; L12/K=0.19 3; M/K=0.11 4
203.9 2	16.4 17	203.81	3/2 ⁺	0.0	1/2 ⁺	M1+E2	0.63 +14-15	0.79 6		$\alpha(K)\text{exp}=0.63$ 9; L12/K=0.20 3; L3/K=0.042 4; M/K=0.045 6
(205.0)	<0.2	512.39	7/2 ⁺	307.78	5/2 ⁺					
218.1 2	9.9 10	1601.20	13/2 ⁺ , 15/2 ⁺	1383.25	13/2 ⁺	E2(+M1)	>1.1	0.40 12		$\alpha(K)\text{exp}=0.079$ 11; M/L12=0.37 12;

$\gamma(^{189}\text{Au})$ (continued)

E_γ [†]	I_γ ^{†&}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [‡]	δ [‡]	α [§]	Comments
235 1	6.0 10	484.04	7/2 ⁻	248.57	5/2 ⁺	E1		0.0484 9	L3/L12≤0.13 The $\alpha(\text{K})_{\text{exp}}$ obscured in this measurement. $\alpha(\text{K})_{\text{exp}} \leq 0.04$ from ^{189m} Hg ε decay; ≈ 0.03 from ^{189g} Hg ε decay (1996Wo04).
236 1	19 3	484.04	7/2 ⁻	247.25	11/2 ⁻	E2		0.216 5	$\alpha(\text{K})_{\text{exp}} = 0.14$ 3; L12/K=0.46 8; L3/K=0.26 4; M/K=0.28 9
238.7 2	54 6	248.57	5/2 ⁺	9.95	3/2 ⁺	M1+E2	2.3 3	0.274 18	$\alpha(\text{K})_{\text{exp}} = 0.20$ 3; L12/K=0.33 3; L3/K=0.11 1
239 1	1.8 5	2178.0		1939.01	⁺				
(248)	<0.7	760.70	9/2 ⁺	512.39	7/2 ⁺				
248.7 2	53 6	248.57	5/2 ⁺	0.0	1/2 ⁺	E2		0.182	$\alpha(\text{K})_{\text{exp}} = 0.113$ 15; L3/K=0.20 6; M/K=0.23 6
249 1	5.6 10	1130.11	11/2 ⁻	880.46	9/2 ⁻	M1+E2	1.4 +8-4	0.31 7	$\alpha(\text{K})_{\text{exp}} = 0.22$ 6
253.2 2	13.4 13	1383.25	13/2 ⁺	1130.11	11/2 ⁻	E1		0.0404	$\alpha(\text{K})_{\text{exp}} = 0.027$ 4
264.0 2	14.5 15	512.39	7/2 ⁺	248.57	5/2 ⁺	M1+E2	0.4 +2-3	0.43 5	$\alpha(\text{K})_{\text{exp}} = 0.36$ 5; L12/K=0.20 3; L3/K<0.02; M/K=0.031 4
279.3 2	9.6 10	770.72	7/2 ⁻	491.58	5/2 ⁻	M1+E2	0.9 2	0.28 4	$\delta < 0.4$ from ce data in the present experiment.
282.6 3	3.1 4	1193.56	-	911.02	7/2 ⁻	M1+E2	1.1 +14-6	0.244 94	$\alpha(\text{K})_{\text{exp}} = 0.21$ 3; L12/K=0.20 2
286 1	0.5 2	1654.20	13/2 ⁻ , 15/2 ⁻	1368.08	(17/2, 13/2, 15/2) ⁻				$\alpha(\text{K})_{\text{exp}} = 0.22$ 7; L12/K=0.37 12
293.0 3	2.0 3	1481.6	13/2 ⁻	1188.60	11/2 ⁻	M1		0.354	$\alpha(\text{K})_{\text{exp}} = 0.37$ 7
297.9 2	28 3	307.78	5/2 ⁺	9.95	3/2 ⁺	M1(+E2)	<0.8	0.29 5	$\alpha(\text{K})_{\text{exp}} = 0.26$ 4; L12/K=0.20 3; M/K=0.056 11; L3/K<0.03
(308)	<0.9	307.78	5/2 ⁺	0.0	1/2 ⁺				$\delta < 1.0$ from ce data in the present experiment.
308 1	3.0 10	512.39	7/2 ⁺	203.81	3/2 ⁺	E2		0.0947 16	$\alpha(\text{K})_{\text{exp}} \leq 0.17$ Mult.: E2(+M1) ($\delta > 0.9$) from 1996Wo04 is unlikely for a $\Delta=2$ transition.
318 1	2.2 8	2257.20	(⁻)	1939.01	⁺	(E1)		0.0235	$\alpha(\text{K})_{\text{exp}} \leq 0.05$
321.1 2	240 20	646.18	13/2 ⁻	325.13	9/2 ⁻	E2		0.0838	$\alpha(\text{K})_{\text{exp}} = 0.046$ 6; L12/K=0.42 7; L3/K=0.13 2; M/K=0.20 6
326 1	2.6 6	2264.81	(⁺)	1939.01	⁺	M1+E2	1.2 +16-6	0.156 61	$\alpha(\text{K})_{\text{exp}} = 0.12$ 5
326.4 3	4.3 6	1188.60	11/2 ⁻	862.06	9/2 ⁻	M1+E2	1.3 +14-6	0.148 56	$\alpha(\text{K})_{\text{exp}} = 0.11$ 4
333.3 4	2.9 7	2272.17	⁺	1939.01	⁺	M1(+E2)	<1.1	0.20 5	$\alpha(\text{K})_{\text{exp}} = 0.19$ 7
335.5 4	2.6 8	847.94	9/2 ⁺	512.39	7/2 ⁺	M1		0.245	$\alpha(\text{K})_{\text{exp}} = 0.27$ 10
339.7 3	1.3 2	647.29	7/2 ⁺	307.78	5/2 ⁺	E2(+M1)	>1.3	0.102 31	$\alpha(\text{K})_{\text{exp}} \leq 0.1$ Mult.: $\alpha(\text{K})_{\text{exp}}$ allows E1 also, but inconsistent with $\Delta J\pi$.
351.9 2	9.8 10	1112.51	11/2 ⁺	760.70	9/2 ⁺	M1		0.215	$\alpha(\text{K})_{\text{exp}} = 0.18$ 3; L12/K=0.12 3

$\gamma(^{189}\text{Au})$ (continued)

E_γ [†]	I_γ ^{†&}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [‡]	δ [‡]	α [§]	Comments
356 [@] 1	6.5 [@] 10	1739.4	13/2 ⁺ , 15/2 ⁺	1383.25	13/2 ⁺	M1+E2	0.9 +6-4	0.143 37	$\alpha(\text{K})_{\text{exp}}=0.11$ 3
356 [@] 1	3.8 [@] 10	2295.00	+	1939.01	+	M1(+E2)	<1.3	0.163 46	$\alpha(\text{K})_{\text{exp}}=0.16$ 7
360 [@] 1	5.5 [@] 10	1130.11	11/2 ⁻	770.72	7/2 ⁻	E2		0.0606 10	$\alpha(\text{K})_{\text{exp}}=0.036$ 12
360 [@] 1	4.1 [@] 10	2295.00	+	1935.02	+	M1(+E2)	<1.1	0.16 4	$\alpha(\text{K})_{\text{exp}}=0.15$ 5
363.0 2	5.9 6	1133.58	9/2 ⁻	770.72	7/2 ⁻	M1+E2	2.5 +16-6	0.078 12	$\alpha(\text{K})_{\text{exp}}=0.058$ 10; L12/K=0.5 2
376.1 4	1.7 4	1188.60	11/2 ⁻	812.67	13/2 ⁻	M1(+E2)	<1.3	0.140 40	$\alpha(\text{K})_{\text{exp}}=0.12$ 4; L12/K≤0.1
378.3 2	14.9 15	862.06	9/2 ⁻	484.04	7/2 ⁻	M1(+E2)	<0.5	0.165 13	$\alpha(\text{K})_{\text{exp}}=0.13$ 2; L12/K=0.22 4; M/K=0.058 20; L3/K<0.007 δ <1.0 from ce data in the present experiment.
382.5 3	2.7 4	2317.51	+	1935.02	+	M1		0.1722	$\alpha(\text{K})_{\text{exp}}=0.25$ 6
384.4 3	25 2	1097.04	13/2 ⁻	712.73	11/2 ⁻	M1+E2	0.7 3	0.131 23	$\alpha(\text{K})_{\text{exp}}=0.096$ 12; L12/K=0.23 5; L3/K<0.06; M/K=0.025 8
386 1	1.5 5	2325.0		1939.01	+				
387.7 2	103 10	712.73	11/2 ⁻	325.13	9/2 ⁻	M1+E2	2.0 +14-6	0.073 17	$\alpha(\text{K})_{\text{exp}}=0.056$ 10; L12/K=0.19 5; L3/K<0.03; M/K=0.09 2
389 1	4.1 13	880.46	9/2 ⁻	491.58	5/2 ⁻	E2		0.0491 8	$\alpha(\text{K})_{\text{exp}}=0.052$ 30
393 [#] 1	1.0 5	1273.21	11/2 ⁻	880.46	9/2 ⁻				
393 1	1.0 5	1745.6		1352.6	(15/2, 13/2, 11/2) ⁻				
395.8 3	3.3 4	880.46	9/2 ⁻	484.04	7/2 ⁻	M1(+E2)	<0.4	0.150 8	$\alpha(\text{K})_{\text{exp}}=0.16$ 3; L12/K=0.31 11
398.9 3	20 5	647.29	7/2 ⁺	248.57	5/2 ⁺	M1		0.1539	$\alpha(\text{K})_{\text{exp}}=0.140$ 22; L12/K=0.18 3; L3/K<0.03; M/K=0.04 2
(399)	<3	646.18	13/2 ⁻	247.25	11/2 ⁻				
400 1	2.7 4	1935.02	+	1534.79	13/2 ⁺				
401 1	2.5 5	2335.14	(+)	1935.02	+				
404.5 3	1.4 5	1534.79	13/2 ⁺	1130.11	11/2 ⁻	E1		0.01358	$\alpha(\text{K})_{\text{exp}}\leq 0.007$
411.4 3	2.5 3	1273.21	11/2 ⁻	862.06	9/2 ⁻	M1+E2	0.6 3	0.115 19	$\alpha(\text{K})_{\text{exp}}=0.095$ 16
417 1	2.2 4	1800.5	15/2 ⁺	1383.25	13/2 ⁺				
417.6 3	1.7 2	1130.11	11/2 ⁻	712.73	11/2 ⁻	M1		0.1362	$\alpha(\text{K})_{\text{exp}}=0.19$ 7
419.5 3	5.8 6	911.02	7/2 ⁻	491.58	5/2 ⁻	M1+E2	0.8 +5-4	0.098 24	$\alpha(\text{K})_{\text{exp}}=0.079$ 20; L12/K=0.23 8
420.7 4	1.6 7	1133.58	9/2 ⁻	712.73	11/2 ⁻	M1(+E2)	<1.7	0.099 35	$\alpha(\text{K})_{\text{exp}}=0.10$ 5
429 [@] 1	2.2 [@] 6	1525.0	-	1097.04	13/2 ⁻	M1		0.1268 20	$\alpha(\text{K})_{\text{exp}}=0.16$ 5
429 [@] 1	5.0 [@] 10	1559.1	-	1130.11	11/2 ⁻	E2		0.0379	$\alpha(\text{K})_{\text{exp}}=0.020$ 15
432.3 4	3.5 10	1312.98	13/2 ⁻	880.46	9/2 ⁻	E2		0.0372	$\alpha(\text{K})_{\text{exp}}\leq 0.05$ Mult.: E2+M1, $\delta>0.2$ from 1996Wo04 is inconsistent with $\Delta J=2$ transition. Also $\alpha(\text{K})_{\text{exp}}$ is consistent with E2.
433.0 3	5.4 9	1145.71	13/2 ⁻ , 15/2 ⁻	712.73	11/2 ⁻	M1+E2	1.8 +43-7	0.057 19	$\alpha(\text{K})_{\text{exp}}=0.044$ 16
433.5 3	5.6 9	1295.52	11/2 ⁻	862.06	9/2 ⁻	M1+E2	0.8 +6-5	0.090 27	$\alpha(\text{K})_{\text{exp}}=0.070$ 20
434.6 2	111 10	681.89	15/2 ⁻	247.25	11/2 ⁻	E2		0.0367	$\alpha(\text{K})_{\text{exp}}=0.025$ 4; L12/K=0.19 7

γ(¹⁸⁹Au) (continued)

E _γ [†]	I _γ ^{†&}	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. [‡]	δ [‡]	α [§]	Comments
437 1	0.6 4	2176.2	+	1739.4	13/2 ⁺ , 15/2 ⁺				
443.4 5	2.5 10	647.29	7/2 ⁺	203.81	3/2 ⁺				
445.6 2	9.2 9	770.72	7/2 ⁻	325.13	9/2 ⁻	M1+E2	0.8 3	0.083 16	α(K)exp=0.084 13 δ<0.7 from ce data in the present experiment.
(449)	<0.4	961.28	(5/2, 3/2) ⁺	512.39	7/2 ⁺				
451 1	3.8 13	1097.04	13/2 ⁻	646.18	13/2 ⁻	M1(+E2)	<0.5	0.103 8	α(K)exp=0.089 10; L12/K=0.46 17
(451)	<0.4	1298.92	11/2 ⁺	847.94	9/2 ⁺				
451 @ 1	2.8 @ 10	1835.1	(13/2 ⁺ , 15/2 ⁺)	1383.25	13/2 ⁺				
453 1	3.5 10	760.70	9/2 ⁺	307.78	5/2 ⁺	E2		0.0330	α(K)exp≤0.030 Mult.: E2(+M1) (δ>3.0) from 1996Wo04 is not likely for ΔJ=2 transition; also a(K)exp is consistent with E2.
455 1	1.3 5	1601.20	13/2 ⁺ , 15/2 ⁺	1145.71	13/2 ⁻ , 15/2 ⁻				
459 1	1.2 6	1273.21	11/2 ⁻	812.67	13/2 ⁻	M1(+E2)	<6	0.070 36	α(K)exp=0.067 42
459.1 2	26 2	1105.28	17/2 ⁻	646.18	13/2 ⁻	E2		0.0319	α(K)exp=0.022 3; L12/K=0.32 11; L3/K≤0.13; M/K≤0.09
(465)	<1	712.73	11/2 ⁻	247.25	11/2 ⁻				
(465)	≤0.7	1112.51	11/2 ⁺	647.29	7/2 ⁺				
479.1 3	2.4 5	1939.01	+	1460.00	11/2 ⁺	M1+E2	0.6 2	0.077 9	α(K)exp=0.065 8
483 @ 1	1.3 @ 4	1295.52	11/2 ⁻	812.67	13/2 ⁻				
483 @ 1	2.4 @ 10	1580.4	-	1097.04	13/2 ⁻	M1		0.0926	α(K)exp=0.10 5
484.0 2	11.7 12	1130.11	11/2 ⁻	646.18	13/2 ⁻	M1		0.0921	α(K)exp=0.078 11; L12/K=0.18 4; L3/K≤0.02; M/K=0.12 7
484 1	2.0 10	2272.17	+	1788.3	(⁺)				
486.3 3	3.0 8	1247.2	(9/2, 7/2) ⁺	760.70	9/2 ⁺	M1+E2	0.8 +6-5	0.066 20	α(K)exp=0.053 15
(487)	<0.4	1133.58	9/2 ⁻	647.29	7/2 ⁺				
499.6 2	24 2	1145.71	13/2 ⁻ , 15/2 ⁻	646.18	13/2 ⁻	M1+E2	0.9 4	0.058 15	α(K)exp=0.049 7; L3/K<0.02; L12/K=0.21 5; M/K=0.09 3
502.3 2	33 3	512.39	7/2 ⁺	9.95	3/2 ⁺	E2		0.0255	α(K)exp=0.025 5; L12/K=0.33 8
504 1	0.8 5	812.3	(5/2, 3/2, 1/2) ⁺	307.78	5/2 ⁺				
(507)	<0.2	1188.60	11/2 ⁻	681.89	15/2 ⁻				
512 1	55 10	760.70	9/2 ⁺	248.57	5/2 ⁺	E2		0.0244	α(K)exp=0.023 5; L12/K=0.26 5; L3/K=0.049 16
522.2 2	5.5 6	1483.4	(7/2) ⁺	961.28	(5/2, 3/2) ⁺	M1+E2	2.2 +11-5	0.032 5	α(K)exp=0.025 4
538.2 2	10.2 10	1298.92	11/2 ⁺	760.70	9/2 ⁺	M1		0.0697	α(K)exp=0.054 8; L12/K=0.15 3
540.0 @ 5	11.0 @ 20	847.94	9/2 ⁺	307.78	5/2 ⁺	E2		0.0215	α(K)exp=0.013 4; L12/K=0.29 8
540.0 @ 5	7.0 @ 14	1352.6	(15/2, 13/2, 11/2) ⁻	812.67	13/2 ⁻	M1+E2	1.2 +7-4	0.041 10	α(K)exp=0.034 8; L12/K=0.22 5
(542)	<0.5	1188.60	11/2 ⁻	646.18	13/2 ⁻				
(555)	<0.2	1368.08	(17/2, 13/2, 15/2) ⁻	812.67	13/2 ⁻				
555.7 3	6.8 7	880.46	9/2 ⁻	325.13	9/2 ⁻	M1+E2	0.5 +3-4	0.055 9	α(K)exp=0.045 6; L12/K=0.12 3

¹⁸⁹Hg ε decay (8.6 min) 1996Wo04 (continued)γ(¹⁸⁹Au) (continued)

E_γ [†]	I_γ ^{†&}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [‡]	δ [‡]	α [§]	$I_{(\gamma+ce)}$ ^{&}	Comments
565.4 2	100 10	812.67	13/2 ⁻	247.25	11/2 ⁻	M1+E2	0.6 +4-3	0.050 10		$\alpha(K)\text{exp}=0.0424$ 40; L12/K=0.17 3; M/K=0.054 14; n/K=0.016 5
(572)	<0.4	1419.83	(13/2,11/2) ⁺	847.94	9/2 ⁺					
578 1	1.1 4	1488.9	(7/2,11/2) ⁻	911.02	7/2 ⁻					
585.9 3	2.2 5	911.02	7/2 ⁻	325.13	9/2 ⁻	M1		0.0558		$\alpha(K)\text{exp}=0.047$ 12
(592)	<0.2	1273.21	11/2 ⁻	681.89	15/2 ⁻					
600 @ 1	4.0 @ 10	847.94	9/2 ⁺	248.57	5/2 ⁺	E2		0.01682	5	$\alpha(K)\text{exp}\leq 0.02$
600 @ 1	24 @ 3	1112.51	11/2 ⁺	512.39	7/2 ⁺	E2		0.01682		$\alpha(K)\text{exp}=0.019$ 6; L12/K=0.28 9
600 @ 1	1.3 @ 4	1247.2	(9/2,7/2) ⁺	647.29	7/2 ⁺					
600.1 5	13.2 30	1312.98	13/2 ⁻	712.73	11/2 ⁻	M1+E2	1.3 +11-5	0.0301 85		$\alpha(K)\text{exp}=0.025$ 7; L12/K=0.22 9
608.5 5	1.4 7	812.3	(5/2,3/2,1/2) ⁺	203.81	3/2 ⁺	E2(+M1)	>2	0.020 4		$\alpha(K)\text{exp}=0.013$ 5
612 1	1.0 3	1295.52	11/2 ⁻	681.89	15/2 ⁻					
614.8 2	11.2 10	862.06	9/2 ⁻	247.25	11/2 ⁻	M1		0.0492		$\alpha(K)\text{exp}=0.039$ 7; L12/K=0.19 3
626.7 3	1.0 3	1273.21	11/2 ⁻	646.18	13/2 ⁻	M1		0.0469		$\alpha(K)\text{exp}=0.063$ 20
630.3 2	4.4 5	2165.21	+	1534.79	13/2 ⁺	M1+E2	1.2 +4-3	0.028 5		$\alpha(K)\text{exp}=0.023$ 3
634 @ 1	4.0 @ 6	880.46	9/2 ⁻	247.25	11/2 ⁻	(M1+E2)	1.0 2	0.030 4		$\alpha(K)\text{exp}=0.025$ 3
634 @ 1	4.1 @ 6	2169.19	(⁺)	1534.79	13/2 ⁺	(M1+E2)	1.0 2	0.030 4		
637.2 2	5.3 5	647.29	7/2 ⁺	9.95	3/2 ⁺	E2		0.01469		$\alpha(K)\text{exp}=0.008$ 2
641.7 3	1.8 3	1133.58	9/2 ⁻	491.58	5/2 ⁻	E2		0.01447		$\alpha(K)\text{exp}=0.009$ 5
										Mult.: M1+E2 ($\delta>3.0$) from 1996Wo04 is not likely for a $\Delta J=2$ transition; also $\alpha(K)\text{exp}$ is consistent with E2.
651.6 2	9.4 9	1298.92	11/2 ⁺	647.29	7/2 ⁺	E2		0.01398		$\alpha(K)\text{exp}=0.011$ 2
653.3 3	1.5 3	961.28	(5/2,3/2) ⁺	307.78	5/2 ⁺	M1+E2	1.7 +25-7	0.0211 69		$\alpha(K)\text{exp}=0.017$ 5
659.0 2	15.4 15	1419.83	(13/2,11/2) ⁺	760.70	9/2 ⁺	E2		0.01364		$\alpha(K)\text{exp}=0.012$ 2; L12/K=0.16 3
663.6 2	6.2 6	2264.81	(⁺)	1601.20	13/2 ⁺ ,15/2 ⁺	M1+E2	0.5 +3-4	0.035 6		$\alpha(K)\text{exp}=0.029$ 4
667.0 3	2.4 5	1312.98	13/2 ⁻	646.18	13/2 ⁻	M1(+E2)	<0.9	0.034 6		$\alpha(K)\text{exp}=0.032$ 9
(669)	≤ 0.6	1481.6	13/2 ⁻	812.67	13/2 ⁻					
670 @ 1	1.3 @ 5	1352.6	(15/2,13/2,11/2) ⁻	681.89	15/2 ⁻	M1		0.0394		$\alpha(K)\text{exp}=0.036$ 15 E_γ : doublet. Evaluators have corrected the K-electron intensity for contribution from the 670 keV transition that deexcites the 1383 keV level.
670 @ 1	0.9 @ 4	1383.25	13/2 ⁺	712.73	11/2 ⁻	[E1]		0.00471		E_γ : doublet.
676 @ 1	4.3 @ 10	1523.8	+	847.94	9/2 ⁺	M1+E2	1.6 +9-5	0.020 5		$\alpha(K)\text{exp}=0.016$ 3
676 @ 1	5.0 @ 9	1788.3	(⁺)	1112.51	11/2 ⁺	(E2)		0.01290		L12/K=0.24 10

$\gamma(^{189}\text{Au})$ (continued)

E_γ †	I_γ †&	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ‡	$\delta^\ddagger$	$\alpha^\S$	Comments
683.4 # 4	1.2 3	1365.3		681.89	15/2 ⁻				
686 1	2.6 8	1534.79	13/2 ⁺	847.94	9/2 ⁺	[E2]		0.01250	$\alpha(\text{K})_{\text{exp}}=0.023$ 4 Mult.: M1+E2, $\delta=0.8$ +4-3 from 1996Wo04 is inconsistent with $\Delta J=2$ transition, possible overlap with 682.2 transition.
686.2 2	5.3 7	1368.08	(17/2,13/2,15/2) ⁻	681.89	15/2 ⁻	(M1)		0.0370	L12/K=0.12 3
^x 694.1 7	1.0 6								
695.3 5	2.6 3	1800.5	15/2 ⁺	1105.28	17/2 ⁻	(E1)		0.00438	$\alpha(\text{K})_{\text{exp}}<0.008$ Mult.: E1 or (E2) in 1996Wo04 from $\alpha(\text{K})_{\text{exp}}$, but $\Delta J\pi$ requires (E1).
697.3 4	1.6 3	2257.20	(⁻)	1559.85	-				
704 @ 1	2.5 @ 3	1188.60	11/2 ⁻	484.04	7/2 ⁻	[E2]		0.01181	
704 @ 1	1.1 @ 3	1516.7	-	812.67	13/2 ⁻	M1+E2	2.0 +11-5	0.0164 25	$\alpha(\text{K})_{\text{exp}}=0.013$ 2
709.1 4	1.1 3	2169.19	(⁺)	1460.00	11/2 ⁺	E2(+M1)	>1.2	0.0162 46	$\alpha(\text{K})_{\text{exp}}=0.011$ 6
(711)	<0.2	1523.4	(⁻)	812.67	13/2 ⁻				
713.0 5	4.5 10	961.28	(5/2,3/2) ⁺	248.57	5/2 ⁺	E2		0.01150	$\alpha(\text{K})_{\text{exp}}=0.0076$ 20
716 @ 1	0.9 @ 4	2176.2	+	1460.00	11/2 ⁺	E2		0.01139	$\alpha(\text{K})_{\text{exp}}=0.008$ 3
716 @ 1	1.4 @ 5	2275.7	+	1559.85	-				
716 @ 1	1.5 @ 8	2317.14	+	1601.20	13/2 ⁺ , 15/2 ⁺				
722 @ 1	2.4 @ 4	1483.4	(7/2) ⁺	760.70	9/2 ⁺	M1+E2	1.1 +5-4	0.021 5	$\alpha(\text{K})_{\text{exp}}=0.017$ 3
722 @ 1	0.9 @ 3	1534.79	13/2 ⁺	812.67	13/2 ⁻				
730 @ 1	1.2 @ 4	1376.2	-	646.18	13/2 ⁻	M1+E2	≈ 1.7	≈ 0.01624	$\alpha(\text{K})_{\text{exp}}\approx 0.013$
730 @ 1	1.1 @ 4	1411.9	19/2 ⁻	681.89	15/2 ⁻				
734 1	1.5 8	2335.14	(⁺)	1601.20	13/2 ⁺ , 15/2 ⁺	M1+E2	0.8 +9-6	0.0232 72	$\alpha(\text{K})_{\text{exp}}=0.019$ 6
735 1	2.5 8	1247.2	(9/2,7/2) ⁺	512.39	7/2 ⁺				
737.0 2	34 3	1383.25	13/2 ⁺	646.18	13/2 ⁻	E1		0.00391	$\alpha(\text{K})_{\text{exp}}=0.0039$ 6
^x 742.0 3	1.5 5								
746.9 3	2.7 3	2045.8	+	1298.92	11/2 ⁺	M1+E2	1.2 +6-4	0.018 4	$\alpha(\text{K})_{\text{exp}}=0.015$ 3
749.7 3	3.6 4	2169.6	(⁺)	1419.83	(13/2,11/2) ⁺	M1+E2	0.6 3	0.024 4	$\alpha(\text{K})_{\text{exp}}=0.020$ 3
751.0 5	1.3 5	2211.01	+	1460.00	11/2 ⁺	M1(+E2)	<2.2	0.0215 79	$\alpha(\text{K})_{\text{exp}}=0.021$ 10
751 1	1.5 7	2239.9		1488.9	(7/2,11/2) ⁻				
751.4 5	1.3 7	1463.9	-	712.73	11/2 ⁻	M1		0.0293	$\alpha(\text{K})_{\text{exp}}=0.038$ 25
757.5 2	6.5 7	961.28	(5/2,3/2) ⁺	203.81	3/2 ⁺	M1+E2	2.6 +12-6	0.0125 14	$\alpha(\text{K})_{\text{exp}}=0.010$ 1
(763)	<0.4	1523.8	+	760.70	9/2 ⁺				
771.9 3	7.7 8	1097.04	13/2 ⁻	325.13	9/2 ⁻	E2		0.00972	$\alpha(\text{K})_{\text{exp}}=0.0067$ 10
(774)	≤ 1	1534.79	13/2 ⁺	760.70	9/2 ⁺				
776.0 3	2.0 4	1488.9	(7/2,11/2) ⁻	712.73	11/2 ⁻	(E2)		0.00961	$\alpha(\text{K})_{\text{exp}}=0.0050$ 27
777 1	1.5 3	2336.1		1559.1	-				
780.1 5	1.1 3	2163.4	+	1383.25	13/2 ⁺	M1		0.0266	$\alpha(\text{K})_{\text{exp}}\leq 0.02$
782.2 3	2.8 3	2317.14	+	1534.79	13/2 ⁺	M1+E2	0.7 4	0.021 5	$\alpha(\text{K})_{\text{exp}}=0.017$ 3

¹⁸⁹Hg ε decay (8.6 min) 1996Wo04 (continued) $\gamma(^{189}\text{Au})$ (continued)

E_γ [†]	I_γ ^{†&}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [‡]	δ [‡]	α [§]	Comments
786.6 2	3.3 3	1298.92	11/2 ⁺	512.39	7/2 ⁺	E2		0.00934	$\alpha(\text{K})_{\text{exp}}=0.009$ 2
788.5 2	4.0 7	1601.20	13/2 ⁺ , 15/2 ⁺	812.67	13/2 ⁻	E1		0.00344	$\alpha(\text{K})_{\text{exp}}=0.002$ 1
(790)	≤0.7	1273.21	11/2 ⁻	484.04	7/2 ⁻				
^x 792.4 4	1.5 4					M1+E2	1.2 +30-7	0.0159 64	$\alpha(\text{K})_{\text{exp}}=0.013$ 5
^x 796.8 4	1.5 5					M1		0.0252	$\alpha(\text{K})_{\text{exp}}=0.027$ 10
799 1	1.1 3	1106.60	(5/2 ⁺ , 3/2 ⁺)	307.78	5/2 ⁺				
800@ 1	4.2@ 6	1481.6	13/2 ⁻	681.89	15/2 ⁻	M1		0.0250	$\alpha(\text{K})_{\text{exp}}=0.032$ 14
800@ 1	3.6@ 6	2335.14	(⁺)	1534.79	13/2 ⁺	[E2]		0.00902	$\alpha(\text{K})_{\text{exp}}=0.003$ 2 Mult.: E1 from 1996Wo04 is inconsistent with $\Delta J\pi$; $\alpha(\text{K})_{\text{exp}}$ is consistent with E1 or E2.
802.4 4	1.0 3	812.3	(5/2, 3/2, 1/2) ⁺	9.95	3/2 ⁺	M1		0.0248	$\alpha(\text{K})_{\text{exp}}=0.020$ 7
805.0 3	2.0 7	1130.11	11/2 ⁻	325.13	9/2 ⁻	E2(+M1)	>0.8	0.0137 48	$\alpha(\text{K})_{\text{exp}}=0.010$ 5
808 1	0.9 3	2268.0		1460.00	11/2 ⁺				
809 1	2.1 4	1456.3	⁺	647.29	7/2 ⁺	M1		0.0243	$\alpha(\text{K})_{\text{exp}}=0.030$ 7
811 1	1.3 5	1295.52	11/2 ⁻	484.04	7/2 ⁻				
812.1 4	1.1 3	1525.0	-	712.73	11/2 ⁻	M1(+E2)	<0.7	0.022 3	$\alpha(\text{K})_{\text{exp}}=0.029$ 9
813 1	2.5 7	1460.00	11/2 ⁺	646.18	13/2 ⁻	E1		0.00324	$\alpha(\text{K})_{\text{exp}}\leq 0.004$
816.5 3	1.8 5	2276.62	⁺	1460.00	11/2 ⁺	M1(+E2)	<1.5	0.0185 53	$\alpha(\text{K})_{\text{exp}}=0.016$ 5
817 1	1.7 5	1463.9	-	646.18	13/2 ⁻				
821.9 3	3.9 4	1534.79	13/2 ⁺	712.73	11/2 ⁻	E1		0.00318	$\alpha(\text{K})_{\text{exp}}=0.0041$ 13
837.8 3	2.2 4	2257.55	(⁺)	1419.83	(13/2, 11/2) ⁺	M1+E2	1.1 +9-5	0.0145 40	$\alpha(\text{K})_{\text{exp}}=0.012$ 3
841@ 1	2.3@ 4	1523.4	(⁻)	681.89	15/2 ⁻				
841@ 1	1.3@ 4	1654.20	13/2 ⁻ , 15/2 ⁻	812.67	13/2 ⁻	E2		0.00814	$\alpha(\text{K})_{\text{exp}}=0.006$ 2
847.2 3	1.0 3	1559.85	-	712.73	11/2 ⁻	M1		0.0216	$\alpha(\text{K})_{\text{exp}}=0.020$ 7
851.2 4	1.1 3	2271.0	⁺	1419.83	(13/2, 11/2) ⁺	M1		0.0213	$\alpha(\text{K})_{\text{exp}}=0.017$ 5
853@ 1	1.1@ 3	1534.79	13/2 ⁺	681.89	15/2 ⁻	[E1]		0.00296	$\alpha(\text{K})_{\text{exp}}=0.008$ 3 Mult.: M1+E2, $\delta>1.2$ from $\alpha(\text{K})_{\text{exp}}$ in 1996Wo04 is inconsistent with $\Delta J\pi$.
853@ 1	1.5@ 3	2273.1		1419.83	(13/2, 11/2) ⁺				
855.6 3	1.1 3	2275.7	⁺	1419.83	(13/2, 11/2) ⁺	E2(+M1)	>0.7	0.0123 45	$\alpha(\text{K})_{\text{exp}}=0.009$ 4
857.7 3	1.5 3	1106.60	(5/2 ⁺ , 3/2 ⁺)	248.57	5/2 ⁺	M1+E2	1.4 +23-6	0.0122 36	$\alpha(\text{K})_{\text{exp}}=0.010$ 3
(868)	≤0.4	1580.4	-	712.73	11/2 ⁻				
868.4 2	5.7 6	1193.56	-	325.13	9/2 ⁻	(E2)		0.00762	$\alpha(\text{K})_{\text{exp}}=0.0039$ 10
^x 874.1 3	1.5 3					M1+E2	1.3 +18-6	0.0121 38	$\alpha(\text{K})_{\text{exp}}=0.010$ 3
(879)	≤0.6	1525.0	-	646.18	13/2 ⁻				
882.4 3	1.3 3	1130.11	11/2 ⁻	247.25	11/2 ⁻	M1		0.0194	$\alpha(\text{K})_{\text{exp}}=0.018$ 3
^x 884.8 4	0.8 3								
888.5 3	2.7 3	1534.79	13/2 ⁺	646.18	13/2 ⁻	[E1]		0.00275	$\alpha(\text{K})_{\text{exp}}=0.006$ 2 Mult.: E2 or (E1) in 1996Wo04 is inconsistent with $\Delta J\pi$.
898.1 4	1.4 3	1145.71	13/2 ⁻ , 15/2 ⁻	247.25	11/2 ⁻	E2(+M1)	>0.8	0.0106 35	$\alpha(\text{K})_{\text{exp}}=0.007$ 4

$\gamma(^{189}\text{Au})$ (continued)

E_γ †	I_γ †&	E_i (level)	J_i^π	E_f	J_f^π	Mult.‡	$\delta^\ddagger$	$\alpha^\S$	Comments
^x 900.1 3	1.9 3					M1+E2	<1.9	0.0140 45	$\alpha(\text{K})\text{exp}=0.012$ 4
903.1 3	1.2 3	1106.60	(5/2 ⁺ , 3/2 ⁺)	203.81	3/2 ⁺	M1(+E2)	<2.6	0.0134 50	$\alpha(\text{K})\text{exp}=0.013$ 6
^x 909.7 4	1.2 3					M1		0.0180	$\alpha(\text{K})\text{exp}=0.017$ 6
912.9 3	1.5 5	1559.1	-	646.18	13/2 ⁻	M1(+E2)	<0.24	0.0175 4	$\alpha(\text{K})\text{exp}=0.024$ 8
919.0 4	1.1 3	1601.20	13/2 ⁺ , 15/2 ⁺	681.89	15/2 ⁻				
925.2 3	1.6 3	2113.8		1188.60	11/2 ⁻				
926.8 3	1.6 5	1739.4	13/2 ⁺ , 15/2 ⁺	812.67	13/2 ⁻	[E1]		0.00254	$\alpha(\text{K})\text{exp}=0.0063$ 23 Mult.: E2 in 1996Wo04 and M1+E2, $\delta>1.4$ from inconsistent with $\Delta J\pi$.
934.2 6	1.9 4	1580.4	-	646.18	13/2 ⁻				
939.8 6	0.8 3	1247.2	(9/2, 7/2) ⁺	307.78	5/2 ⁺				
941.4 2	13.6 14	1188.60	11/2 ⁻	247.25	11/2 ⁻	M1+E2	1.3 +5-4	0.0102 19	$\alpha(\text{K})\text{exp}=0.0085$ 12; L12/K=0.26 9
951 @ 1	1.5 @ 5	1597.2		646.18	13/2 ⁻				
951 @ 1	1.9 @ 6	2264.0		1312.98	13/2 ⁻				
952 1	0.8 4	961.28	(5/2, 3/2) ⁺	9.95	3/2 ⁺	(E2)		0.00634	$\alpha(\text{K})\text{exp}=0.004$ 2 Mult.: E2 or E1 in 1996Wo04, but $\Delta J\pi$ consistent with E2.
954.9 3	3.6 4	1601.20	13/2 ⁺ , 15/2 ⁺	646.18	13/2 ⁻	E1		0.00240	$\alpha(\text{K})\text{exp}=0.002$ 1
958.7 3	1.7 3	2257.55	(⁺)	1298.92	11/2 ⁺	M1(+E2)	<1.1	0.013 3	$\alpha(\text{K})\text{exp}=0.012$ 3
972.1 3	3.3 3	1654.20	13/2 ⁻ , 15/2 ⁻	681.89	15/2 ⁻	M1+E2	0.7 5	0.012 3	$\alpha(\text{K})\text{exp}=0.010$ 2
977.9 3	2.8 3	2276.62	⁺	1298.92	11/2 ⁺	M1(+E2)	<1.0	0.0127 23	$\alpha(\text{K})\text{exp}=0.011$ 2
981 1	1.0 4	2293.9		1312.98	13/2 ⁻				
981.2 4	1.2 4	2169.6	(⁺)	1188.60	11/2 ⁻				
987.8 4	1.1 3	1312.98	13/2 ⁻	325.13	9/2 ⁻				
(999)	≤ 1	1247.2	(9/2, 7/2) ⁺	248.57	5/2 ⁺				
999.5 3	1.6 3	1760.2		760.70	9/2 ⁺				
1003.6 3	0.8 4	1764.3		760.70	9/2 ⁺				
1013.8 5	1.3 4	1774.5		760.70	9/2 ⁺				
^x 1017.5 4	1.2 3								
1022.6 3	0.6 3	1835.1	(13/2 ⁺ , 15/2 ⁺)	812.67	13/2 ⁻				
1026.2 5	1.8 3	1273.21	11/2 ⁻	247.25	11/2 ⁻	M1+E2	1.2 +20-6	0.0086 26	$\alpha(\text{K})\text{exp}=0.007$ 2
1039 1	0.6 3	2145.0		1105.28	17/2 ⁻				
1048.4 3	2.6 8	1295.52	11/2 ⁻	247.25	11/2 ⁻	M1+E2	1.1 +16-6	0.0085 26	$\alpha(\text{K})\text{exp}=0.007$ 2
1049 1	0.9 3	1730.6		681.89	15/2 ⁻				
1057.0 10	1.0 4	1739.4	13/2 ⁺ , 15/2 ⁺	681.89	15/2 ⁻				
1064.4 4	1.8 6	1877.1	-	812.67	13/2 ⁻	M1+E2	≈ 0.7	≈ 0.00977	$\alpha(\text{K})\text{exp}=0.008$ 4
1074.8 3	2.5 3	1756.7	-	681.89	15/2 ⁻	M1		0.01177	$\alpha(\text{K})\text{exp}=0.013$ 2
1083 @ 1	1.4 @ 5	1595.4		512.39	7/2 ⁺				
1083 @ 1	1.0 @ 5	2272.17	⁺	1188.60	11/2 ⁻				$\alpha(\text{K})\text{exp}=0.008$ 4 Mult.: M1+E2, $\delta\approx 1$ for the doublet.

¹⁸⁹Hg ε decay (8.6 min) 1996Wo04 (continued) $\gamma(^{189}\text{Au})$ (continued)

E_γ †	I_γ †&	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ‡	$\delta^\ddagger$	$\alpha^\S$	Comments
1093 @ 1	3.1 @ 8	1739.4	13/2 ⁺ , 15/2 ⁺	646.18	13/2 ⁻	[E1]		0.00188	$\alpha(\text{K})\text{exp}=0.007\ 2$ Mult.: M1+E2, $\delta=0.9\ +11-7$ from $\alpha(\text{K})\text{exp}$ (1996Wo04) is inconsistent with $\Delta J\pi$.
1093 @ 1	0.8 @ 4	2281.9		1188.60	11/2 ⁻				
1105.4 3	1.9 3	1352.6	(15/2, 13/2, 11/2) ⁻	247.25	11/2 ⁻	E2		0.00473	$\alpha(\text{K})\text{exp}\leq 0.004$
^x 1114.8 3	1.2 3					M1		0.01073	$\alpha(\text{K})\text{exp}=0.012\ 3$
1122.2 2	7.8 8	1935.02	+	812.67	13/2 ⁻	E1		0.00180	$\alpha(\text{K})\text{exp}=0.0018\ 4$
1125 # 1	0.6 3	2255.1		1130.11	11/2 ⁻				
1126.4 3	2.4 5	1939.01	+	812.67	13/2 ⁻	(E1)		0.00179	$\alpha(\text{K})\text{exp}<0.003$
1128.7 3	1.0 3	2240.96	(⁺)	1112.51	11/2 ⁺	M1(+E2)	<0.9	0.0091 14	$\alpha(\text{K})\text{exp}=0.014\ 5$
1134.8 2	11.0 11	1460.00	11/2 ⁺	325.13	9/2 ⁻	E1		1.76×10^{-3}	$\alpha(\text{K})\text{exp}=0.0009\ 3$
1140.3 3	1.1 3	1822.2	-	681.89	15/2 ⁻	M1(+E2)	<1.6	0.0081 21	$\alpha(\text{K})\text{exp}=0.007\ 2$
^x 1142.6 4	0.9 3								
1145 1	2.4 5	2257.55	(⁺)	1112.51	11/2 ⁺	M1(+E2)	<1.0	0.0086 14	$\alpha(\text{K})\text{exp}=0.0083\ 21$
1150 1	0.9 3	2338.6		1188.60	11/2 ⁻				
1153 1	1.0 3	1835.1	(13/2 ⁺ , 15/2 ⁺)	681.89	15/2 ⁻				
1159.7 5	7.4 7	2264.81	(⁺)	1105.28	17/2 ⁻	(E1)		1.70×10^{-3}	$\alpha(\text{K})\text{exp}=0.0024\ 8$
1161.0 4	1.7 5	2274.1		1112.51	11/2 ⁺				
1164.3 5	2.8 3	1488.9	(7/2, 11/2) ⁻	325.13	9/2 ⁻	M1+E2	1.4 +14-6	0.0061 15	$\alpha(\text{K})\text{exp}=0.005\ 1$
1167.8 3	1.8 3	2264.81	(⁺)	1097.04	13/2 ⁻				
1171.8 2	9.9 10	2317.51	+	1145.71	13/2 ⁻ , 15/2 ⁻	(E1)		1.67×10^{-3}	$\alpha(\text{K})\text{exp}=0.0020\ 5$ Mult.: E1 or (E2) in 1996Wo04 from $\alpha(\text{K})\text{exp}$, but $\Delta J\pi$ requires (E1).
1188.9 5	3.5 4	1835.1	(13/2 ⁺ , 15/2 ⁺)	646.18	13/2 ⁻				
1198.0 2	3.7 4	2295.00	+	1097.04	13/2 ⁻				
1212 1	1.8 6	2317.51	+	1105.28	17/2 ⁻				
1213 1	2.4 8	1460.00	11/2 ⁺	247.25	11/2 ⁻				
1222.7 4	1.0 3	2335.14	(⁺)	1112.51	11/2 ⁺				
^x 1228.6 3	1.8 3								
1234.3 3	2.0 3	1559.85	-	325.13	9/2 ⁻				
1238.0 3	1.2 3	2335.14	(⁺)	1097.04	13/2 ⁻				
1253.3 2	5.4 6	1935.02	+	681.89	15/2 ⁻				
1257.3 3	1.9 3	1939.01	+	681.89	15/2 ⁻				
1259 1	1.3 3	1905.2		646.18	13/2 ⁻				
1264.9 4	0.8 3	2370.2		1105.28	17/2 ⁻				
1276.2 3	1.4 3	1523.4	(⁻)	247.25	11/2 ⁻				
1287.7 2	8.3 8	1534.79	13/2 ⁺	247.25	11/2 ⁻	E1		1.46×10^{-3}	$\alpha(\text{K})\text{exp}=0.0014\ 5$
1289 1	2.1 3	1935.02	+	646.18	13/2 ⁻				
1292.7 3	1.9 4	1939.01	+	646.18	13/2 ⁻				
1301.1 5	2.5 5	2113.8		812.67	13/2 ⁻				
1312.9 3	1.8 3	1559.85	-	247.25	11/2 ⁻				

$\gamma(^{189}\text{Au})$ (continued)

E_γ †	I_γ †&	$E_i(\text{level})$	J_i^π	E_f	J_f^π
1331.0 3	0.8 4	2436.3		1105.28	17/2 ⁻
1352.8 3	0.8 3	2165.21	+	812.67	13/2 ⁻
1356.4 3	0.9 3	2169.19	(⁺)	812.67	13/2 ⁻
1364 @ 1	1.6 @ 4	2045.8	+	681.89	15/2 ⁻
1364 @ 1	1.3 @ 4	2176.8		812.67	13/2 ⁻
1379.0 2	3.6 10	2240.96	(⁺)	862.06	9/2 ⁻
1395.4 3	1.0 3	2257.20	(⁻)	862.06	9/2 ⁻
1398.5 3	1.1 3	2211.01	+	812.67	13/2 ⁻
1407.2 3	1.4 3	1654.20	13/2 ⁻ , 15/2 ⁻	247.25	11/2 ⁻
1409 # 1	0.8 4	2169.6	(⁺)	760.70	9/2 ⁺
1421.4 # 3	1.3 3	2268.98		847.94	9/2 ⁺
1428.8 3	1.6 5	2276.62	+	847.94	9/2 ⁺
1431.8 3	1.0 5	2293.9		862.06	9/2 ⁻
1444.9 3	2.2 3	2257.55	(⁺)	812.67	13/2 ⁻
1447.8 3	3.5 3	2094.0		646.18	13/2 ⁻
1451.9 3	2.9 5	2264.81	(⁺)	812.67	13/2 ⁻
^x 1455.0 4	1.2 3				
1460.6 8	1.8 6	2273.1		812.67	13/2 ⁻
^x 1476.4 3	1.0 3				
1482.0 4	2.9 5	2295.00	+	812.67	13/2 ⁻
1483.3 4	2.2 5	1730.6		247.25	11/2 ⁻
1487.4 4	1.3 4	2169.19	(⁺)	681.89	15/2 ⁻
^x 1491.9 4	1.7 5				
1495 1	1.1 3	2176.8		681.89	15/2 ⁻
1496.8 3	3.0 10	2257.55	(⁺)	760.70	9/2 ⁺
1498.9 3	4.4 6	2145.0		646.18	13/2 ⁻
1503.6 4	1.3 4	2316.0		812.67	13/2 ⁻
1511.5 3	4.0 4	2272.17	+	760.70	9/2 ⁺
1513.7 3	1.5 5	2274.1		760.70	9/2 ⁺
1519 @ 1	0.8 @ 3	2165.21	+	646.18	13/2 ⁻
1519 @ 1	0.6 @ 3	2200.9		681.89	15/2 ⁻
1523 @ 1	2.3 @ 5	2169.19	(⁺)	646.18	13/2 ⁻
1523 @ 1	1.2 @ 3	2335.7		812.67	13/2 ⁻
1528.9 4	1.1 3	2211.01	+	681.89	15/2 ⁻
1544.7 3	1.8 3	2257.55	(⁺)	712.73	11/2 ⁻
1557.0 3	1.6 8	2269.7		712.73	11/2 ⁻
1559.6 2	3.4 7	2272.17	+	712.73	11/2 ⁻
1568.4 5	2.0 3	2281.00		712.73	11/2 ⁻
1583.0 5	0.8 3	2295.7		712.73	11/2 ⁻
^x 1590.1 4	1.1 2				

$\gamma(^{189}\text{Au})$ (continued)

E_γ †	I_γ †&	$E_i(\text{level})$	J_i^π	E_f	J_f^π
1592.7 4	1.2 2	2274.6		681.89	15/2 ⁻
1594.8 3	4.2 4	2240.96	(⁺)	646.18	13/2 ⁻
1599.4 8	2.2 4	2281.00		681.89	15/2 ⁻
1605.7 4	1.4 3	2251.9		646.18	13/2 ⁻
1610 1	0.5 2	2257.20	(⁻)	647.29	7/2 ⁺
1613 1	0.9 4	2295.00	+	681.89	15/2 ⁻
1618.9 4	1.0 2	2264.81	(⁺)	646.18	13/2 ⁻
1626.0 2	8.6 15	2272.17	+	646.18	13/2 ⁻
1630.5 3	4.7 6	2276.62	+	646.18	13/2 ⁻
1634.0 3	2.3 3	2316.0		681.89	15/2 ⁻
1636 1	1.1 3	2281.9		646.18	13/2 ⁻
1648.9 3	11.1 10	2295.00	+	646.18	13/2 ⁻
1649 1	0.8 4	2330.9		681.89	15/2 ⁻
1657.8 3	1.8 2	2339.7		681.89	15/2 ⁻
^x 1660.0 5	1.0 2				
^x 1662.9 6	1.0 2				
^x 1665.3 3	1.6 2				
1671 1	0.7 3	2483.7		812.67	13/2 ⁻
1671.1 3	5.8 7	2317.14	+	646.18	13/2 ⁻
^x 1675.5 4	1.4 3				
1687.8 3	1.7 2	1935.02	+	247.25	11/2 ⁻
1691.7 3	12.8 10	1939.01	+	247.25	11/2 ⁻
1703 @ 1	1.1 @ 3	2349.2		646.18	13/2 ⁻
1703 @ 1	0.9 @ 3	2384.7		681.89	15/2 ⁻
1724 1	0.5 3	2405.9		681.89	15/2 ⁻
1736 1	0.6 3	2417.9		681.89	15/2 ⁻
1744.7 5	1.3 3	2257.20	(⁻)	512.39	7/2 ⁺
1771.1 4	1.2 2	2417.1		646.18	13/2 ⁻
1796.2 5	0.8 3	2608.9		812.67	13/2 ⁻
^x 1822.7 3	2.1 2				
1845.9 4	1.1 4	2492.1		646.18	13/2 ⁻
^x 1888.5 3	1.4 2				
^x 1895.7 4	1.0 2				
1915.8 3	2.5 3	2240.96	(⁺)	325.13	9/2 ⁻
1922.0 2	11.1 10	2169.19	(⁺)	247.25	11/2 ⁻
1929.5 3	7.2 7	2176.8		247.25	11/2 ⁻
1931.9 3	8.1 8	2257.20	(⁻)	325.13	9/2 ⁻
1943.8 2	16.8 17	2268.98		325.13	9/2 ⁻
1945.9 4	1.4 2	2271.0	+	325.13	9/2 ⁻
1951.2 3	1.5 2	2276.62	+	325.13	9/2 ⁻
1963.7 3	1.7 2	2211.01	+	247.25	11/2 ⁻

$\gamma(^{189}\text{Au})$ (continued)

E_γ [†]	I_γ ^{†&}	$E_i(\text{level})$	J_i^π	E_f	J_f^π
1986.3 3	3.6 4	2311.3		325.13	9/2 ⁻
1993.2 3	1.6 2	2240.96	(⁺)	247.25	11/2 ⁻
2009.9 3	6.0 6	2257.20	(⁻)	247.25	11/2 ⁻
^x 2016.7 3	2.0 3				
2021.8 3	11.5 12	2268.98		247.25	11/2 ⁻
2024.7 2	30 3	2272.17	⁺	247.25	11/2 ⁻
2029.0 5	1.2 3	2275.7	⁺	247.25	11/2 ⁻
2033.7 2	21 2	2281.00		247.25	11/2 ⁻
2063.8 5	0.8 2	2311.3		247.25	11/2 ⁻
^x 2080.7 4	1.6 2				
2137.4 3	1.0 2	2384.7		247.25	11/2 ⁻
2169.6 5	0.6 2	2417.1		247.25	11/2 ⁻

[†] From [1996Wo04](#), except as noted.

[‡] From Adopted Gammas, where the multipolarity and mixing ratios are based mainly on the conversion electron measurements in [1996Wo04](#).

[§] From BrIcc v2.3b (16-Dec-2014) [2008Ki07](#), “Frozen Orbitals” appr.

[&] For absolute intensity per 100 decays, multiply by ≈ 0.078 .

[@] Multiply placed with intensity suitably divided.

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

^x γ ray not placed in level scheme.

^{189}Hg ε decay (8.6 min) 1996Wo04

Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiply placed: intensity suitably divided

Legend

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

$13/2^{+}$ $0.0+x$ 8.6 min 2
 $Q^{+}=3960\ 40$
 $^{189}\text{Hg}_{109}$
 $\% \varepsilon + \% \beta^{+} = 100$

^{189}Hg ε decay (8.6 min) 1996Wo04

Decay Scheme (continued)

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

@ Multiply placed: intensity suitably divided

Legend

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

¹⁸⁹Hg ε decay (8.6 min) 1996Wo04

Decay Scheme (continued)

Intensities: I_(γ+ce) per 100 parent decays
@ Multiplied: intensity suitably divided

Legend

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}

^{189}Hg ϵ decay (8.6 min) 1996Wo04

Decay Scheme (continued)

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

@ Multiply placed: intensity suitably divided

Legend

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

^{189}Hg ε decay (8.6 min) 1996Wo04

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiply placed: intensity suitably divided

Legend

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

^{189}Hg ϵ decay (8.6 min) 1996Wo04

Decay Scheme (continued)

Legend

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

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiply placed: intensity suitably divided

^{189}Hg ε decay (8.6 min) 1996Wo04

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiplied: intensity suitably divided

Legend

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

¹⁸⁹Hg ε decay (8.6 min) 1996Wo04

Decay Scheme (continued)

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

@ Multiply placed: intensity suitably divided

Legend

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}

^{189}Hg ϵ decay (8.6 min) 1996Wo04

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiply placed: intensity suitably divided

Legend

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

^{189}Hg ϵ decay (8.6 min) 1996Wo04

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiply placed: intensity suitably divided

Legend

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

$13/2^{+}$ $0.0+x$ 8.6 min 2
 $Q^{+}=3960$ 40
 $^{189}\text{Hg}_{109}$
 $\% \epsilon + \% \beta^{+} = 100$

^{189}Hg ε decay (8.6 min) 1996Wo04

Decay Scheme (continued)

Legend

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

Intensities: $I_{(\gamma+ee)}$ per 100 parent decays
 @ Multiply placed: intensity suitably divided

^{189}Hg ϵ decay (8.6 min) 1996Wo04

Decay Scheme (continued)

 Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiplied: intensity suitably divided

Legend

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

^{189}Hg ε decay (8.6 min) 1996Wo04

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiply placed: intensity suitably divided

Legend

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

$^{189}_{79}\text{Au}_{110}$

^{189}Hg ϵ decay (8.6 min) 1996Wo04

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiply placed: intensity suitably divided

Legend

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

$^{174}\text{Yb}(^{19}\text{F},4n\gamma)$ 1992Bo23,1993Pe17

Includes $^{181}\text{Ta}(^{12}\text{C},4n\gamma)$ from 1997Pe26.

1992Bo23, 1993Pe17: $^{174}\text{Yb}(^{19}\text{F},4n)$, E=86-100 MeV; Chateau de Cristal array of 10 escape-suppressed Ge detectors, 26-74 BaF₂ scintillators; measured E γ , I γ , $\gamma\gamma$, DCO ratios. Both are brief reports with detailed level schemes and band structures but with no information about gamma-ray intensities, angular distributions or correlations.

1997Pe26 (same group as 1992Bo23, 1993Pe17): measured lifetime and g factor of isomers using the time differential perturbed angular distribution technique in $^{181}\text{Ta}(^{12}\text{C},4n\gamma)$, E=70 MeV reaction. Also 2001MaZN (priv. comm.) from these authors.

 ^{189}Au Levels

E(level) [†]	J π [‡]	T _{1/2}	Comments
247.25 ^{&} 16	11/2 ^{-#}	4.59 [#] min 11	% ϵ +% β^+ $\approx$ 100; %IT=? E(level): from Adopted Levels.
325.13 [@] 10	9/2 ^{-#}	190 [#] ns 15	
646.2 [@] 8	13/2 ⁻		
682.2 ^{&} 10	15/2 ⁻		
713.1 9	11/2 ⁻		
812.2 9	13/2 ⁻		
1097.1 13			
1105.2 [@] 13	17/2 ⁻		
1130.1 11	(15/2 ⁻)		J π : 11/2 ⁻ in Adopted Levels.
1146.2 13			
1352.2 14			
1383.1 10	13/2 ⁺		
1412.2 ^{&} 15	19/2 ⁻		
1600.2 10			
1662.2 [@] 16	21/2 ⁻		
1739.1 14	(17/2 ⁺)		J π : 13/2 ⁺ , 15/2 ⁺ in Adopted Levels.
1745.2 17			
2062.1 17	21/2 ⁺		
2205.5 ^{&} 17	23/2 ⁻		
2251.0 18	25/2 ⁺		
2299.2 [@] 19	25/2 ⁻		
2400.9 18	25/2 ⁺		
2451.0 17			
2516.0 21	(27/2 ⁺)		
2543.0 21			
2554.8 ^{&} 17	(27/2 ⁻)		J π : (27/2 ⁻) in 1992Bo23.
2554.8+x ^a	31/2 ⁻	9 ns 2	T _{1/2} : from γ (t) (1997Pe26).
2555.0 ^b 23	31/2 ⁺	242 ns 10	g=0.42 3 (1997Pe26) E(level): 2516.0+y, y=38.8 keV in 2001MaZN, 39 in 1997Pe26. J π : (25/2 ⁺) in 1992Bo23.
2863.7+x 8	(33/2 ⁻)		T _{1/2} : from γ (t) (1997Pe26). J π : from Adopted Levels and level scheme consistency in 1993Pe17. J π =(29/2 ⁻) in 1992Bo23.
2929.0 25			
2968.2 22	(29/2 ⁻)		J π : from 1992Bo23.
2989.9+x ^a 8	35/2 ⁻		J π : (31/2 ⁻) in 1992Bo23.
3004.2 [@] 22	29/2 ⁻		
3062.0 ^b 25	35/2 ⁺		J π : (29/2 ⁺) in 1992Bo23.
3162.1+x ^c 11			
3221.2 24			

Continued on next page (footnotes at end of table)

$^{174}\text{Yb}(^{19}\text{F},4n\gamma)$ **1992Bo23,1993Pe17 (continued)** ^{189}Au Levels (continued)

E(level) [†]	J ^π [‡]	Comments
3359.8+x ¹⁰	(37/2 ⁻)	J ^π : from Adopted Levels and level scheme consistency in 1993Pe17 . J ^π =(33/2 ⁻) in 1992Bo23 .
3553 ³		E(level): this level corresponds to 3710 in Adopted Levels.
3560.9+x ^a ¹¹	39/2 ⁻	J ^π : (35/2 ⁻) in 1992Bo23 .
3562 ³	(37/2 ⁺)	J ^π : from Adopted Levels and level scheme consistency in 1993Pe17 . J ^π =(31/2 ⁺) in 1992Bo23 .
3839.5+x ^c ¹¹		
3845 ^b ³	39/2 ⁺	J ^π : (33/2 ⁺) in 1992Bo23 .
3964.8+x ¹⁴		
4105.9+x ¹²	(41/2 ⁻)	J ^π : from Adopted Levels and level scheme consistency in 1993Pe17 . J ^π =(37/2 ⁻) in 1992Bo23 .
4200.8+x ¹⁷		E(level): this level corresponds to 4527+x in Adopted Levels.
4254.9+x ^a ¹⁵	43/2 ⁻	J ^π : (39/2 ⁻) in 1992Bo23 .
4290.8+x ¹⁷		
4325 ³	(41/2 ⁺)	J ^π : from Adopted Levels and level scheme consistency in 1993Pe17 . J ^π =(35/2 ⁺) in 1992Bo23 .
4479 ^b ³	43/2 ⁺	J ^π : (37/2 ⁺) in 1992Bo23 .
4527.5+x ^c ¹⁵		
4675.5+x ^c ¹⁸		
4698 ^b ³	47/2 ⁺	J ^π : (41/2 ⁺) in 1992Bo23 ; (45/2 ⁻) in Adopted Levels.
4718.9+x ¹⁸		E(level): this level corresponds to 5368+x in Adopted Levels.
4797.9+x ¹⁸		E(level): this level corresponds to 6179 in Adopted Levels.
4878 ³		
4904.9+x ^a ¹⁸	47/2 ⁻	
5173 ³		
5315 ^b ³	51/2 ⁺	J ^π : (45/2 ⁺) in 1992Bo23 .
5429.5+x ^c ²¹		
5601 ⁴		
5664 ⁴		
5707.9+x ^a ²¹	51/2 ⁻	
5915 ^b ⁴	55/2 ⁺	E(level): this level corresponds to 6234 in Adopted Levels.
6234 ^b ⁴	57/2 ⁺	E(level), J ^π : this level corresponds to 5634, (53/2 ⁺) in Adopted Levels; ordering of the 319-600 γ cascade is reversed in $^{176}\text{Yb}(^{19}\text{F},6n\gamma)$ (1992Ve05) and in the Adopted dataset.
6305.9+x ^a ²³	55/2 ⁻	
6307.5+x ^c ²³		
7091 ^b ⁴	61/2 ⁺	
7955 ^b ⁴	65/2 ⁺	

[†] From least-squares fit to E_γ values, assuming Δ(E_γ)=1 keV for each E_γ.

[‡] The assignments from [1993Pe17](#) are given here when these differ from those in [1992Bo23](#).

From Adopted Levels.

@ Band(A): Prolate band based on 9/2⁻.

& Band(B): Oblate sequence based on 11/2⁻.

^a Band(C): Oblate sequence based on (31/2⁻).

^b Band(D): Oblate sequence based on 31/2⁺.

^c Band(E): γ cascade.

$^{174}\text{Yb}(^{19}\text{F}, 4n\gamma)$ **1992Bo23,1993Pe17 (continued)** $\gamma(^{189}\text{Au})$

E_γ †	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	α	Comments
(x)	2554.8+x	31/2 ⁻	2554.8	(27/2 ⁻)			
38.8 3	2555.0	31/2 ⁺	2516.0	(27/2 ⁺)	[E2]	435 18	E_γ , Mult.: from 2001MaZN, uncertainty assigned by the evaluators. Other: 39 keV (1997Pe26 in Fig. 1). E_γ : from Adopted Gammas.
77.9 1	325.13	9/2 ⁻	247.25	11/2 ⁻			
104	2554.8	(27/2 ⁻)	2451.0				
126	2989.9+x	35/2 ⁻	2863.7+x	(33/2 ⁻)			
148	4675.5+x		4527.5+x				
150	2400.9	25/2 ⁺	2251.0	25/2 ⁺			
154	2554.8	(27/2 ⁻)	2400.9	25/2 ⁺			
154	4479	43/2 ⁺	4325	(41/2 ⁺)			
189	2251.0	25/2 ⁺	2062.1	21/2 ⁺			
201	3560.9+x	39/2 ⁻	3359.8+x	(37/2 ⁻)			
219	4698	47/2 ⁺	4479	43/2 ⁺			E_γ : 218 in 1997Pe13.
236	4200.8+x		3964.8+x				
253	1383.1	13/2 ⁺	1130.1	(15/2 ⁻)			
253	3221.2		2968.2	(29/2 ⁻)			
265	2516.0	(27/2 ⁺)	2251.0	25/2 ⁺			
283	3845	39/2 ⁺	3562	(37/2 ⁺)			
292	2543.0		2251.0	25/2 ⁺			
299	3162.1+x		2863.7+x	(33/2 ⁻)			
309	2863.7+x	(33/2 ⁻)	2554.8+x	31/2 ⁻			
319 ‡	6234	57/2 ⁺	5915	55/2 ⁺			
321	646.2	13/2 ⁻	325.13	9/2 ⁻			
326	4290.8+x		3964.8+x				
332	3553		3221.2				
349	2554.8	(27/2 ⁻)	2205.5	23/2 ⁻			
356	1739.1	(17/2 ⁺)	1383.1	13/2 ⁺			
370	3359.8+x	(37/2 ⁻)	2989.9+x	35/2 ⁻			
374	2929.0		2555.0	31/2 ⁺			
384	1097.1		713.1	11/2 ⁻			
388	713.1	11/2 ⁻	325.13	9/2 ⁻			
393	1745.2		1352.2				
399	4878		4479	43/2 ⁺			
428	5601		5173				
435	682.2	15/2 ⁻	247.25	11/2 ⁻			E_γ : 434 in 1993Pe17.
435	2989.9+x	35/2 ⁻	2554.8+x	31/2 ⁻			
459	1105.2	17/2 ⁻	646.2	13/2 ⁻			
464	4718.9+x		4254.9+x	43/2 ⁻			
475	5173		4698	47/2 ⁺			
480	4325	(41/2 ⁺)	3845	39/2 ⁺			
484	1130.1	(15/2 ⁻)	646.2	13/2 ⁻			
491	5664		5173				
496	3359.8+x	(37/2 ⁻)	2863.7+x	(33/2 ⁻)			
500	1146.2		646.2	13/2 ⁻			
500	3562	(37/2 ⁺)	3062.0	35/2 ⁺			
507	3062.0	35/2 ⁺	2555.0	31/2 ⁺			
540	1352.2		812.2	13/2 ⁻			
543	4797.9+x		4254.9+x	43/2 ⁻			
545	4105.9+x	(41/2 ⁻)	3560.9+x	39/2 ⁻			
557	1662.2	21/2 ⁻	1105.2	17/2 ⁻			
565	812.2	13/2 ⁻	247.25	11/2 ⁻			
571	3560.9+x	39/2 ⁻	2989.9+x	35/2 ⁻			
598	6305.9+x	55/2 ⁻	5707.9+x	51/2 ⁻			E_γ : 600 in 1997Pe13.
600 ‡	5915	55/2 ⁺	5315	51/2 ⁺			

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$^{174}\text{Yb}(^{19}\text{F},4n\gamma)$ **1992Bo23,1993Pe17** (continued) $\gamma(^{189}\text{Au})$ (continued)

$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π
605	3964.8+x		3359.8+x	(37/2 ⁻)	746	4105.9+x	(41/2 ⁻)	3359.8+x	(37/2 ⁻)
617	5315	51/2 ⁺	4698	47/2 ⁺	754	5429.5+x		4675.5+x	
634	4479	43/2 ⁺	3845	39/2 ⁺	763	4325	(41/2 ⁺)	3562	(37/2 ⁺)
637	2299.2	25/2 ⁻	1662.2	21/2 ⁻	783	3845	39/2 ⁺	3062.0	35/2 ⁺
650	2062.1	21/2 ⁺	1412.2	19/2 ⁻	788	1600.2		812.2	13/2 ⁻
650	4904.9+x	47/2 ⁻	4254.9+x	43/2 ⁻	793	2205.5	23/2 ⁻	1412.2	19/2 ⁻
669	2968.2	(29/2 ⁻)	2299.2	25/2 ⁻	803	5707.9+x	51/2 ⁻	4904.9+x	47/2 ⁻
670	1383.1	13/2 ⁺	713.1	11/2 ⁻	849	3839.5+x		2989.9+x	35/2 ⁻
678	3839.5+x		3162.1+x		857	7091	61/2 ⁺	6234	57/2 ⁺
688	4527.5+x		3839.5+x		864	7955	65/2 ⁺	7091	61/2 ⁺
694	4254.9+x	43/2 ⁻	3560.9+x	39/2 ⁻	878	6307.5+x		5429.5+x	
705	3004.2	29/2 ⁻	2299.2	25/2 ⁻	954	1600.2		646.2	13/2 ⁻
730	1412.2	19/2 ⁻	682.2	15/2 ⁻	1039	2451.0		1412.2	19/2 ⁻
737	1383.1	13/2 ⁺	646.2	13/2 ⁻					

[†] From **1992Bo23** unless otherwise stated.

[‡] **1992Ve05** in $^{176}\text{Yb}(^{19}\text{F},6n\gamma)$ propose a reversed ordering of the 319-600 cascade, thus giving a different energy and $J\pi$ for the intermediate level.

$^{176}\text{Yb}(^{19}\text{F}, 6n\gamma)$ **1992Ve05**

1992Ve05: E(^{19}F)=107 MeV. Measured $E\gamma$, $\gamma\gamma$, DCO ratios using ORIRIS spectrometer. Deduced high-spin levels, $J\pi$, band structures. It is a brief paper with a detailed level scheme, but with no information about gamma-ray intensities, DCO ratios, etc.

 ^{189}Au Levels

E(level) [†]	$J^{\pi\ddagger}$	$T_{1/2}$	Comments
247.25@ 16	11/2 ⁻ #	4.59 [#] min 11	% ε +% β^+ ≈100; %IT=? E(level): from Adopted Gammas.
325.13 ^h 10	9/2 ⁻ #	190 [#] ns 15	
646.1 ^h 5	13/2 ⁻		
681.8@ 5	15/2 ⁻		
712.6 5	11/2 ⁻		
812.7 5	13/2 ⁻		
1097.7 8	(15/2 ⁻)		
1105.4 ^h 8	17/2 ⁻		
1352.7 7			
1383.3 8	13/2 ⁺		J^{π} : from 1992Bo23 in $^{174}\text{Yb}(^{19}\text{F}, 4n\gamma)$, (17/2 ⁻) in 1992Ve05.
1412.1@ 7	19/2 ⁻		
1600.5 7			
1662.6 ^h 9	21/2 ⁻		
1688.1 9			
1746.5 9			
2062.6 9	(21/2 ⁺)		
2205.6@ 9	23/2 ⁻		
2250.6 10	(25/2 ⁺)		
2299.9 ^h 10	25/2 ⁻		
2319.4 10			
2401.3 10	(27/2 ⁺)		J^{π} : (25/2 ⁺) in Adopted Levels.
2450.9 9	23/2 ⁻		
2515.6 11	(27/2 ⁺ , 29/2 ⁺)		J^{π} : (27/2 ⁺) in Adopted Levels.
2554.5@ 10	27/2 ⁻		
2554.5+x& 31/2 ⁻ #		9.3 [#] ns 5	
2554.6 ^f 12	31/2 ⁺ #	242 [#] ns 10	E(level): 2515.9+y, y=38.8 keV (2001MaZN), 39 keV (1997Pe26). See $^{174}\text{Yb}(^{19}\text{F}, 4n\gamma)$ dataset for both references.
2863.4+x ^a 4	33/2 ⁻		
2969.1 ⁱ 12	29/2 ⁻		
2989.4+x& 4	35/2 ⁻		
3004.3 ^h 12	29/2 ⁻		
3061.9 ^f 13	35/2 ⁺		
3161.0+x ^c 6	(37/2 ⁻)		
3222.6 ⁱ 12	31/2 ⁻		
3359.6+x ^a 5	37/2 ⁻		
3377.9 ⁱ 12	33/2 ⁻		
3560.3+x& 5	39/2 ⁻		
3562.4 14	37/2 ⁺		
3710.2 ⁱ 13			
3838.7+x ^c 6	(39/2 ⁻)		
3845.1 ^f 14	39/2 ⁺		
3921.8 ⁱ 13	(37/2 ⁻)		
3965.5+x 5	(39/2 ⁻)		
3979.7 14			

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$^{176}\text{Yb}(^{19}\text{F},6n\gamma)$ **1992Ve05 (continued)** ^{189}Au Levels (continued)

$E(\text{level})^{\dagger}$	$J^{\pi\ddagger}$	$E(\text{level})^{\dagger}$	$J^{\pi\ddagger}$	$E(\text{level})^{\dagger}$	$J^{\pi\ddagger}$
4103.3+x ^a 6	41/2 ⁻	5165.9 15		6316.7+x ^c 11	(57/2 ⁻)
4254.1+x ^{&} 6	43/2 ⁻	5174.0 15	49/2 ⁺	6358.9 ^d 16	(57/2)
4291.3+x 6	(41/2 ⁻)	5263.9+x ^c 9	(49/2 ⁻)	6378.9 16	
4306.5+x ^b 7	(43/2 ⁻)	5315.1 ^f 15	51/2 ⁺	6395.5+x 10	
4325.2 14	41/2 ⁺	5368.7+x ^a 8	(49/2 ⁻)	6880.7 ^d 17	(61/2)
4352.0 ^g 14	(41/2 ⁺)	5429.1+x 9	(47/2 ⁻)	7091.6 ^e 18	(61/2 ⁺)
4479.5 ^f 14	43/2 ⁺	5634.4 ^e 16	(53/2 ⁺)	7284.2 17	(61/2 ⁻)
4527.2+x ^c 6	(43/2 ⁻)	5708.1+x ^{&} 8	51/2 ⁻	7600.5 ^d 17	(65/2)
4638.5 ^g 14	(43/2 ⁺)	5734.8+x ^c 10	(53/2 ⁻)	7848.9 18	(65/2)
4675.0+x ^c 7	(45/2 ⁻)	5860.7 16		7955.7 ^e 18	(65/2 ⁺)
4695.3+x ^a 7	(45/2 ⁻)	5923.2 ^d 16	55/2 ⁺	8181.8 18	
4698.1 ^f 15	47/2 ⁺	5964.7+x ^b 10	(51/2 ⁻)	8261.3 18	
4879.1 14		6097.3+x ^a 8	(53/2 ⁻)	8433.4 ^d 18	(69/2)
4904.1+x ^{&} 7	47/2 ⁻	6179.3 17		8680.1 ^e 19	(69/2 ⁺)
4915.7 15		6201.8 16		8803.8 19	
5084.5 15		6234.3 ^e 17	(57/2 ⁺)	9140.5 20	
5102.6 ^g 14	(47/2 ⁺)	6306.1+x ^{&} 10	(55/2 ⁻)	9313.6 ^d 19	(73/2)
5125.3+x ^b 8	(47/2 ⁻)	6306.2+x 10		9580.4 ^e 20	(73/2 ⁺)

[†] From least-squares fit to $E\gamma$ values, assuming $\Delta(E\gamma)=0.5$ keV for each $E\gamma$.

[‡] From 1992Ve05, except as noted.

From Adopted Levels.

@ Band(A): Structure based on 11/2⁻.

& Band(B): $\pi h_{11/2} \nu i_{13/2}^2$, $\alpha=-1/2$.

^a Band(b): $\pi h_{11/2} \nu i_{13/2}^2$, $\alpha=+1/2$.

^b Band(C): γ cascade based on (43/2⁻).

^c Band(D): γ cascade based on (37/2⁻).

^d Band(E): Band based on (55/2⁺).

^e Band(F): Band based on (53/2⁺).

^f Band(G): γ cascade based on 31/2⁺.

^g Band(H): Structure based on (41/2⁺).

^h Band(I): Band based on 9/2⁻.

ⁱ Band(J): γ cascade based on 29/2⁻.

 $\gamma(^{189}\text{Au})$

$E_{\gamma}^{\dagger}$	$E_i(\text{level})$	J_i^{π}	E_f	J_f^{π}	Mult.	α	Comments
x	2554.5+x	31/2 ⁻	2554.5	27/2 ⁻			
38.8 3	2554.6	31/2 ⁺	2515.6	(27/2 ⁺ , 29/2 ⁺)	(E2)	435 18	E_{γ} , Mult.: from 2001MaZN, measured by recoil-catcher method. Uncertainty of 0.3 keV assigned by the evaluator. Other: 39 (1997Pe26, from Fig. 1); see $^{174}\text{Yb}(^{19}\text{F}, 4n\gamma)$ dataset for 1997Pe26 and 2001MaZN.
77.9 1	325.13	9/2 ⁻	247.25	11/2 ⁻			E_{γ} : from Adopted Gammas.
125.6	2989.4+x	35/2 ⁻	2863.4+x	33/2 ⁻			
141.0	5315.1	51/2 ⁺	5174.0	49/2 ⁺			

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$^{176}\text{Yb}(^{19}\text{F},6n\gamma)$ 1992Ve05 (continued) $\gamma(^{189}\text{Au})$ (continued)

E_γ [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	E_γ [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π
147.5	4675.0+x	(45/2 ⁻)	4527.2+x	(43/2 ⁻)	507.3	3061.9	35/2 ⁺	2554.6	31/2 ⁺
150.6	2401.3	(27/2 ⁺)	2250.6	(25/2 ⁺)	507.3	4352.0	(41/2 ⁺)	3845.1	39/2 ⁺
150.7	4254.1+x	43/2 ⁻	4103.3+x	41/2 ⁻	522.1	6880.7	(61/2)	6358.9	(57/2)
153.2	2554.5	27/2 ⁻	2401.3	(27/2 ⁺)	540.0	1352.7		812.7	13/2 ⁻
154.2	4479.5	43/2 ⁺	4325.2	41/2 ⁺	542.9	4103.3+x	41/2 ⁻	3560.3+x	39/2 ⁻
155.2	3377.9	33/2 ⁻	3222.6	31/2 ⁻	544.1	3921.8	(37/2 ⁻)	3377.9	33/2 ⁻
187.0	5102.6	(47/2 ⁺)	4915.7		544.9	6179.3		5634.4	(53/2 ⁺)
188.0	2250.6	(25/2 ⁺)	2062.6	(21/2 ⁺)	557.2	1662.6	21/2 ⁻	1105.4	17/2 ⁻
200.7	3560.3+x	39/2 ⁻	3359.6+x	37/2 ⁻	565.5	812.7	13/2 ⁻	247.25	11/2 ⁻
211.5	3921.8	(37/2 ⁻)	3710.2		571.2	3560.3+x	39/2 ⁻	2989.4+x	35/2 ⁻
218.6	4698.1	47/2 ⁺	4479.5	43/2 ⁺	581.9	6316.7+x	(57/2 ⁻)	5734.8+x	(53/2 ⁻)
223.3	5102.6	(47/2 ⁺)	4879.1		582.7	1688.1		1105.4	17/2 ⁻
236.1	4527.2+x	(43/2 ⁻)	4291.3+x	(41/2 ⁻)	588.9	5263.9+x	(49/2 ⁻)	4675.0+x	(45/2 ⁻)
240.6	4879.1		4638.5	(43/2 ⁺)	598.0	6306.1+x	(55/2 ⁻)	5708.1+x	51/2 ⁻
253.3	3222.6	31/2 ⁻	2969.1	29/2 ⁻	599.9 [‡]	6234.3	(57/2 ⁺)	5634.4	(53/2 ⁺)
256.8	2319.4		2062.6	(21/2 ⁺)	606.3	3965.5+x	(39/2 ⁻)	3359.6+x	37/2 ⁻
265.0	2515.6	(27/2 ⁺ , 29/2 ⁺)	2250.6	(25/2 ⁺)	608.2	5923.2	55/2 ⁺	5315.1	51/2 ⁺
277.3	4915.7		4638.5	(43/2 ⁺)	617.1	5315.1	51/2 ⁺	4698.1	47/2 ⁺
283.0	3845.1	39/2 ⁺	3562.4	37/2 ⁺	634.5	4479.5	43/2 ⁺	3845.1	39/2 ⁺
286.6	4638.5	(43/2 ⁺)	4352.0	(41/2 ⁺)	637.3	2299.9	25/2 ⁻	1662.6	21/2 ⁻
286.8	5165.9		4879.1		649.8	4904.1+x	47/2 ⁻	4254.1+x	43/2 ⁻
288.6	4254.1+x	43/2 ⁻	3965.5+x	(39/2 ⁻)	650.4	2062.6	(21/2 ⁺)	1412.1	19/2 ⁻
297.7	3161.0+x	(37/2 ⁻)	2863.4+x	33/2 ⁻	669.2	2969.1	29/2 ⁻	2299.9	25/2 ⁻
308.6	2863.4+x	33/2 ⁻	2554.5+x	31/2 ⁻	673.6	5368.7+x	(49/2 ⁻)	4695.3+x	(45/2 ⁻)
313.3	4638.5	(43/2 ⁺)	4325.2	41/2 ⁺	677.8	3838.7+x	(39/2 ⁻)	3161.0+x	(37/2 ⁻)
315.9	7600.5	(65/2)	7284.2	(61/2 ⁻)	686.7	5860.7		5174.0	49/2 ⁺
319.3 [‡]	5634.4	(53/2 ⁺)	5315.1	51/2 ⁺	688.1	4527.2+x	(43/2 ⁻)	3838.7+x	(39/2 ⁻)
321.0	646.1	13/2 ⁻	325.13	9/2 ⁻	693.9	4254.1+x	43/2 ⁻	3560.3+x	39/2 ⁻
325.9	4291.3+x	(41/2 ⁻)	3965.5+x	(39/2 ⁻)	704.4	3004.3	29/2 ⁻	2299.9	25/2 ⁻
332.1	3710.2		3377.9	33/2 ⁻	720.2	7600.5	(65/2)	6880.7	(61/2)
349.0	2554.5	27/2 ⁻	2205.6	23/2 ⁻	724.4	8680.1	(69/2 ⁺)	7955.7	(65/2 ⁺)
369.0	4675.0+x	(45/2 ⁻)	4306.5+x	(43/2 ⁻)	728.8	6097.3+x	(53/2 ⁻)	5368.7+x	(49/2 ⁻)
370.3	3359.6+x	37/2 ⁻	2989.4+x	35/2 ⁻	730.3	1412.1	19/2 ⁻	681.8	15/2 ⁻
385.1	1097.7	(15/2 ⁻)	712.6	11/2 ⁻	737.2	1383.3	13/2 ⁺	646.1	13/2 ⁻
386.3	5084.5		4698.1	47/2 ⁺	743.6	4103.3+x	41/2 ⁻	3359.6+x	37/2 ⁻
387.5	712.6	11/2 ⁻	325.13	9/2 ⁻	746.3	4306.5+x	(43/2 ⁻)	3560.3+x	39/2 ⁻
389.1	6097.3+x	(53/2 ⁻)	5708.1+x	51/2 ⁻	754.1	5429.1+x	(47/2 ⁻)	4675.0+x	(45/2 ⁻)
393.8	1746.5		1352.7		762.8	4325.2	41/2 ⁺	3562.4	37/2 ⁺
399.5	4879.1		4479.5	43/2 ⁺	783.2	3845.1	39/2 ⁺	3061.9	35/2 ⁺
408.9	3377.9	33/2 ⁻	2969.1	29/2 ⁻	787.8	1600.5		812.7	13/2 ⁻
417.3	3979.7		3562.4	37/2 ⁺	789.2	4352.0	(41/2 ⁺)	3562.4	37/2 ⁺
434.6	681.8	15/2 ⁻	247.25	11/2 ⁻	793.5	2205.6	23/2 ⁻	1412.1	19/2 ⁻
435.2	2989.4+x	35/2 ⁻	2554.5+x	31/2 ⁻	803.8	5708.1+x	51/2 ⁻	4904.1+x	47/2 ⁻
435.7	6358.9	(57/2)	5923.2	55/2 ⁺	819.0	5125.3+x	(47/2 ⁻)	4306.5+x	(43/2 ⁻)
441.4	4695.3+x	(45/2 ⁻)	4254.1+x	43/2 ⁻	832.9	8433.4	(69/2)	7600.5	(65/2)
459.3	1105.4	17/2 ⁻	646.1	13/2 ⁻	838.7	5923.2	55/2 ⁺	5084.5	
460.4	9140.5		8680.1	(69/2 ⁺)	839.4	5964.7+x	(51/2 ⁻)	5125.3+x	(47/2 ⁻)
464.1	5102.6	(47/2 ⁺)	4638.5	(43/2 ⁺)	848.1	8803.8		7955.7	(65/2 ⁺)
464.7	5368.7+x	(49/2 ⁻)	4904.1+x	47/2 ⁻	848.8	3838.7+x	(39/2 ⁻)	2989.4+x	35/2 ⁻
470.9	5734.8+x	(53/2 ⁻)	5263.9+x	(49/2 ⁻)	857.3	7091.6	(61/2 ⁺)	6234.3	(57/2 ⁺)
475.7	5174.0	49/2 ⁺	4698.1	47/2 ⁺	864.1	7955.7	(65/2 ⁺)	7091.6	(61/2 ⁺)
480.0	4325.2	41/2 ⁺	3845.1	39/2 ⁺	877.1	6306.2+x		5429.1+x	(47/2 ⁻)
496.4	3359.6+x	37/2 ⁻	2863.4+x	33/2 ⁻	880.2	9313.6	(73/2)	8433.4	(69/2)
500.4	3562.4	37/2 ⁺	3061.9	35/2 ⁺	886.7	6201.8		5315.1	51/2 ⁺

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^{19}\text{F}, 6n\gamma)$ **1992Ve05** (continued) $\gamma(^{189}\text{Au})$ (continued)

$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π
900.3	9580.4	(73/2 ⁺)	8680.1	(69/2 ⁺)	1038.8	2450.9	23/2 ⁻	1412.1	19/2 ⁻
924.9	7284.2	(61/2 ⁻)	6358.9	(57/2)	1063.8	6378.9		5315.1	51/2 ⁺
966.4	6395.5+x		5429.1+x	(47/2 ⁻)	1090.2	8181.8		7091.6	(61/2 ⁺)
968.2	7848.9	(65/2)	6880.7	(61/2)	1169.7	8261.3		7091.6	(61/2 ⁺)
975.8	3965.5+x	(39/2 ⁻)	2989.4+x	35/2 ⁻					

[†] From **1992Ve05**, except as noted.

[‡] **1992Bo23** (also **1993Pe17**) propose a reverse ordering of the 319.3-599.9 cascade, thus defining the intermediate level with different energy and $J\pi$.

$^{181}\text{Ta}(^{12}\text{C}, 4n\gamma)$ **1975De20**

1975De20: $^{181}\text{Ta}(^{12}\text{C}, 4n\gamma)$, $E=70-85$ MeV; Ge(Li) detectors; measured $E\gamma$, $I\gamma$, $I\gamma(\theta)$, $\gamma\gamma$ -coin, delayed γ . Deduced levels, $J\pi$, $T_{1/2}$, conversion coefficients. A total of 32 γ rays reported placed amongst 25 levels up to 4219 keV and four bands. Several γ rays were not placed in the level scheme. A comparison with later studies shows that most of these belong to ^{189}Au .

Some of the cascades have either a different ordering of γ rays or a missed transition in a cascade, thus some of the level energies and $J\pi$ values above 2.5 MeV excitation given here do not match those in the Adopted dataset (where high-spin structures are mainly based on the more extensive work of **1992Ve05**), even when the same gamma rays seem involved.

 ^{189}Au Levels

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}$	Comments
247.25@ 16	11/2 ⁻ #	4.59 [#] min 11	E(level): from Adopted Levels.
325.13& 10	9/2 ⁻ #	190 [#] ns 15	
484.0 5	7/2 ⁻		
491.6 5	5/2 ⁻		
646.1& 5	13/2 ⁻		
681.5@ 5	15/2 ⁻		
712.6 5	11/2 ⁻		
812.7 5	13/2 ⁻		
1105.1& 8	17/2 ⁻		
1411.6@ 7	19/2 ⁻		
1661.8& 9	21/2 ⁻		E(level): level not confirmed in any other study, it is not included in the Adopted dataset.
1719.5 7	17/2 ⁻		
2061.5 ^a 8	21/2 ⁻		$J\pi$: 21/2 ⁽⁺⁾ in Adopted Levels.
2203.7@ 8	23/2 ⁻		$J\pi$: (25/2 ⁺) in Adopted Levels.
2248.7 ^a 9	23/2 ⁻		
2298.8& 10	25/2 ⁻		$J\pi$: (25/2 ⁺) in Adopted Levels.
2399.1 9	(21/2 ⁻)		$J\pi$: (27/2 ⁺) in Adopted Levels.
2513.3 ^a 10	25/2 ⁻		E(level): in Adopted dataset, the 9-ns isomer lies above a 2554.7, (27/2 ⁻) level at an unspecified energy. $J\pi$: (27/2 ⁻) in Adopted Levels. $T_{1/2}$: $\gamma(t)$ (1975De20). No such level in the Adopted dataset.
2552.7 ^b 9	21/2 ⁺	9.3 ns 5	
2678.7 ^b 10	(25/2 ⁺)		
2712.9 ^c 12	29/2 ⁺	440 ns 50	
			$T_{1/2}$: $\gamma(t)$ (1975De20). Note that the value is 242 ns 10 in Adopted Levels, taken from 1997Pe26 . E(level), $J\pi$: in Adopted dataset, this isomer with $T_{1/2}=242$ ns 10 is at 2554.8 keV, $J\pi=31/2^+$ decaying by a 39-keV γ transition.
2987.6 ^b 12	(29/2 ⁺)		$J\pi$: (35/2 ⁻) in Adopted Levels. In the Adopted dataset, this level decays by 125.6 and 435.2 γ rays.
3220.3 ^c 13	33/2 ⁺		$J\pi$: (37/2 ⁻) in Adopted Levels.
3357.8 ^b 13	(33/2 ⁺)		
4001.8 ^c 14	37/2 ⁺		
4219.6 15			

[†] From least-squares fit to $E\gamma$ values, assuming $\Delta(E\gamma)=0.5$ keV for each $E\gamma$, and keeping the energy of the 247 level as fixed.

[‡] From **1975De20**, except as noted. Several assignments are different, see Adopted Levels for $J\pi$ assignments taken from later and more detailed studies by **1992Ve05** and **1992Bo23** (also **1993Pe17**).

From Adopted Levels.

@ Band(A): $\pi_{h11/2}$ band.

& Band(B): $\pi_{h9/2}$ band.

$^{181}\text{Ta}(^{12}\text{C},4n\gamma)$ **1975De20 (continued)** ^{189}Au Levels (continued)^a Band(C): Band based on $21/2^-$.^b Band(D): Band based on $21/2^+$.^c Band(E): Band based on $29/2^+$.

$\gamma(^{189}\text{Au})$									
E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	$\delta^\ddagger$	α	Comments
77.9 1		325.13	$9/2^-$	247.25	$11/2^-$				E_γ : from Adopted Gammas. $E_\gamma=78.0$ in 1975De20 .
^x 103.5 §	38.0 15								Placed from a 2554, ($27/2^-$) level in the Adopted dataset.
^x 114.0	11.7 15								
126.0	8.3 15	2678.7	$(25/2^+)$	2552.7	$21/2^+$				Placed from a 2989+x, ($35/2^-$) level in the Adopted dataset.
^x 141.0	12.3 15								Placed from a 5315, ($51/2^+$) level in the Adopted dataset.
150.3 §	5.9 12	2399.1	$(21/2^-)$	2248.7	$23/2^-$				Mult.: M1(+E2) in 1975De20 based on intensity considerations in a cascade.
153.5 §	13.1 13	2552.7	$21/2^+$	2399.1	$(21/2^-)$	(E1)			Mult.: based on intensity considerations in a cascade.
166.5 @		491.6	$5/2^-$	325.13	$9/2^-$				
187.1 &	32.0 25	2248.7	$23/2^-$	2061.5	$21/2^-$	M1(+E2)	<1.1	1.0 2	$\alpha(\text{exp})=1.2$ 4; $A_2=-0.32$ 7
199.6	16.8 17	2712.9	$29/2^+$	2513.3	$25/2^-$	M2			$\alpha(\text{exp})=4.9$ 11 Transition related to 440-ns isomer and a fast component. E_γ : transition from this isomer is not reported or confirmed in later studies (1979Go15 , 1992Ve05 , 1992Bo23 , 1993Pe17 and 1997Pe26). This γ is not included in the Adopted dataset.
217.8	8.7 8	4219.6		4001.8	$37/2^+$	(Q)			$A_2=+0.15$ 7 A 218.6 γ is placed from a 4698, ($47/2^+$) level in Adopted Levels. Mult.: (E2) in 1975De20 .
236.8 @		484.0	$7/2^-$	247.25	$11/2^-$				
^x 251	3.2 15								A 253.3 γ is placed from a 3223, ($31/2^-$) level in the Adopted dataset.
^x 256.5 §	6.1 12								Placed from a 2319 level in the Adopted dataset.
264.6	35.0 35	2513.3	$25/2^-$	2248.7	$23/2^-$	M1(+E2)	<1.0	0.32 17	$\alpha(\text{exp})=0.6$ 3 (1975De20); $A_2=-0.27$ 27 Transition related to 440-ns isomer.
^x 292.0 §	3.6 18								Placed from a 2543 level in the Adopted dataset.
307.7 §	7.4 22	1719.5	$17/2^-$	1411.6	$19/2^-$				E_γ : γ not confirmed in any other study, not included in the Adopted dataset.
308.9	23.2 25	2987.6	$(29/2^+)$	2678.7	$(25/2^+)$				A 308.6 γ is placed from 2863+x, ($33/2^-$) level in the Adopted dataset.

Continued on next page (footnotes at end of table)

$^{181}\text{Ta}(^{12}\text{C},4n\gamma)$ **1975De20 (continued)** $\gamma(^{189}\text{Au})$ (continued)

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	Comments
321.0	26 3	646.1	13/2 ⁻	325.13	9/2 ⁻		$A_2=+0.5$ 5
349.2 [§]	14.5 15	2552.7	21/2 ⁺	2203.7	23/2 ⁻	D	$A_2=-0.38$ 9 Mult.: (E1) in 1975De20 , however, this contradicts mult=Q in Adopted dataset taken from $\gamma(\theta)$ data in 1979Go15 . Mult.: E2 in 1975De20 .
370.2	12.0 15	3357.8	(33/2 ⁺)	2987.6	(29/2 ⁺)		
387.5 [@]		712.6	11/2 ⁻	325.13	9/2 ⁻		
434.3 ^{&}	100 5	681.5	15/2 ⁻	247.25	11/2 ⁻	(Q)	$A_2=+0.14$ 4
459.0	12.1 13	1105.1	17/2 ⁻	646.1	13/2 ⁻	(Q)	$A_2=+0.28$ 21
507.4	20 2	3220.3	33/2 ⁺	2712.9	29/2 ⁺		$A_2=+0.13$ 15 A 507.3 γ is placed from a 3062, (35/2 ⁺) level in Adopted Levels. Mult.: E2 in 1975De20 .
^x 540.0	10.2 15						Placed from a 1353 level in the Adopted dataset.
556.7	5.4 6	1661.8	21/2 ⁻	1105.1	17/2 ⁻	(Q)	$A_2=+0.29$ 22 Mult.: E2 in 1975De20 .
565.5	7.5 9	812.7	13/2 ⁻	247.25	11/2 ⁻		
^x 634.5	5.5 9					(D)	$A_2=-0.27$ 27 Placed from a 4480, (43/2 ⁺) level in the Adopted dataset.
637.0	4.3 9	2298.8	25/2 ⁻	1661.8	21/2 ⁻	(Q)	$A_2=+0.62$ 38 Mult.: E2 in 1975De20 .
649.8 ^{&}	61 5	2061.5	21/2 ⁻	1411.6	19/2 ⁻	D+Q	$A_2=-0.27$ 8 Mult.: M1+E2 in 1975De20 .
729.8 ^{&}	96 5	1411.6	19/2 ⁻	681.5	15/2 ⁻	(Q)	$A_2=+0.14$ 4 Mult.: E2 in 1975De20 .
781.5	11.5 15	4001.8	37/2 ⁺	3220.3	33/2 ⁺	(Q)	$A_2=+0.36$ 22 A 783.2 γ is placed from a 3845, (39/2 ⁺) level in Adopted Levels. Mult.: E2 in 1975De20 .
792.2 [§]	21.0 15	2203.7	23/2 ⁻	1411.6	19/2 ⁻	(Q)	$A_2=+0.19$ 8 Mult.: E2 in 1975De20 .
1038.2 [§]	9.5 15	1719.5	17/2 ⁻	681.5	15/2 ⁻	D+Q	$A_2=-0.55$ 43 Placement from a 2451, 23/2 ⁻ level in the Adopted dataset. Mult.: M1+E2 in 1975De20 . Note that A_2 is positive in $\gamma(\theta)$ data of 1979Go15 in ($\alpha,6n\gamma$) suggesting mult=(Q).
^x 1039.9	9.6 15						$A_2=+0.36$ 26 This γ is not confirmed in any of the later high-spin studies.

[†] From $\gamma(\theta)$ data, and a few from ce data when conversion coefficients are given.[‡] Deduced by evaluators from ce data.[§] Transition related to the 9.3-ns isomer.[&] Transition related to the 440-ns and 9.3-ns isomers.[@] From level-scheme Fig. 1 in **1975De20**, not listed in authors' Table 1.^x γ ray not placed in level scheme.

$^{191}\text{Ir}(\alpha,6n\gamma)$ **1979Go15****1979Go15:** $E(^4\text{He})=77$ MeV. Measured E_γ , I_γ , $\gamma(\theta)$, $\gamma\gamma$ -coin, ce. ^{189}Au Levels

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$T_{1/2}$	Comments
247.25 @ 16	11/2 ⁻	4.59 min 11	E(level), $T_{1/2}$: from Adopted Levels. J^π : (25/2 ⁺) in Adopted Levels.
325.13 & 10	9/2 ⁻		
646.4 & 4	13/2 ⁻		
681.8 @ 3	15/2 ⁻		
712.6 4	11/2 ⁻		
812.7 3	13/2 ⁻		
1105.7 & 5	17/2 ⁻		
1412.1 @ 5	19/2 ⁻		
1662.7 & 6	21/2 ⁻		
2062.5 5	21/2 ⁽⁺⁾		
2205.2 @ 5	23/2 ⁻		
2250.6 6	23/2 ⁽⁺⁾		
2299.8 6	25/2 ⁻		
2400.8 6	25/2 ⁽⁺⁾		
2450.9 6	(23/2 ⁻) [#]		
2515.7 7	(25/2)		$T_{1/2}$: from Adopted Levels. E(level): $x=38.8$ keV (2001MaZN, 39 in 1997Pe26). In Adopted Levels, this level is at 2555, (31/2 ⁺). A 199.6-keV transition from this isomer proposed by 1975De20 was not confirmed by 1979Go15 from lack of coincidences between 200 γ and 265.1 γ or 188.0 γ as required by level scheme in 1975De20. $T_{1/2}$: $\gamma(t)$ (1979Go15). In Adopted Levels, this half-life is assigned to a 2554+x, (31/2 ⁻) level with no known transition from it. J^π : (33/2 ⁻) in Adopted Levels. J^π : (35/2 ⁻) in Adopted Levels. E(level), J^π : this level is 3062, (35/2 ⁺) in Adopted Levels. E(level), J^π : this level is 3359+x, (37/2 ⁻) in Adopted Levels. E(level), J^π : this level is 3560, (39/2 ⁻) in Adopted Levels. E(level), J^π : this level is 3845.1, (39/2 ⁺) in Adopted Levels.
2515.7+x 7		242 ns 10	
2554.1 @ 6	27/2 ⁻	11 ns 4	
2862.7 7	29/2		
2988.3 7	31/2		
3023.1+x 3			
3233.0 7	31/2		
3433.2 8			
3806.6+x 5			

[†] From least-squares fit to E_γ data, except as noted.[‡] As proposed by 1979Go15 from $\gamma(\theta)$ data and band structures, unless otherwise stated.[#] From Adopted Levels.@ Band(A): $\pi h_{11/2}$ band.& Band(B): $\pi h_{9/2}$ band. $\gamma(^{189}\text{Au})$

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	$\alpha^\S$	Comments
x		2515.7+x		2515.7	(25/2)			E_γ : $x=38.8$ keV (2001MaZN, 39 in 1997Pe26). E_γ : from Adopted Gammas. $A_2=-0.11$ 4; $A_4=-0.02$ 6 $A_2=-0.21$ 11; $A_4=+0.06$ 17 $A_2=-0.22$ 5; $A_4=-0.01$ 8 $A_2=-0.16$ 2; $A_4=-0.01$ 3
77.9 1		325.13	9/2 ⁻	247.25	11/2 ⁻			
125.6 3	4 1	2988.3	31/2	2862.7	29/2	D		
150.1 3	2 1	2400.8	25/2 ⁽⁺⁾	2250.6	23/2 ⁽⁺⁾	(M1) [‡]	2.28	
153.2 3	10 5	2554.1	27/2 ⁻	2400.8	25/2 ⁽⁺⁾	(E1) [‡]	0.1409 21	
188.0 3	21 3	2250.6	23/2 ⁽⁺⁾	2062.5	21/2 ⁽⁺⁾	D		

Continued on next page (footnotes at end of table)

$^{191}\text{Ir}(\alpha,6n\gamma)$ **1979Go15 (continued)** $\gamma(^{189}\text{Au})$ (continued)

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	α [§]	Comments
200.2 3	10 2	3433.2		3233.0	31/2			$A_2=+0.08$ 2; $A_4=-0.03$ 3
265.1 3	42 9	2515.7	(25/2)	2250.6	23/2 ⁽⁺⁾			$A_2=-0.02$ 2; $A_4=+0.01$ 3
308.6 3	22 2	2862.7	29/2	2554.1	27/2 ⁻	D		$A_2=0.00$ 2; $A_4=-0.01$ 3
321.3 3	12 3	646.4	13/2 ⁻	325.13	9/2 ⁻	(E2)	0.0837	$A_2=+0.21$ 5; $A_4=-0.03$ 8
349.0 3	13 2	2554.1	27/2 ⁻	2205.2	23/2 ⁻	(E2)	0.066	$A_2=+0.26$ 4; $A_4=-0.08$ 6
370.3 3	10 2	3233.0	31/2	2862.7	29/2	D		$A_2=-0.09$ 3; $A_4=-0.03$ 5
387.5 3	4 2	712.6	11/2 ⁻	325.13	9/2 ⁻	D		$A_2=-0.31$ 16; $A_4=-0.01$ 24
434.6 3	100 7	681.8	15/2 ⁻	247.25	11/2 ⁻	(E2)	0.0367	$A_2=+0.22$ 2; $A_4=-0.05$ 3
459.3 3	11 1	1105.7	17/2 ⁻	646.4	13/2 ⁻	(E2)		$A_2=+0.28$ 3; $A_4=-0.09$ 5
507.5 3	23 5	3023.1+x		2515.7+x		(Q)		$A_2=+0.31$ 7; $A_4=-0.05$ 10
557.0 3	8 2	1662.7	21/2 ⁻	1105.7	17/2 ⁻	(E2)		$A_2=+0.22$ 6; $A_4=-0.08$ 9
565.5 3	10 2	812.7	13/2 ⁻	247.25	11/2 ⁻	D		$A_2=+0.03$ 3; $A_4=+0.03$ 5
637.1 3	4 1	2299.8	25/2 ⁻	1662.7	21/2 ⁻	(Q)		$A_2=+0.43$ 8; $A_4=-0.10$ 12
650.3 3	59 4	2062.5	21/2 ⁽⁺⁾	1412.1	19/2 ⁻	D		$A_2=-0.16$ 2; $A_4=0.00$ 3
730.3 3	93 7	1412.1	19/2 ⁻	681.8	15/2 ⁻	Q		$A_2=+0.20$ 2; $A_4=-0.05$ 3
783.4 3	12 1	3806.6+x		3023.1+x		Q		$A_2=+0.32$ 3; $A_4=-0.11$ 5
793.2 3	20 1	2205.2	23/2 ⁻	1412.1	19/2 ⁻	(Q)		$A_2=+0.21$ 2; $A_4=-0.03$ 3
1038.8 3	9 1	2450.9	(23/2 ⁻)	1412.1	19/2 ⁻	(Q)		$A_2=+0.33$ 5; $A_4=+0.01$ 8

[†] From $\gamma(\theta)$ except as noted. For stretched quadrupole transitions, (E2) is assigned here for $E_\gamma < 600$ keV based on assumed level half-life < 20 ns (typical coincidence resolving time) and RUL for E2 and M2.

[‡] From experimental conversion coefficients, however, values are not given in 1979Go15.

[§] From BrIcc v2.3b (16-Dec-2014) 2008Ki07, "Frozen Orbitals" appr.

Adopted Levels, Gammas

$Q(\beta^-) = -5010$ 30; $S(n) = 7500$ 30; $S(p) = 4540$ 30; $Q(\alpha) = 4640$ 40 2017Wa10

$S(2n) = 17650$ 30; $S(2p) = 7520$ 40; $Q(\epsilon p) = 910$ 30 (2017Wa10).

^{189}Hg produced and identified by 1955Sm42 in proton bombardment of gold target, followed by half-life measurements. Later studies of ^{189}Hg decay: 1957Ch34, 1960Po07, 1961An02, 1963Ka17, 1966Na01, 1966Fo13, 1967Na02, 1970ErZX, 1975Be17, 1976KeZO, 1988Ko22, 1996Wo04.

 ^{189}Hg LevelsCross Reference (XREF) Flags

A	^{189}Tl ϵ decay (2.3 min)	E	^{175}Lu (^{19}F , 5n γ)
B	^{189}Tl ϵ decay (1.4 min)	F	^{181}Ta (^{14}N , 6n γ)
C	^{160}Gd (^{34}S , 5n γ)		
D	^{160}Gd (^{34}S , 5n γ):SD		

E(level)	J^π	$T_{1/2}$	XREF	Comments
0.0	$3/2^-$	7.6 min 2	A	$\% \epsilon + \% \beta^+ = 100$; $\% \alpha < 0.00003$ $\mu = -0.6086$ 8 (1986UI02, 2014StZZ) $Q = -0.8$ 3 (1986UI02, 2016St14) RMS charge radius $\langle r^2 \rangle^{1/2} = 5.4100$ fm 40 (2013An02 evaluation). $\% \alpha$: from 1963Ka17, determined for both parent and isomer assuming $T_{1/2} = 9.5$ min. $E(\alpha) \approx 4850$ from systematics. Not seen by 1963Ka17. μ : optical pumping/rad detection and NMR/rad detection (1986UI02). Q : NMR optical pumping/rad detection (1986UI02). Other values: 1.1 4 (1985KI09, optical pumping/rad detection), 1.15 25 (1976Bo09). J^π : spin from optical pumping/rad detection (1976Bo09), parity from comparison of μ with Schmidt limit for configuration = $\nu p_{3/2}$. $T_{1/2}$: weighted average of 8.0 min 7 (1976KeZO), 7.5 min 2 (1975Be17) and 7.7 min 2 (1970ErZX). Others: 8.5 min 2 (1966Na01), 9.5 min (1963Ka17), 9.6 min (1961An02), 9 min (1960Po07), 23 min 2 (1957Ch34), 20 min 10 (1955Sm42).
64.3 5	$(5/2)^-$	0.40 ns 4	A	J^π : M1+E2 to $3/2^-$; systematics of odd-A Hg isotopes. $T_{1/2}$: from ^{189}Tl ϵ decay (2.3 min) (1985Ab03).
$0.0 + x^{\ddagger}$	$13/2^+$	8.6 min 2	C EF	$\% \epsilon + \% \beta^+ = 100$; $\% \alpha < 0.00003$ $\mu = -1.058$ 6 (1979Da06, 2014StZZ) $Q = +0.66$ 19 (1986UI02, 2016St14) $\% \alpha$: see comment on ground state. μ : collinear laser spectroscopy (1979Da06). Q : NMR/optical pumping/rad detection (1986UI02). E(level): $x = 80$ 30 (2001Sc41, 2017Au03, mass doublet). J^π : spin from optical quantum beat spectroscopy (1979Da06), parity from comparison of μ with Schmidt limit for configuration = $\nu i_{13/2}$. $T_{1/2}$: weighted average of 8.7 min 2 (1975Be17), 8.7 min 2 (1970ErZX), 8.5 min 3 (1967Na02) and 8.4 min 5 (1966Fo13).
$403.1 + x^{\ddagger}$ 2	$17/2^+$		C EF	
$473.93 + x$ 17	$15/2^+$		C EF	
$901.02 + x^d$ 24	$(15/2^-)$		C	
$1029.94 + x^{\ddagger}$ 22	$21/2^+$		C EF	
$1110.26 + x$ 19	$19/2^+$		C EF	
$1440.04 + x^d$ 23	$(19/2^-)$		C	
$1691.05 + x^a$ 21	$21/2^-$		C EF	
$1762.9 + x^{\ddagger}$ 3	$25/2^+$		C EF	
$1916.9 + x^a$ 3	$25/2^-$		C EF	
$1976.1 + x^{\&}$ 4	$(23/2^-)$		C F	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{189}Hg Levels (continued)

E(level)	$J^{\pi\dagger}$	XREF	E(level)	$J^{\pi\dagger}$	XREF
2034.3+x ^d 3	(23/2 ⁻)	C	4329.0+x [@] 6	(41/2 ⁺)	C
2220.5+x ^{&} 3	(27/2 ⁻)	C F	4438.5+x 6	(41/2 ⁺)	C
2236.0+x 4	(29/2 ⁻)	C	4479.3+x ^{&} 6	(43/2 ⁻)	C
2244.7+x 4	(29/2 ⁻)	C	4517.3+x 6	(43/2 ⁻)	C
2253.1+x ^a 3	29/2 ⁻	C EF	4549.8+x 5	(39/2 ⁻)	C
2477.0+x [#] 4	29/2 ⁺	C EF	4700.8+x ^a 6	(45/2 ⁻)	C
2615.9+x [‡] 4	29/2 ⁺	C F	4713.2+x [#] 6	45/2 ⁺	C F
2674.3+x [#] 4	33/2 ⁺	C EF	4760.7+x ^c 6	(45/2 ⁻)	C
2675.6+x ^d 5	(25/2 ⁻)	C	4869.6+x 6	(45/2 ⁺)	C
2682.0+x 4	(29/2 ⁺)	C	4960.4+x 6	(43/2 ⁻)	C
2686.1+x ^{&} 4	(31/2 ⁻)	C F	5002.2+x [@] 6	(45/2 ⁺)	C
2821.3+x ^a 4	33/2 ⁻	C EF	5035.9+x ^b 5	(45/2 ⁻)	C
2947.2+x 4	(31/2 ⁻)	C	5117.7+x ^{&} 7	(47/2 ⁻)	C
2949.2+x ^b 4	(33/2 ⁻)	C F	5544.5+x [@] 7	(47/2 ⁺)	C
3123.4+x [@] 5	(33/2 ⁺)	C F	5583.2+x [#] 7	49/2 ⁺	C F
3153.6+x [#] 5	37/2 ⁺	C EF	5702.5+x ^c 6	(49/2 ⁻)	C
3307.1+x 5	(33/2 ⁺)	C	5899.9+x ^b 6	(49/2 ⁻)	C
3343.9+x ^{&} 4	(35/2 ⁻)	C F	5952.2+x ^{&} 7	(51/2 ⁻)	C
3400.2+x [‡] 4	(33/2 ⁺)	C	6535.7+x [#] 8	(53/2 ⁺)	C
3439.3+x ^c 5	(37/2 ⁻)	C	6819.7+x ^{&} 8	(55/2 ⁻)	C
3449.3+x 5	(37/2 ⁻)	C	y ^e	J $\approx$ (29/2,31/2)	D
3467.1+x ^b 4	(37/2 ⁻)	C F	366.4+y ^e 2	J+2	D
3540.7+x ^a 4	37/2 ⁻	C F	774.5+y ^e 3	J+4	D
3793.2+x [@] 5	(37/2 ⁺)	C F	1223.2+y ^e 4	J+6	D
3826.0+x 5	(37/2 ⁺)	C	1711.7+y ^e 4	J+8	D
3875.4+x [#] 6	41/2 ⁺	C F	2239.7+y ^e 5	J+10	D
3992.4+x ^{&} 5	(39/2 ⁻)	C	2806.6+y ^e 5	J+12	D
4062.7+x 6	(41/2 ⁺)	C	3410.5+y ^e 6	J+14	D
4172.7+x ^a 5	(41/2 ⁻)	C	4050.8+y ^e 6	J+16	D
4227.9+x ^b 5	(41/2 ⁻)	C	4726.7+y ^e 6	J+18	D
4237.3+x ^c 5	(41/2 ⁻)	C	5434.3+y ^e 9	J+20	D

[†] From heavy-ion reaction data, except as noted.

[‡] Band(A): Ground state band, $\pi=+, \alpha=+1/2$. Quasiparticle configuration A (1994Be27,1983Gu12).

Band(B): Rotational band, $\pi=+, \alpha=+1/2$. Quasiparticle configuration ABC (1994Be27,1983Gu12).

@ Band(C): Rotational band based on 33/2⁺. Quasiparticle configuration ACD (1983Gu12).

& Band(D): Rotational band, $\pi=-, \alpha=-1/2$. Quasiparticle configuration ABE at low spin (1994Be27,1983Gu12), and ABCDE after crossing (1994Be27).

^a Band(E): Rotational band, $\pi=-, \alpha=+1/2$. Quasiparticle configuration ABF (1994Be27,1983Gu12).

^b Band(F): Noncollective band based on 33/2⁻, $\alpha=+1/2$. Quasiparticle configuration ABF' (1994Be27).

^c Band(G): Noncollective band based on 37/2⁻, $\alpha=+1/2$.

^d Band(H): Band based on (15/2⁻).

^e Band(I): SD Band. Identified from $\gamma\gamma$ coin with known transitions in ^{189}Hg . Population of this band is 0.5% of total yield for ^{189}Hg .

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Hg})$									Comments
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult. [‡]	$\delta^\&$	$\alpha^\#$	
64.3	(5/2) ⁻	64.3 5	100	0.0	3/2 ⁻	M1(+E2)	≈0.01	5.18	B(M1)(W.u.)=0.033 3; B(E2)(W.u.)≈0.32 E _γ ,Mult.,δ: from ¹⁸⁹ Tl ε decay (2.3 min) (1985Ab03).
403.1+x	17/2 ⁺	403.1 2	100	0.0+x	13/2 ⁺	E2		0.0465	
473.93+x	15/2 ⁺	473.9 2	100	0.0+x	13/2 ⁺	M1+E2	-0.11 7	0.1048 21	
901.02+x	(15/2) ⁻	901.1 3	100	0.0+x	13/2 ⁺	D			
1029.94+x	21/2 ⁺	626.8 2	100	403.1+x	17/2 ⁺	E2		0.01594	
1110.26+x	19/2 ⁺	636.3 2	100 3	473.93+x	15/2 ⁺	E2		0.01542	
		707.2 2	83 3	403.1+x	17/2 ⁺	M1+E2	-0.52 15	0.0318 25	
1440.04+x	(19/2) ⁻	539.1 3	16 5	901.02+x	(15/2) ⁻				
		1036.9 3	100 14	403.1+x	17/2 ⁺	D			
1691.05+x	21/2 ⁻	251.0 3	5.4 13	1440.04+x	(19/2) ⁻				
		580.8 2	97 2	1110.26+x	19/2 ⁺	E1		0.00652	
		661.0 2	100 4	1029.94+x	21/2 ⁺	E1		0.00504	
1762.9+x	25/2 ⁺	733.0 2	100	1029.94+x	21/2 ⁺	E2		0.01135	
1916.9+x	25/2 ⁻	154.1 3	1.7 6	1762.9+x	25/2 ⁺	(D)			
		225.8 2	100.0 14	1691.05+x	21/2 ⁻	E2		0.260	
1976.1+x	(23/2) ⁻	946.2 3	100	1029.94+x	21/2 ⁺	D			
2034.3+x	(23/2) ⁻	594.3 3	100 15	1440.04+x	(19/2) ⁻				
		1004.3 3	65 23	1029.94+x	21/2 ⁺	D			
2220.5+x	(27/2) ⁻	244.4 3	69 2	1976.1+x	(23/2) ⁻	(E2)		0.201	
		457.6 2	100 5	1762.9+x	25/2 ⁺	D			
2236.0+x	(29/2) ⁻	319.1 3	100	1916.9+x	25/2 ⁻	(E2)		0.0888	
2244.7+x	(29/2) ⁻	327.9 3	100	1916.9+x	25/2 ⁻	(E2)		0.0821	
2253.1+x	29/2 ⁻	336.0 2	100	1916.9+x	25/2 ⁻	E2		0.0765	
2477.0+x	29/2 ⁺	714.1 2	100	1762.9+x	25/2 ⁺	E2		0.01200	
2615.9+x	29/2 ⁺	853.3 5	100	1762.9+x	25/2 ⁺	(E2)		0.00828	
2674.3+x	33/2 ⁺	58.8 5	0.56 4	2615.9+x	29/2 ⁺	E2		62 3	I _γ : from B(E2)(58.8γ)/B(E2)(197.2γ)=1.84 8 (1983Gu12) in (¹⁴ N,6nγ).
		197.2 2	100.0 21	2477.0+x	29/2 ⁺	E2		0.410	
2675.6+x	(25/2) ⁻	641.3 3	100	2034.3+x	(23/2) ⁻	D			
2682.0+x	(29/2) ⁺	919.1 3	100	1762.9+x	25/2 ⁺	Q			
2686.1+x	(31/2) ⁻	432.9 3	13 2	2253.1+x	29/2 ⁻	D+Q			
		465.7 2	100 6	2220.5+x	(27/2) ⁻	(E2)		0.0321	
2821.3+x	33/2 ⁻	568.2 2	100	2253.1+x	29/2 ⁻	(E2)		0.0199	E _γ : 565.5 2 in (¹⁹ F,5nγ) is not used in averaging.
2947.2+x	(31/2) ⁻	331.5 3	69 15	2615.9+x	29/2 ⁺	D			
		470.0 3	100 23	2477.0+x	29/2 ⁺	D			
2949.2+x	(33/2) ⁻	696.0 3	77 9	2253.1+x	29/2 ⁻	Q			
		704.6 3	100 9	2244.7+x	(29/2) ⁻	Q			
		713.3 3	97 9	2236.0+x	(29/2) ⁻	Q			
3123.4+x	(33/2) ⁺	441.4 ^a 3	6 2	2682.0+x	(29/2) ⁺	(E2)		0.0367	

Adopted Levels, Gammas (continued)

 $\gamma(^{189}\text{Hg})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult. ‡	$\alpha^\#$	Comments
3123.4+x	(33/2 ⁺)	646.4 3	100 5	2477.0+x	29/2 ⁺	Q		
3153.6+x	37/2 ⁺	479.3 2	100	2674.3+x	33/2 ⁺	(E2)	0.0299	
3307.1+x	(33/2 ⁺)	830.1 3	100	2477.0+x	29/2 ⁺	Q		
3343.9+x	(35/2 ⁻)	657.8 2	100	2686.1+x	(31/2 ⁻)	Q		
3400.2+x	(33/2 ⁺)	784.0 3	100 33	2615.9+x	29/2 ⁺	Q		
		923.5 3	67 22	2477.0+x	29/2 ⁺	Q		
3439.3+x	(37/2 ⁻)	618.0 3	100	2821.3+x	33/2 ⁻	Q		
3449.3+x	(37/2 ⁻)	628.0 3	100	2821.3+x	33/2 ⁻			
3467.1+x	(37/2 ⁻)	517.9 3	100 8	2949.2+x	(33/2 ⁻)	(E2)	0.0248	
		645.8 3	6 2	2821.3+x	33/2 ⁻	Q		
3540.7+x	37/2 ⁻	719.4 3	100	2821.3+x	33/2 ⁻	Q		
3793.2+x	(37/2 ⁺)	669.7 3	100	3123.4+x	(33/2 ⁺)	Q		
3826.0+x	(37/2 ⁺)	702.6 3	100	3123.4+x	(33/2 ⁺)	Q		
3875.4+x	41/2 ⁺	721.8 3	100	3153.6+x	37/2 ⁺	Q		
3992.4+x	(39/2 ⁻)	648.5 3	100	3343.9+x	(35/2 ⁻)	Q		
4062.7+x	(41/2 ⁺)	909.1 3	100	3153.6+x	37/2 ⁺	Q		
4172.7+x	(41/2 ⁻)	632.0 3	21 5	3540.7+x	37/2 ⁻	Q		
		705.7 3	100 8	3467.1+x	(37/2 ⁻)	Q		
4227.9+x	(41/2 ⁻)	687.1 3	26 11	3540.7+x	37/2 ⁻	Q		
		760.8 3	100 21	3467.1+x	(37/2 ⁻)	Q		
4237.3+x	(41/2 ⁻)	788.0 3	100 27	3449.3+x	(37/2 ⁻)	Q		
		798.0 3	100 27	3439.3+x	(37/2 ⁻)	Q		
4329.0+x	(41/2 ⁺)	503.0 3	100 22	3826.0+x	(37/2 ⁺)	(E2)	0.0265	
		535.8 3	61 11	3793.2+x	(37/2 ⁺)	(E2)	0.0228	
4438.5+x	(41/2 ⁺)	645.3 3	100	3793.2+x	(37/2 ⁺)	Q		
4479.3+x	(43/2 ⁻)	486.9 3	100	3992.4+x	(39/2 ⁻)	(E2)	0.0287	
4517.3+x	(43/2 ⁻)	280.0 3	100	4237.3+x	(41/2 ⁻)	D		
4549.8+x	(39/2 ⁻)	557.3 3	38 15	3992.4+x	(39/2 ⁻)			
		1205.9 3	100 31	3343.9+x	(35/2 ⁻)			
4700.8+x	(45/2 ⁻)	528.0 3	100	4172.7+x	(41/2 ⁻)	(E2)	0.0236	
4713.2+x	45/2 ⁺	837.8 3	100	3875.4+x	41/2 ⁺	Q		
4760.7+x	(45/2 ⁻)	243.4 3	100 13	4517.3+x	(43/2 ⁻)	D		
		523.4 3	63 13	4237.3+x	(41/2 ⁻)	(E2)	0.0241	
4869.6+x	(45/2 ⁺)	994.2 3	100	3875.4+x	41/2 ⁺	Q		
4960.4+x	(43/2 ⁻)	968.0 3	100	3992.4+x	(39/2 ⁻)			
5002.2+x	(45/2 ⁺)	673.2 3	100	4329.0+x	(41/2 ⁺)	Q		
5035.9+x	(45/2 ⁻)	808.0 3	100 33	4227.9+x	(41/2 ⁻)			
		863.1 3	100 33	4172.7+x	(41/2 ⁻)	Q		
5117.7+x	(47/2 ⁻)	638.4 3	100	4479.3+x	(43/2 ⁻)	Q		
5544.5+x	(47/2 ⁺)	542.3 3	100	5002.2+x	(45/2 ⁺)	D		
5583.2+x	49/2 ⁺	870.0 3	100	4713.2+x	45/2 ⁺	Q		
5702.5+x	(49/2 ⁻)	941.8 3	100	4760.7+x	(45/2 ⁻)	Q		

 E_γ : 866.3 6 in ($^{14}\text{N}, 6n\gamma$) is not used in averaging.

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Hg})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult. [‡]	$\alpha^\#$	$I_{(\gamma+ce)}^\@$
5899.9+x	(49/2 ⁻)	864.0 3	100	5035.9+x	(45/2 ⁻)	Q		
5952.2+x	(51/2 ⁻)	834.5 3	100	5117.7+x	(47/2 ⁻)	Q		
6535.7+x	(53/2 ⁺)	952.5 3	100	5583.2+x	49/2 ⁺	Q		
6819.7+x	(55/2 ⁻)	867.5 3	100	5952.2+x	(51/2 ⁻)	Q		
366.4+y	J+2	366.4 2		y	J $\approx$ (29/2,31/2)	[E2]	0.0601	1.00 10
774.5+y	J+4	408.1 2		366.4+y	J+2	[E2]	0.0450	1.00 15
1223.2+y	J+6	448.7 2		774.5+y	J+4	[E2]	0.0352	0.86 19
1711.7+y	J+8	488.5 2		1223.2+y	J+6	[E2]	0.0285	0.89 16
2239.7+y	J+10	528.0 2		1711.7+y	J+8	[E2]	0.0236	0.62 11
2806.6+y	J+12	566.9 2		2239.7+y	J+10	[E2]	0.0200	0.58 11
3410.5+y	J+14	603.9 2		2806.6+y	J+12	[E2]	0.01733	0.53 14
4050.8+y	J+16	640.3 2		3410.5+y	J+14	[E2]	0.01521	0.58 11
4726.7+y	J+18	675.9 2		4050.8+y	J+16			
5434.3+y?	J+20	707.6 ^a 6		4726.7+y	J+18			

[†] Weighted averages of values from ¹⁶⁰Gd(³⁴S,5n γ), ¹⁷⁵Lu(¹⁹F,5n γ) and ¹⁸¹Ta(¹⁴N,6n γ), as available, with exceptions noted. For SD band, values are from ¹⁶⁰Gd(³⁴S,5n γ):SD.

[‡] From $\gamma(\theta)$, $\gamma\gamma(\theta)$ (DCO), $\gamma\gamma$ (lin pol) and ce data in various heavy-ion reaction datasets, except as noted.

[§] Relative photon branching ratios deduced from ¹⁶⁰Gd(³⁴S,5n γ).

& From 1981Bo08 unless otherwise stated.

[@] Relative I(γ +ce) values within the superdeformed band.

[#] From BrIcc code (2008Ki07), “Frozen Orbitals” appr.

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

Adopted Levels, Gammas

Adopted Levels, Gammas (continued)

Band(F): Noncollective
band based on $33/2^-$,
 $\alpha=+1/2$

Band(G): Noncollective
band based on $37/2^-$,
 $\alpha=+1/2$

Band(I): SD Band

Band(H): Band based on $(15/2^-)$

^{189}Tl ε decay (2.3 min) 1974Ha10,1976Ha25,1985Ab03

Parent: ^{189}Tl : $E=0$; $J^\pi=(1/2^+)$; $T_{1/2}=2.3$ min 2; $Q(\varepsilon)=5010$ 30; $\% \varepsilon + \% \beta^+$ decay=100

^{189}Tl - J^π , $T_{1/2}$: From ^{189}Tl Adopted Levels.

^{189}Tl - $Q(\varepsilon)$: From 2017Wa10.

Substantial amount of data available in 1976GoZE thesis have not been included here based on advice from J. Wood (1980WoZN).

 ^{189}Hg Levels

E(level)	J^π [†]	$T_{1/2}$	Comments
0.0	$3/2^-$		
64.3 5	$(5/2)^-$	0.40 ns 4	$T_{1/2}$: measured by 1985Ab03.

[†] From Adopted Levels.

 $\gamma(^{189}\text{Hg})$

E_γ [†]	I_γ [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	δ	α [‡]	Comments
64.3 5		64.3	$(5/2)^-$	0.0	$3/2^-$	M1(+E2)	≈ 0.01	5.18	E_γ , Mult., δ : from 1985Ab03. δ : other: 0.4 from 1987BoZT.
^x 333.7	100 13								
^x 451.0	49 9								
^x 522.3	27 7								
^x 942.2	69 16								

[†] From 1974Ha10, except as noted.

[‡] From BrIcc v2.3b (16-Dec-2014) 2008Ki07, "Frozen Orbitals" appr.

^x γ ray not placed in level scheme.

 ^{189}Tl ε decay (2.3 min) 1974Ha10,1976Ha25,1985Ab03Decay Scheme

Intensities: Relative I_γ

^{189}Tl ε decay (1.4 min) [1972Va12,1974Ha10,1976Ha25](#)

Parent: ^{189}Tl : $E=281.7$; $J^\pi=(9/2^-)$; $T_{1/2}=1.4$ min I ; $Q(\varepsilon)=5010.30$; $\% \varepsilon + \% \beta^+$ decay=100

^{189}Tl - $E, J^\pi, T_{1/2}$: From ^{189}Tl Adopted Levels.

^{189}Tl - $Q(\varepsilon)$: From [2017Wa10](#).

Substantial amount of data available in [1976GoZE](#) thesis have not been included here based on advice from J. Wood ([1980WoZN](#)).

 $\gamma(^{189}\text{Hg})$

<u>E_γ</u> [†]	<u>I_γ</u> [†]
^x 215.6	100.8
^x 228.4	56.6
^x 317.5	111.1
^x 335	≈70
^x 445.2	15.3

[†] From [1974Ha10](#).

^x γ ray not placed in level scheme.

$^{160}\text{Gd}(^{34}\text{S}, 5\text{n}\gamma)$ 1994Be27

1994Be27: $^{160}\text{Gd}(^{34}\text{S}, 5\text{n}\gamma)$, E=159, 162 and 165 MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ and $\gamma\gamma(\theta)$ (DCO) using the Argonne-Notre Dame BGO γ -ray facility, an array consisting of 12 Compton-suppressed Ge detectors and 50 hexagonal BGO scintillators.

 ^{189}Hg Levels

Level scheme was first proposed by 1981Bo08 with 12 excited states and two bands, later extended by 1983Gu12 with 25 excited states and four band structures. The level scheme adopted here is from 1994Be27, which is much enhanced, yet built on levels from previous studies. Only in a few cases levels in 1983Gu12 are different from those in 1994Be27, as a result of some missing transitions in 1983Gu12 in band structures.

A, B, C, D, E, F and F' refer to quasineutron orbitals.

E(level) [†]	J ^{π‡}	Comments
0.0+x [@]	13/2 ⁺	E(level): x=80 keV 30 (2001Sc41,2017Au03).
403.3+x [@] 3	17/2 ⁺	
474.10+x 25	15/2 ⁺	
901.10+x ^f 25	(15/2 ⁻) [#]	
1030.2+x [@] 3	21/2 ⁺	
1110.4+x 3	19/2 ⁺	
1440.2+x ^f 3	(19/2 ⁻) [#]	
1691.2+x ^c 3	21/2 ⁻	
1763.2+x [@] 4	25/2 ⁺	
1917.3+x ^c 4	25/2 ⁻	
1976.4+x ^b 4	23/2 ⁻	
2034.5+x ^f 4	(23/2 ⁻) [#]	
2220.9+x ^b 4	(27/2 ⁻)	
2236.4+x 5	(29/2 ⁻)	
2245.2+x 5	(29/2 ⁻)	
2253.7+x ^c 4	29/2 ⁻	
2477.6+x ^{&} 5	29/2 ⁺	
2616.7+x [@] 5	29/2 ⁺	
2674.7+x ^{&} 5	33/2 ⁺	
2675.8+x ^f 5	(25/2 ⁻) [#]	
2682.3+x 5	(29/2 ⁺)	
2686.6+x ^b 5	(31/2 ⁻)	
2821.9+x ^c 5	33/2 ⁻	
2947.9+x 5	(31/2 ⁻)	
2949.7+x ^d 4	(33/2 ⁻)	
3123.9+x ^a 6	(33/2 ⁺)	
3154.4+x ^{&} 6	37/2 ⁺	
3307.7+x 6	(33/2 ⁺)	
3344.4+x ^b 5	(35/2 ⁻)	
3400.9+x [@] 5	(33/2 ⁺)	
3439.9+x ^e 6	(37/2 ⁻)	
3449.9+x 6	(37/2 ⁻)	
3467.6+x ^d 5	(37/2 ⁻)	
3541.2+x ^c 5	37/2 ⁻	
3793.7+x ^a 6	(37/2 ⁺)	
3826.5+x 6	(37/2 ⁺)	
3876.2+x ^{&} 7	41/2 ⁺	
3992.9+x ^b 6	(39/2 ⁻)	

Continued on next page (footnotes at end of table)

$^{160}\text{Gd}(^{34}\text{S}, 5n\gamma)$ **1994Be27** (continued) ^{189}Hg Levels (continued)

$E(\text{level})^{\dagger}$	$J^{\pi\ddagger}$	Comments
4063.5+x 7	(41/2 ⁺)	
4173.2+x ^c 5	(41/2 ⁻)	
4228.3+x ^d 5	(41/2 ⁻)	
4237.9+x ^e 6	(41/2 ⁻)	
4329.5+x ^a 6	(41/2 ⁺)	
4439.0+x 7	(41/2 ⁺)	
4479.8+x ^b 7	(43/2 ⁻)	
4517.9+x 6	(43/2 ⁻)	J^{π} : from figure 1 of 1994Be27 . $J\pi=(43/2^+)$ in table 1 of 1994Be27 seems a misprint.
4550.3+x 6	(39/2 ⁻)	J^{π} : from figure 1 of 1994Be27 . $J=(37/2)$ in table 1 of 1994Be27 .
4701.2+x ^c 6	(45/2 ⁻)	
4713.9+x ^{&} 8	45/2 ⁺	
4761.3+x ^e 6	(45/2 ⁻)	
4870.4+x 8	(45/2 ⁺)	
4960.9+x 7	(43/2 ⁻)	
5002.7+x ^a 7	(45/2 ⁺)	
5036.3+x ^d 6	(45/2 ⁻)	
5118.2+x ^b 7	(47/2 ⁻)	
5545.0+x ^a 8	(47/2 ⁺)	J^{π} : $\pi=+$ from figure 1 of 1994Be27 ; $\pi=-$ in table 1 of 1994Be27 seems a misprint.
5583.9+x ^{&} 8	49/2 ⁺	
5703.1+x ^e 7	(49/2 ⁻)	
5900.3+x ^d 6	(49/2 ⁻)	
5952.7+x ^b 8	(51/2 ⁻)	
6536.4+x ^{&} 9	(53/2 ⁺)	
6820.2+x ^b 9	(55/2 ⁻)	

[†] From least-squares fit to E_{γ} values.

[‡] From **1994Be27** based on band structures and DCO values. Also $\gamma(\theta)$ and $\gamma(\text{pol})$ data from **1981Bo08** and $\gamma(\theta)$ data from **1983Gu12** are used in assigning multiplicities and $J\pi$ values.

Parity is tentatively assigned (**1994Be27**).

@ Band(A): Ground state band, $\pi=+, \alpha=+1/2$. Quasiparticle configuration A (**1994Be27**, **1983Gu12**), ABC after alignment.

& Band(B): Rotational band, $\pi=+, \alpha=+1/2$. Quasiparticle configuration ABC (**1994Be27**, **1983Gu12**).

^a Band(C): Band based on 33/2⁺. Quasiparticle configuration ACD (**1983Gu12**).

^b Band(D): Rotational band, $\pi=-, \alpha=-1/2$. Quasiparticle configuration ABE at low spin (**1994Be27**, **1983Gu12**), and ABCDE after crossing (**1994Be27**).

^c Band(E): Rotational band, $\pi=-, \alpha=+1/2$. Quasiparticle configuration ABF (**1994Be27**, **1983Gu12**).

^d Band(F): Noncollective band based on 33/2⁻, $\pi=-, \alpha=+1/2$. Quasiparticle configuration ABF' (**1994Be27**).

^e Band(G): Noncollective band based on 33/2⁻, $\pi=-, \alpha=+1/2$.

^f Band(H): Band based on (15/2⁻).

 $\gamma(^{189}\text{Hg})$

$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	$E_i(\text{level})$	J_i^{π}	E_f	J_f^{π}	Mult. [†]	$\alpha^{\ddagger}$	Comments
(57.7)		2674.7+x	33/2 ⁺	2616.7+x	29/2 ⁺	[E2]	67.9	
154.1 3	0.6 2	1917.3+x	25/2 ⁻	1763.2+x	25/2 ⁺	(D)		DCO=0.76 14
197.2 3	14.1 3	2674.7+x	33/2 ⁺	2477.6+x	29/2 ⁺	(E2)	0.410	Mult.: $\Delta J=0$ transition. DCO=1.24 7

Continued on next page (footnotes at end of table)

$^{160}\text{Gd}(^{34}\text{S}, 5n\gamma)$ **1994Be27** (continued) $\gamma(^{189}\text{Hg})$ (continued)

E_γ [†]	I_γ [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	$\alpha^\ddagger$	Comments
226.1 3	35.4 5	1917.3+x	25/2 ⁻	1691.2+x	21/2 ⁻	(E2)	0.259	DCO=1.12 3
243.4 3	1.6 2	4761.3+x	(45/2 ⁻)	4517.9+x	(43/2 ⁻)	D		DCO=0.68 8
244.5 3	6.1 2	2220.9+x	(27/2 ⁻)	1976.4+x	23/2 ⁻	(E2)	0.200	DCO=1.12 8
251.0 3	1.2 3	1691.2+x	21/2 ⁻	1440.2+x	(19/2 ⁻)	D		DCO=0.80 12
280.0 3	1.7 2	4517.9+x	(43/2 ⁻)	4237.9+x	(41/2 ⁻)	D		DCO=0.69 10
319.1 3	2.8 2	2236.4+x	(29/2 ⁻)	1917.3+x	25/2 ⁻	(E2)	0.0888	DCO=1.53 9
327.9 3	2.8 2	2245.2+x	(29/2 ⁻)	1917.3+x	25/2 ⁻	(E2)	0.0821	DCO=1.43 6
331.5 3	0.9 2	2947.9+x	(31/2 ⁻)	2616.7+x	29/2 ⁺	D		DCO=0.66 26
336.4 3	23.9 5	2253.7+x	29/2 ⁻	1917.3+x	25/2 ⁻	(E2)	0.0763	DCO=1.44 4
403.3 3	100.0 2	403.3+x	17/2 ⁺	0.0+x	13/2 ⁺	(E2)	0.0464	DCO=1.37 3
432.9 3	1.3 2	2686.6+x	(31/2 ⁻)	2253.7+x	29/2 ⁻	D+Q		DCO=0.91 8
441.4 [§] 3	0.5 2	3123.9+x	(33/2 ⁺)	2682.3+x	(29/2 ⁺)	(E2)	0.0367	DCO=1.19 16
457.7 3	8.9 5	2220.9+x	(27/2 ⁻)	1763.2+x	25/2 ⁺	D		DCO=0.67 6
465.7 3	10.4 6	2686.6+x	(31/2 ⁻)	2220.9+x	(27/2 ⁻)	(E2)	0.0321	DCO=1.43 5
470.0 3	1.3 3	2947.9+x	(31/2 ⁻)	2477.6+x	29/2 ⁺	D		DCO=0.65 24
474.1 3	1.0 3	474.10+x	15/2 ⁺	0.0+x	13/2 ⁺	D+Q		DCO=0.67 7
479.7 3	13.6 5	3154.4+x	37/2 ⁺	2674.7+x	33/2 ⁺	(E2)	0.0298	DCO=1.40 3
486.9 3	2.7 2	4479.8+x	(43/2 ⁻)	3992.9+x	(39/2 ⁻)	(E2)	0.0287	DCO=1.46 9
503.0 3	1.8 4	4329.5+x	(41/2 ⁺)	3826.5+x	(37/2 ⁺)	(E2)	0.0265	DCO=1.41 12
517.8 3	8.5 7	3467.6+x	(37/2 ⁻)	2949.7+x	(33/2 ⁻)	(E2)	0.0248	DCO=1.39 5
523.4 3	1.0 2	4761.3+x	(45/2 ⁻)	4237.9+x	(41/2 ⁻)	(E2)	0.0241	DCO=0.99 14
528.0 3	0.5 2	4701.2+x	(45/2 ⁻)	4173.2+x	(41/2 ⁻)	(E2)	0.0236	DCO=1.12 12
535.8 3	1.1 2	4329.5+x	(41/2 ⁺)	3793.7+x	(37/2 ⁺)	(E2)	0.0228	DCO=1.41 12
539.1 3	0.6 2	1440.2+x	(19/2 ⁻)	901.10+x	(15/2 ⁻)			
542.3 3	0.9 2	5545.0+x	(47/2 ⁺)	5002.7+x	(45/2 ⁺)	D		DCO=0.74 10
557.3 3	0.5 2	4550.3+x	(39/2 ⁻)	3992.9+x	(39/2 ⁻)			
568.2 3	14.5 5	2821.9+x	33/2 ⁻	2253.7+x	29/2 ⁻	(E2)	0.0199	DCO=1.37 5
580.8 2	21.7 5	1691.2+x	21/2 ⁻	1110.4+x	19/2 ⁺	D		DCO=0.70 6
594.3 3	4.0 6	2034.5+x	(23/2 ⁻)	1440.2+x	(19/2 ⁻)			
618.0 3	0.5 2	3439.9+x	(37/2 ⁻)	2821.9+x	33/2 ⁻	Q		DCO=1.41 14
626.9 3	100.0 14	1030.2+x	21/2 ⁺	403.3+x	17/2 ⁺	Q		DCO=1.26 3
628.0 3	0.5 3	3449.9+x	(37/2 ⁻)	2821.9+x	33/2 ⁻			
632.0 3	0.8 2	4173.2+x	(41/2 ⁻)	3541.2+x	37/2 ⁻	Q		DCO=1.37 11
636.3 3	15.6 5	1110.4+x	19/2 ⁺	474.10+x	15/2 ⁺	Q		DCO=1.25 5
638.4 3	0.7 2	5118.2+x	(47/2 ⁻)	4479.8+x	(43/2 ⁻)	Q		DCO=1.45 14
641.3 3	3.4 3	2675.8+x	(25/2 ⁻)	2034.5+x	(23/2 ⁻)	D		DCO=0.73 18
645.3 3	1.1 3	4439.0+x	(41/2 ⁺)	3793.7+x	(37/2 ⁺)	Q		DCO=1.37 7
645.8 3	0.5 2	3467.6+x	(37/2 ⁻)	2821.9+x	33/2 ⁻	Q		DCO=1.63 20
646.3 3	8.4 4	3123.9+x	(33/2 ⁺)	2477.6+x	29/2 ⁺	Q		DCO=1.37 4
648.5 3	5.5 4	3992.9+x	(39/2 ⁻)	3344.4+x	(35/2 ⁻)	Q		DCO=1.36 5
657.8 3	8.8 5	3344.4+x	(35/2 ⁻)	2686.6+x	(31/2 ⁻)	Q		DCO=1.38 11
661.0 3	22.4 8	1691.2+x	21/2 ⁻	1030.2+x	21/2 ⁺	D		DCO=1.33 5
								Mult.: $\Delta J=0$ transition.
669.8 3	3.7 3	3793.7+x	(37/2 ⁺)	3123.9+x	(33/2 ⁺)	Q		DCO=1.39 10
673.2 3	1.2 3	5002.7+x	(45/2 ⁺)	4329.5+x	(41/2 ⁺)	Q		DCO=1.41 28
687.1 3	0.5 2	4228.3+x	(41/2 ⁻)	3541.2+x	37/2 ⁻	Q		DCO=1.24 15
696.0 3	2.7 3	2949.7+x	(33/2 ⁻)	2253.7+x	29/2 ⁻	Q		DCO=1.41 11
702.6 3	4.4 3	3826.5+x	(37/2 ⁺)	3123.9+x	(33/2 ⁺)	Q		DCO=1.49 9
704.5 3	3.5 3	2949.7+x	(33/2 ⁻)	2245.2+x	(29/2 ⁻)	Q		DCO=1.44 5
705.7 3	3.9 3	4173.2+x	(41/2 ⁻)	3467.6+x	(37/2 ⁻)	Q		DCO=1.44 5
707.1 3	13.0 5	1110.4+x	19/2 ⁺	403.3+x	17/2 ⁺	D+Q		DCO=0.68 5
713.3 3	3.4 3	2949.7+x	(33/2 ⁻)	2236.4+x	(29/2 ⁻)	Q		DCO=1.35 7
714.2 3	37.9 7	2477.6+x	29/2 ⁺	1763.2+x	25/2 ⁺	Q		DCO=1.26 3
719.3 3	8.4 6	3541.2+x	37/2 ⁻	2821.9+x	33/2 ⁻	Q		DCO=1.48 6

Continued on next page (footnotes at end of table)

$^{160}\text{Gd}(^{34}\text{S}, 5n\gamma)$ **1994Be27** (continued) $\gamma(^{189}\text{Hg})$ (continued)

E_γ [†]	I_γ [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	Comments
721.8 3	6.8 5	3876.2+x	41/2 ⁺	3154.4+x	37/2 ⁺	Q	DCO=1.41 10
733.0 3	64.0 14	1763.2+x	25/2 ⁺	1030.2+x	21/2 ⁺	Q	DCO=1.40 3
760.8 3	1.9 4	4228.3+x	(41/2 ⁻)	3467.6+x	(37/2 ⁻)	Q	DCO=1.38 9
784.0 3	0.9 3	3400.9+x	(33/2 ⁺)	2616.7+x	29/2 ⁺	Q	DCO=1.39 15
788.0 3	1.1 3	4237.9+x	(41/2 ⁻)	3449.9+x	(37/2 ⁻)	Q	DCO=1.68 10
798.0 3	1.1 3	4237.9+x	(41/2 ⁻)	3439.9+x	(37/2 ⁻)	Q	DCO=1.64 13
808.0 3	0.6 2	5036.3+x	(45/2 ⁻)	4228.3+x	(41/2 ⁻)		
830.1 3	1.6 2	3307.7+x	(33/2 ⁺)	2477.6+x	29/2 ⁺	Q	DCO=1.62 26
834.5 3	0.8 2	5952.7+x	(51/2 ⁻)	5118.2+x	(47/2 ⁻)	Q	DCO=1.00 12
837.7 3	2.1 5	4713.9+x	45/2 ⁺	3876.2+x	41/2 ⁺	Q	DCO=1.39 9
853.7 3	7.0 5	2616.7+x	29/2 ⁺	1763.2+x	25/2 ⁺	Q	DCO=1.44 12
863.1 3	0.6 2	5036.3+x	(45/2 ⁻)	4173.2+x	(41/2 ⁻)	Q	DCO=1.46 19
864.0 3	0.5 2	5900.3+x	(49/2 ⁻)	5036.3+x	(45/2 ⁻)	Q	DCO=1.46 19
867.5 3	0.5 2	6820.2+x	(55/2 ⁻)	5952.7+x	(51/2 ⁻)	Q	DCO=1.40 23
870.0 3	0.7 2	5583.9+x	49/2 ⁺	4713.9+x	45/2 ⁺	Q	DCO=1.32 8
901.1 3	1.0 3	901.10+x	(15/2 ⁻)	0.0+x	13/2 ⁺	D	DCO=0.70 22
909.1 3	0.8 3	4063.5+x	(41/2 ⁺)	3154.4+x	37/2 ⁺	Q	DCO=1.09 14
919.1 3	4.2 5	2682.3+x	(29/2 ⁺)	1763.2+x	25/2 ⁺	Q	DCO=1.33 11
923.5 3	0.6 2	3400.9+x	(33/2 ⁺)	2477.6+x	29/2 ⁺	(Q)	DCO=0.85 31
941.8 3	1.4 3	5703.1+x	(49/2 ⁻)	4761.3+x	(45/2 ⁻)	Q	DCO=1.20 10
946.2 3	7.9 4	1976.4+x	23/2 ⁻	1030.2+x	21/2 ⁺	D	DCO=0.75 8
952.5 3	0.5 2	6536.4+x	(53/2 ⁺)	5583.9+x	49/2 ⁺	Q	DCO=0.91 20
968.0 3	0.7 3	4960.9+x	(43/2 ⁻)	3992.9+x	(39/2 ⁻)		
994.2 3	0.9 3	4870.4+x	(45/2 ⁺)	3876.2+x	41/2 ⁺	Q	DCO=1.53 15
1004.3 3	2.6 9	2034.5+x	(23/2 ⁻)	1030.2+x	21/2 ⁺	D	DCO=0.64 15
1036.9 3	3.7 5	1440.2+x	(19/2 ⁻)	403.3+x	17/2 ⁺	D	DCO=0.81 11
1205.9 3	1.3 4	4550.3+x	(39/2 ⁻)	3344.4+x	(35/2 ⁻)		DCO=0.82 16

[†] From **1994Be27**, except as noted. Multipolarities are based on DCO data in **1994Be27**, mult=Q indicates stretched quadrupole (most likely E2 for intraband transitions), mult=D indicates $\Delta J=1$, dipole (M1 or M1+E2 for all intraband transitions; E1 or M1 or M1+E2 for interband transitions). For stretched quadrupole transitions, (E2) is assigned here for $E_\gamma < 600$ keV based on assumed level half-life < 20 ns (typical coincidence resolving time) and RUL for E2 and M2.

[‡] From BrIcc code (**2008Ki07**), “Frozen Orbitals” appr.

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

$^{160}\text{Gd}(^{34}\text{S},5n\gamma):\text{SD}$ [1992Be18,1991Dr04](#)

[1992Be18](#), [1991Dr04](#) (also [1990Ja13](#)): $^{160}\text{Gd}(^{34}\text{S},5n\gamma)$, $E=167, 172$ MeV; 0.5 mg/cm² self-supporting target, $>97\%$ enriched.

Argonne-Notre Dame BGO γ -ray facility. SD band deduced from γ and $\gamma\gamma$ data.

 ^{189}Hg Levels

E(level) [†]	J^π	Comments
$y^{\ddagger}$	$J \approx (29/2, 31/2)$	J^π : from fitting by 1992Be18 and 1992Be25 . The procedure, as described in 1992Be18 , involves fitting of the experimental dynamic moments of inertia with rotational frequencies $\hbar\omega$. Other: $J=31/2$ from fitting by 1994Zh40 and 1998Li54 .
$366.4+y^{\ddagger} 2$	$J+2$	
$774.5+y^{\ddagger} 3$	$J+4$	
$1223.2+y^{\ddagger} 4$	$J+6$	
$1711.7+y^{\ddagger} 4$	$J+8$	
$2239.7+y^{\ddagger} 5$	$J+10$	
$2806.6+y^{\ddagger} 5$	$J+12$	
$3410.5+y^{\ddagger} 6$	$J+14$	
$4050.8+y^{\ddagger} 6$	$J+16$	
$4726.7+y^{\ddagger} 6$	$J+18$	
$5434.3+y^{\ddagger} 9$	$J+20$	

[†] From E_γ values.

[‡] Band(A): SD band ([1992Be18](#)). Population of this band is 0.5% of total yield for ^{189}Hg . The SD band was identified from $\gamma\gamma$ coin with known transitions in ^{189}Hg .

 $\gamma(^{189}\text{Hg})$

E_γ [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	$I_{(\gamma+ce)}^{\ddagger}$
$366.4 2$	$366.4+y$	$J+2$	y	$J \approx (29/2, 31/2)$	$1.00 10$
$408.1 2$	$774.5+y$	$J+4$	$366.4+y$	$J+2$	$1.00 15$
$448.7 2$	$1223.2+y$	$J+6$	$774.5+y$	$J+4$	$0.86 19$
$488.5 2$	$1711.7+y$	$J+8$	$1223.2+y$	$J+6$	$0.89 16$
$528.0 2$	$2239.7+y$	$J+10$	$1711.7+y$	$J+8$	$0.62 11$
$566.9 2$	$2806.6+y$	$J+12$	$2239.7+y$	$J+10$	$0.58 11$
$603.9 2$	$3410.5+y$	$J+14$	$2806.6+y$	$J+12$	$0.53 14$
$640.3 2$	$4050.8+y$	$J+16$	$3410.5+y$	$J+14$	$0.58 11$
$675.9 2$	$4726.7+y$	$J+18$	$4050.8+y$	$J+16$	
$707.6 § 6$	$5434.3+y?$	$J+20$	$4726.7+y$	$J+18$	

[†] From [1992Be18](#).

[‡] Relative $I(\gamma+ce)$ values within the band ([1991Dr04](#)).

§ Placement of transition in the level scheme is uncertain.

$^{175}\text{Lu}(^{19}\text{F}, 5n\gamma)$ **1981Bo08**

1981Bo08: $^{175}\text{Lu}(^{19}\text{F}, 5n\gamma)$, $E(^{19}\text{F})=100$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma(\theta)$, $\gamma(\text{lin pol})$ using two Ge(Li) detectors. A total of 14 γ rays reported.

 ^{189}Hg Levels

$E(\text{level})^{\dagger}$	$J^{\pi\ddagger}$	Comments
0.0+x [#]	13/2 ⁺	E(level): x=80 keV 30 (2001Sc41,2017Au03).
403.0+x [#] 2	17/2 ⁺	
473.89+x 18	15/2 ⁺	
1029.87+x [#] 23	21/2 ⁺	
1110.18+x 20	19/2 ⁺	
1690.92+x [@] 24	21/2 ⁻	
1763.0+x [#] 3	25/2 ⁺	
1916.6+x [@] 3	25/2 ⁻	
2252.5+x [@] 4	29/2 ⁻	
2477.1+x [#] 4	29/2 ⁺	
2674.3+x [#] 5	(33/2 ⁺)	
2818.0+x? [@] 5	(33/2 ⁻)	
3153.5+x [#] 5	(37/2 ⁺)	

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

[‡] As proposed by **1981Bo08** based on $\gamma(\theta)$, $\gamma(\text{lin pol})$ and band assignments.

[#] Band(A): Band based on 13/2⁺.

[@] Band(B): Band based on 21/2⁻.

 $\gamma(^{189}\text{Hg})$

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	δ	$\alpha^\dagger$	Comments
197.2 2		2674.3+x	(33/2 ⁺)	2477.1+x	29/2 ⁺	[E2]		0.410	E_γ : mixed with line from ¹⁹ F. $A_2=+0.26$ 2; $A_4=-0.14$ 2 $\text{Pol}=+0.35$ 8. E_γ : from level-scheme Fig. 3 in 1981Bo08 . $E_\gamma=255.7$ in authors' Table 1 seems a misprint.
225.7 2	27 3	1916.6+x	25/2 ⁻	1690.92+x	21/2 ⁻	E2		0.260	
335.9 2	15 2	2252.5+x	29/2 ⁻	1916.6+x	25/2 ⁻	E2		0.0766	$A_2=+0.27$ 4; $A_4=-0.12$ 4 $\text{Pol}=+0.44$ 9.
403.0 2	100	403.0+x	17/2 ⁺	0.0+x	13/2 ⁺	E2		0.0465	$A_2=+0.20$ 2; $A_4=-0.08$ 2 $\text{Pol}=+0.25$ 8.
473.9 2	15 2	473.89+x	15/2 ⁺	0.0+x	13/2 ⁺	M1+E2	-0.11 7	0.1048 21	$A_2=-0.79$ 3; $A_4=+0.06$ 3 $\text{Pol}=-0.07$ 10.
479.2 2	8 1	3153.5+x	(37/2 ⁺)	2674.3+x	(33/2 ⁺)	[E2]		0.0201	$A_2=+0.02$ 10; $A_4=-0.05$ 10 E_γ : 568.2 in Adopted dataset. $\text{Pol}=-0.12$ 19.
565.5 2	7 1	2818.0+x?	(33/2 ⁻)	2252.5+x	29/2 ⁻				
580.8 2	27 3	1690.92+x	21/2 ⁻	1110.18+x	19/2 ⁺	E1		0.00652	$A_2=-0.17$ 3; $A_4=-0.08$ 4 $\text{Pol}=+0.18$ 13.
626.8 2	73 7	1029.87+x	21/2 ⁺	403.0+x	17/2 ⁺	E2		0.01594	$A_2=+0.24$ 2; $A_4=-0.07$ 2 $\text{Pol}=+0.22$ 7.
636.3 2	14 2	1110.18+x	19/2 ⁺	473.89+x	15/2 ⁺	E2		0.01542	$A_2=+0.31$ 4; $A_4=-0.10$ 4 $\text{Pol}=+0.43$ 12.

Continued on next page (footnotes at end of table)

$^{175}\text{Lu}(^{19}\text{F}, 5n\gamma)$ **1981Bo08 (continued)** $\gamma(^{189}\text{Hg})$ (continued)

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	δ	$\alpha^\dagger$	Comments
661.0 2	13 1	1690.92+x	21/2 ⁻	1029.87+x	21/2 ⁺	E1		0.00504	$A_2=+0.09$ 3; $A_4=-0.03$ 3 Pol=-0.65 17.
707.2 2	12 1	1110.18+x	19/2 ⁺	403.0+x	17/2 ⁺	M1+E2	-0.52 15	0.0318 25	$A_2=-0.37$ 4; $A_4=+0.03$ 5 Pol=-0.07 19.
714.1 2	30 3	2477.1+x	29/2 ⁺	1763.0+x	25/2 ⁺	E2		0.01200	$A_2=+0.18$ 2; $A_4=-0.05$ 2 Pol=+0.30 10.
733.1 2	43 4	1763.0+x	25/2 ⁺	1029.87+x	21/2 ⁺	E2		0.01135	$A_2=+0.20$ 2; $A_4=-0.13$ 2 Pol=+0.43 10.

[†] From BrIcc code (2008Ki07), “Frozen Orbitals” appr.

$^{181}\text{Ta}(^{14}\text{N},6n\gamma)$ 1983Gu12

1983Gu12: $^{181}\text{Ta}(^{14}\text{N},6n\gamma)$, $E(^{14}\text{N})=90\text{-}110$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma(\theta)$, ce-ce coincidence. NaI, Ge detectors for γ -measurements; a spectrometer with a superconducting solenoid electron transporter and two Si(Li) detectors for electron measurements. A total of 28 γ rays were reported.

 ^{189}Hg Levels

There are some differences in the level scheme presented by 1983Gu12 and the adopted level scheme from $^{160}\text{Gd}(^{34}\text{S},5n\gamma)$ (1994Be27). For example the 704.8-518.2 cascade is reversed in 1994Be27 and also there is another transition connecting this cascade to the band based on $21/2^-$.

E(level) [†]	J^π [‡]	Comments
0.0+x [#]	$13/2^+$	E(level): x=80 keV 30 (2001Sc41,2017Au03).
403.00+x [#] 19	$17/2^+$	
473.8+x 3	$15/2^+$	
1029.80+x [#] 25	$21/2^+$	
1110.1+x 3	$19/2^+$	
1690.8+x ^{&} 3	$21/2^-$	
1762.8+x [#] 4	$25/2^+$	
1916.7+x ^{&} 4	$25/2^-$	
1976.1+x ^a 5	$23/2^-$	
2220.4+x ^a 5	$27/2^-$	
2252.6+x ^{&} 4	$29/2^-$	
2434.9+x 6	$29/2^-$	
2476.9+x [@] 4	$29/2^+$	
2615.5+x [#] 5	$29/2^+$	
2674.3+x [@] 4	$33/2^+$	
2686.0+x ^a 5	$31/2^-$	
2820.7+x ^{&} 5	$33/2^-$	
3123.7+x 6	$33/2^+$	
3139.7+x 7	$(33/2^-)$	
3153.5+x [@] 5	$(37/2^+)$	
3343.8+x ^a 7	$(35/2^-)$	
3540.2+x ^{&} 6	$37/2^-$	
3793.1+x 8	$(37/2^+)$	
3875.2+x [@] 6	$41/2^+$	
4713.3+x? 8	$(41/2^-)$	J^π : $45/2^+$ in Adopted Levels.
5579.6+x? 10	$(45/2^+)$	J^π : $49/2^+$ in Adopted Levels.

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

[‡] As proposed by 1983Gu12 based on $\gamma(\theta)$ data and band assignments.

[#] Band(A): Band based on $13/2^+$.

[@] Band(B): Band based on $29/2^+$.

[&] Band(C): Band based on $21/2^-$.

^a Band(D): Band based on $23/2^-$.

$^{181}\text{Ta}(^{14}\text{N}, 6n\gamma)$ 1983Gu12 (continued) $\gamma(^{189}\text{Hg})$

Experimental internal conversion electron data such as K/L ratios are from 1983Gu12 deduced from their (ce)(ce) coincidence experiment.

E_γ †	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.§	$\alpha^\ddagger$	Comments
58.8 5	0.080 13	2674.3+x	33/2 ⁺	2615.5+x	29/2 ⁺	E2	62 3	L12/L3=1.0 5 I _γ : deduced by evaluators from B(E2)(58.8)/B(E2)(197.4)=1.84 18 (1983Gu12).
197.4 2	14 2	2674.3+x	33/2 ⁺	2476.9+x	29/2 ⁺	E2	0.409	A ₂ =+0.23 10; A ₄ =+0.04 10; K/L=1.0 1 I _γ (142°)/I _γ (90°)=1.04 11.
225.9 2	28 1	1916.7+x	25/2 ⁻	1690.8+x	21/2 ⁻	E2	0.259	A ₂ =+0.29 6; A ₄ =-0.11 3; K/L=1.1 3 I _γ (142°)/I _γ (90°)=1.23 9.
244.3 4	6 2	2220.4+x	27/2 ⁻	1976.1+x	23/2 ⁻	(E2)	0.0766	I _γ (142°)/I _γ (90°)=1.2 7.
335.9 2	16 1	2252.6+x	29/2 ⁻	1916.7+x	25/2 ⁻			A ₂ =+0.36 2; A ₄ =-0.10 5 I _γ (142°)/I _γ (90°)=1.30 13.
403.0 2	100 2	403.00+x	17/2 ⁺	0.0+x	13/2 ⁺	E2	0.0465	K/L=2.8 3; A ₂ =+0.40 5; A ₄ =0.00 5 I _γ (142°)/I _γ (90°)=1.30 4.
457.5 4	8 1	2220.4+x	27/2 ⁻	1762.8+x	25/2 ⁺	D		A ₂ =-0.30 10 I _γ (142°)/I _γ (90°)=0.82 20.
465.6 2	15 2	2686.0+x	31/2 ⁻	2220.4+x	27/2 ⁻	(E2)	0.0321	A ₂ =+0.33 6 I _γ (142°)/I _γ (90°)=1.26 16.
473.8 4	9 1	473.8+x	15/2 ⁺	0.0+x	13/2 ⁺	D+Q		A ₂ =-0.75 5; A ₄ =+0.39 20 I _γ (142°)/I _γ (90°)=0.47 9.
479.2 2	12 2	3153.5+x	(37/2 ⁺)	2674.3+x	33/2 ⁺	(E2)	0.0299	A ₂ =+0.40 10; A ₄ =0.00 10 I _γ (142°)/I _γ (90°)=1.18 19.
518.2 & 4	6 2	2434.9+x	29/2 ⁻	1916.7+x	25/2 ⁻	(E2)	0.0247	A ₂ =+0.40 20 I _γ (142°)/I _γ (90°)=1.14 37.
568.1 2	13 3	2820.7+x	33/2 ⁻	2252.6+x	29/2 ⁻	(E2)	0.0199	A ₂ =+0.12 4 I _γ (142°)/I _γ (90°)=1.19 15.
580.7 2	11 2	1690.8+x	21/2 ⁻	1110.1+x	19/2 ⁺	D		A ₂ =-0.37 5; A ₄ =-0.04 6 I _γ (142°)/I _γ (90°)=0.73 9.
626.8 2	77 2	1029.80+x	21/2 ⁺	403.00+x	17/2 ⁺	E2	0.01594	A ₂ =+0.20 2; A ₄ =-0.05 4; K/L=4.0 5 I _γ (142°)/I _γ (90°)=1.37 20.
636.3 2	10 1	1110.1+x	19/2 ⁺	473.8+x	15/2 ⁺	Q		A ₂ =+0.20 6; A ₄ =+0.12 8 Note that positive A ₄ is inconsistent with stretched quadrupole. I _γ (142°)/I _γ (90°)=1.44 25.
646.8 4	8 1	3123.7+x	33/2 ⁺	2476.9+x	29/2 ⁺	(Q)		I _γ (142°)/I _γ (90°)=1.17 22.
657.8 4	9 1	3343.8+x	(35/2 ⁻)	2686.0+x	31/2 ⁻	Q		A ₂ =+0.41 6; A ₄ =-0.16 8 I _γ (142°)/I _γ (90°)=1.5 5.
661.0 2	13 2	1690.8+x	21/2 ⁻	1029.80+x	21/2 ⁺	D		A ₂ =+0.12 4 I _γ (142°)/I _γ (90°)=1.04 19; ΔJ=0 transition.
669.4 6	4 2	3793.1+x	(37/2 ⁺)	3123.7+x	33/2 ⁺	D+Q	0.01200	I _γ (142°)/I _γ (90°)=1.7 9.
704.8 & 4	5 2	3139.7+x	(33/2 ⁻)	2434.9+x	29/2 ⁻			A ₂ =-0.70 10; A ₄ =+0.45 10 I _γ (142°)/I _γ (90°)=0.43 12.
707.1 4	7 2	1110.1+x	19/2 ⁺	403.00+x	17/2 ⁺			A ₂ =+0.13 3; K/L=4 1 I _γ (142°)/I _γ (90°)=1.07 10.
714.1 2	23 2	2476.9+x	29/2 ⁺	1762.8+x	25/2 ⁺	(E2)		I _γ (142°)/I _γ (90°)=1.12 30.
719.5 4	7 2	3540.2+x	37/2 ⁻	2820.7+x	33/2 ⁻	(Q)		I _γ (142°)/I _γ (90°)=1.12 30.
721.7 4	7 2	3875.2+x	41/2 ⁺	3153.5+x	(37/2 ⁺)	(Q)		I _γ (142°)/I _γ (90°)=1.12 30.
*731.5								E _γ : from the single spectra shown in Fig. 1 in 1983Gu12, however, not listed in authors' Table 1.

Continued on next page (footnotes at end of table)

$^{181}\text{Ta}(^{14}\text{N},6n\gamma)$ **1983Gu12** (continued) $\gamma(^{189}\text{Hg})$ (continued)

E_γ [†]	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [§]	$\alpha^\ddagger$	Comments
733.0 2	50 2	1762.8+x	25/2 ⁺	1029.80+x	21/2 ⁺	(E2)	0.01135	$A_2=+0.25$ 2; $A_4=+0.01$ 2; $K/L=4$ 1 $I_\gamma(142^\circ)/I_\gamma(90^\circ)=1.63$ 14.
838.1 @ 4	6 2	4713.3+x?	(41/2 ⁻)	3875.2+x	41/2 ⁺			
852.7 4	6 2	2615.5+x	29/2 ⁺	1762.8+x	25/2 ⁺	(E2)	0.00830	$K(853)/K(733)=0.7$ 1, deduced from ce-ce coincidence intensities in the ce(L)(59 keV) gate. $I_\gamma(142^\circ)/I_\gamma(90^\circ)=1.05$ 29.
866.3 @ 6	3 2	5579.6+x?	(45/2 ⁺)	4713.3+x?	(41/2 ⁻)			E_γ : 870.0 in Adopted dataset.
946.4 4	5 2	1976.1+x	23/2 ⁻	1029.80+x	21/2 ⁺	D		$A_2=-0.46$ 4 $I_\gamma(142^\circ)/I_\gamma(90^\circ)=0.54$ 20.

[†] **1983Gu12** state an uncertainty of 0.2 keV for most γ rays, rising to 0.6 keV for the weakest ones. Evaluators assign 0.2 keV for $I_\gamma \geq 10$, 0.4 keV for $I_\gamma = 5-9$ and 0.6 keV for $I_\gamma < 5$.

[‡] From BrIcc code (**2008Ki07**), “Frozen Orbitals” appr.

[§] For stretched quadrupole transitions, (E2) is assigned here for $E_\gamma < 600$ keV based on assumed level half-life < 20 ns (typical coincidence resolving time) and RUL for E2 and M2.

[&] Ordering of the 704.8-518.2 γ cascade is reversed as well as built on another level in **1994Be27** and Adopted Levels.

@ Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

Adopted Levels, Gammas

$Q(\beta^-) = -6772$ 16; $S(n) = 10350$ 30; $S(p) = 1703$ 15; $Q(\alpha) = 4817$ 9 2017Wa10

$S(2n) = 18314$ 12, $S(2p) = 6166$ 24, $Q(\epsilon p) = 466$ 9 (2017Wa10).

Identification and production of ^{189}Tl isotope by 1972Va12 in $\text{Pb}(p, X)$ reaction; measured half-life and γ -ray energies and intensities. In 1976Ha25 (also 1974Ha10), the isotope was produced in $^{181}\text{Ta}(^{16}\text{O}, xn)$ reaction; measured half-life and γ -radiation characteristics.

1987Bo44 (also 1987Bi08, 1986BoZY thesis, 1985Bo46): measured Hyperfine structure, isotope-shift and moments.

Mass measurements: 2000Ra23 (also 1997Ra14, 1999Sc46).

Nuclear structure calculations:

SD bands (theory): 2009Al12, 2009Ch62, 1991Sa12, 1991Ch36.

Normal-deformed levels (theory): 1989Be34, 1988Ar12, 1977Go09, 1976Di14.

 ^{189}Tl Levels

The high-spin level scheme is primarily adopted here from 1996RiZZ with the exception of sequence 5 in authors' figure 1, since the lower members of this sequence and connecting transitions to the $(9/2^-)$ isomer were not corroborated by the $\gamma\gamma$ coin data in ϵ decay study by 2009Sa09.

Cross Reference (XREF) Flags

A	^{189}Pb ϵ decay (39 s)	F	$^{156}\text{Gd}(^{37}\text{Cl}, 4n\gamma)$:SD
B	^{189}Pb ϵ decay (50 s)	G	$^{165}\text{Ho}(^{28}\text{Si}, 4n\gamma)$
C	^{193}Bi α decay (3.2 s)	H	$^{169}\text{Tm}(^{24}\text{Mg}, 4n\gamma)$
D	^{193}Bi α decay (63.6 s)		
E	$^{156}\text{Gd}(^{37}\text{Cl}, 4n\gamma)$		

E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF	Comments
0.0 ^j	(1/2 ⁺)	2.3 min 2	A CD	$\% \epsilon + \% \beta^+ = 100$ J ^π : suggested by model calculations, expected configuration= $\pi 1/2[400]$ (prolate) (2009Sa09); favored α decay from ^{193}Bi α decay (3.2 s) with parent J ^π =(1/2 ⁺). T _{1/2} : from 1976Ha25 (also 1974Ha10).
281 ^{&} 7	(9/2 ⁻)	1.4 min 1	B DE GH	$\% \epsilon + \% \beta^+ = 98$ 2; $\% \text{IT} < 4$ $\mu = 3.756$ 22 (2012Ba32, 2014StZZ) $Q = -2.29$ 4 (1987Bo44, 2016St14) RMS charge radius ($\langle r^2 \rangle$) ^{1/2} = 5.424 fm 6 (2004An14, evaluation). The evaluators assume that this value corresponds to the isomer in ^{189}Tl and not the g.s. No value is listed in the recent evaluation by 2013An02. μ : hyperfine structure with HFA correction (2012Ba32). Other value: +3.878 6 (1987Bo44, collinear fast atomic beam laser spectroscopy). Q: collinear fast atomic beam laser spectroscopy (1987Bo44, also 1987Bi08, 1986BoZY thesis, 1985Bo46). Other: 1992ScZU. E(level): from ^{193}Bi α -decay (1985Co06). Value of 258 keV proposed in 1996RiZZ on the basis of interconnecting γ rays between the high-spin and low-spin structure is proven incorrect by 2009Sa09 in their $\gamma\gamma$ coin data from ^{182}Pb ϵ decay, where several γ rays were observed similar to the ones in the in-beam study of 1996RiZZ. J ^π : suggested by model calculations, expected configuration= $\pi 9/2[505]$ (oblate) (2009Sa09); favored α decay from ^{193}Bi α decay (63.6 s) with parent J ^π =(9/2 ⁻). $\% \text{IT}$: from B(M4)(W.u.) < 10 (RUL). T _{1/2} : from 1976Ha25 (also 1974Ha10). Other: 1.4 min 4 (1972Va12).
318.80 ^j 20	(3/2 ⁺)		A	J ^π : γ to (1/2 ⁺); model calculation, expected configuration= $\pi 1/2[400]$ (prolate) (2009Sa09). E(level): a level of this energy was also seen by 1996RiZZ. However the γ transition establishing this level and subsequent band appears to have been based

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Adopted Levels, Gammas (continued) ^{189}Tl Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF	Comments
463.57? 19	(3/2 ⁺)		A	on coincidences not confirmed in β decay study (2009Sa09). The placement of the deexciting γ is also not confirmed in 2009Sa09 due to lack of evidence from $\gamma\gamma$ coincidence data.
599.79 ⁱ 16	(9/2 ⁻)		B	J ^π : γ to (1/2 ⁺); model calculation, expected configuration= $\pi 3/2[402]$ (prolate) (2009Sa09).
667.30 ^a 10	(11/2 ⁻)	37.8 ps 35	B E GH	J ^π : γ to (9/2 ⁻); possible band assignment.
667.53? 19	(3/2 ⁻)		A	J ^π : M1+E2 γ to (9/2 ⁻); band member.
744.70 ^g 16	(7/2 ⁻)		B	J ^π : γ to (1/2 ⁺); model calculation, expected configuration= $\pi 3/2[532]$ (prolate) (2009Sa09).
885.54? 24			A	J ^π : γ to (9/2 ⁻); possible band assignment.
981.37 ^{&} 9	(13/2 ⁻)	1.9 ps 6	B E G	E(level): possible gammas to (3/2 ⁻) and (3/2 ⁺) suggest 1/2,3/2,5/2.
1028.12 ⁱ 16	(13/2 ⁻)		B	J ^π : M1 γ to (11/2 ⁻); E2 γ to (9/2 ⁻); band member.
1032.6? 5			A	J ^π : γ to (9/2 ⁻); band member.
1062.50 ^g 15	(9/2 ⁻)		B	J ^π : γ to (3/2 ⁻) suggests 1/2 to 7/2 ⁻ .
1105.43 ^h 18	(11/2 ⁻)		B	J ^π : gammas to (7/2 ⁻) and (9/2 ⁻); band member.
1147.51 ^f 14	(13/2 ⁺)	209 ps 12	B E GH	J ^π : gammas to (7/2 ⁻) and (11/2 ⁻); model calculation, expected configuration= $\pi 11/2[505]$ (prolate) (2009Sa09).
1227.79 25	(11/2 ⁻)		B	J ^π : E1 γ to (11/2 ⁻); γ to (13/2 ⁻); model calculation, expected configuration= $\pi 13/2[606]$ (oblate) (2009Sa09).
1325.00 14	(13/2 ⁻)		B GH	J ^π : log $ft=6.5$ from (13/2 ⁺) parent; γ to (7/2 ⁻).
1332.27 ^g 20	(11/2 ⁻)		B	J ^π : M1 γ to (11/2 ⁻); γ to (9/2 ⁻).
1368.9? 5			A	J ^π : gammas to (7/2 ⁻) and (9/2 ⁻); band member.
1388.78 23	(11/2 ⁻)		B	J ^π : γ to (3/2 ⁺) suggests (1/2 to 7/2 ⁺).
1408.76 ^a 15	(15/2 ⁻)		B E GH	J ^π : log $ft=6.5$ from (13/2 ⁺) parent; γ to (7/2 ⁻).
1420.94 22			B	J ^π : M1 γ to (13/2 ⁻); (E2) γ to (11/2 ⁻); band member.
1461.0 ^h 5	(13/2 ⁻)		B	J ^π : γ to (9/2 ⁻) suggests (5/2 ⁻ to 13/2 ⁻).
1464.30 22	(13/2 ⁻)		B	J ^π : γ to (11/2 ⁻); band member.
1489.8? 11			A	J ^π : log $ft=6.5$ from (13/2 ⁺) parent; γ to (9/2 ⁻); γ from (17/2 ⁻).
1492.51 25	(11/2 ⁻)		B	J ^π : γ to (3/2 ⁺) suggests (1/2 to 7/2 ⁺).
1532.9 3	(11/2,13/2,15/2 ⁻)		B	J ^π : log $ft=6.5$ from (13/2 ⁺) parent; γ to (9/2 ⁻); weak γ to (7/2 ⁻).
1546.38 ^f 17	(15/2 ⁺)		B E	J ^π : log $ft \approx 6.5$ from (13/2 ⁺) parent; γ to (11/2 ⁻). Possible γ to (7/2 ⁻) favors (11/2 ⁻).
1553.2 3	(11/2,13/2 ⁻)		B	J ^π : M1+E2 γ to (13/2 ⁺); band member.
1614.9 5	(11/2,13/2 ⁻)		B	J ^π : log $ft=6.8$ from (13/2 ⁺) parent; γ to (9/2 ⁻).
1645.66 ^{&} 20	(17/2 ⁻)	1.80 ps 42	B E GH	J ^π : log $ft=6.6$ from (13/2 ⁺) parent; γ to (9/2 ⁻).
1716.7? 5			A	Q _t =2.7 3 (2007Ch41).
1745.7 4			GH	J ^π : E2 γ to (13/2 ⁻); γ to (15/2 ⁻); band member.
1752.6 4	(11/2,13/2 ⁻)		B	J ^π : γ to (3/2 ⁺) suggests (1/2 to 7/2 ⁺).
1756.81 ⁱ 21	(17/2 ⁻)		B	J ^π : gammas to (15/2 ⁻) and (15/2 ⁺) suggest (13/2,15/2,17/2).
1761.2 3	(11/2,13/2,15/2 ⁻)		B	J ^π : log $ft=6.8$ from (13/2 ⁺) parent; γ to (9/2 ⁻).
1783.2 ^g 5	(13/2 ⁻)		B	J ^π : γ to (13/2 ⁻); possible band member.
1812.6 3	(11/2,13/2,15/2)		B	J ^π : log $ft=6.7$ from (13/2 ⁺) parent; γ to (11/2 ⁻).
1829.73 ^f 25	(17/2 ⁺)	9.0 ps 11	B E GH	J ^π : log $ft=7.0$ from (13/2 ⁺) parent; band member.
1845.0 5	(17/2 ⁻)		B E H	J ^π : log $ft=6.6$ from (13/2 ⁺) parent.
				Q _t =1.1 1 (2007Ch41).
				J ^π : E2 γ to (13/2 ⁺); (M1) γ to (15/2 ⁺); band member. Note that log $ft=6.79$ from (13/2 ⁺) parent is too low for a $\Delta J=2$, $\Delta\pi=\text{no}$ β transition.
				XREF: H(?).
				J ^π : $\Delta J=0$, dipole γ to (17/2 ⁻); γ to (13/2 ⁻).

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Adopted Levels, Gammas (continued)

 ^{189}Tl Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF	Comments
1861.4 3	(11/2,13/2,15/2)		B	J ^π : log ft=6.7 from (13/2 ⁺) parent.
1865.0 5	(11/2,13/2,15/2 ⁻)		B	J ^π : log ft=7.0 from (13/2 ⁺) parent; γ to (11/2 ⁻).
1878.0 3	(11/2,13/2,15/2 ⁻)		B	J ^π : log ft=6.5 from (13/2 ⁺) parent; γ to (11/2 ⁻).
1893.9 11	(11/2,13/2,15/2)		B	J ^π : log ft=6.9 from (13/2 ⁺) parent.
1959.6 4	(11/2,13/2,15/2)		B	J ^π : log ft=6.7 from (13/2 ⁺) parent.
1962.2 5	(11/2,13/2,15/2)		B	J ^π : log ft=7.0 from (13/2 ⁺) parent.
1995.3 ^e 3	(17/2 ⁺)		B E GH	J ^π : ΔJ=1, (M1) γ to (15/2 ⁺); γ to (13/2 ⁺); band member. Note that log ft=6.98 from (13/2 ⁺) parent is too low for a ΔJ=2, Δπ=no β transition.
2006.3 4	(13/2 ⁻ ,15/2)		B	J ^π : log ft=6.9 from (13/2 ⁺) parent; γ to (17/2 ⁻).
2025.3 5	(11/2,13/2,15/2 ⁻)		B	J ^π : log ft=7.0 from (13/2 ⁺) parent; γ to (11/2 ⁻).
2062.0 7			G	
2147.6 ^d 3	(19/2 ⁻)	7.1 ps 14	E GH	J ^π : ΔJ=1, (M1) γ to (17/2 ⁻). J ^π was proposed as (21/2 ⁻) in 1991Po15 (also in 2007Ch41), based on ΔJ=2, Q assignment in 1991Po15. But in 1995Re18, the 502 transition is proposed as a stretched dipole based on DCO ratios for the cascading 303 and 199 transitions, parallel to the 502 transition.
2163.4 ^a 4	(19/2 ⁻)		E H	J ^π : gammas to (15/2 ⁻) and (17/2 ⁻); band member.
2174.5 4	(11/2,13/2,15/2 ⁻)		B	J ^π : log ft=6.7 from (13/2 ⁺) parent; γ to (11/2 ⁻).
2185.0 3	(13/2 ⁻ ,15/2)		B	J ^π : log ft=6.3 from (13/2 ⁺) parent; γ to (17/2 ⁻).
2213.4 5	(11/2,13/2,15/2 ⁻)		B	J ^π : log ft=7.1 from (13/2 ⁺) parent; γ to (11/2 ⁻).
2237.1 ^e 3	(21/2 ⁺)	8.6 ps 12	E GH	Q _t =3.8 3 (2007Ch41). J ^π : ΔJ=2, E2 γ to (17/2 ⁺); band member.
2237.2 6			G	J ^π : γ to (15/2 ⁺) in in-beam γ suggests (15/2,17/2,19/2 ⁺).
2308.1? 4			GH	J ^π : γ to (17/2 ⁻) suggests (17/2,19/2,21/2 ⁻).
2308.2 ^f 5	(19/2 ⁺)		G	J ^π : gammas to (15/2 ⁺) and (17/2 ⁺); band member.
2420.3 5	(11/2,13/2,15/2)		B	J ^π : log ft=7.0 from (13/2 ⁺) parent.
2500.7& 5	(21/2 ⁻)		E	J ^π : gammas to (17/2 ⁻) and (19/2 ⁻); band member.
2632.5 ^e 5	(25/2 ⁺)	2.08 ps 28	E GH	Q _t =7.8 5 (2007Ch41). J ^π : ΔJ=2, E2 γ to (21/2 ⁺); band member.
2649.6 ^c 4	(23/2 ⁻)	<6.1 ps	E GH	Q _t >2.8 (2007Ch41). J ^π : ΔJ=2, E2 γ to (19/2 ⁻); band member.
2668.6 ^d 11	(23/2 ⁻)		E	J ^π : γ to (19/2 ⁻); band member.
2698.0 ^a 8	(23/2 ⁻)		E	J ^π : gammas to (19/2 ⁻) and (21/2 ⁻); band member.
2788.4 ^b 6	(25/2 ⁻)		E GH	J ^π : ΔJ=1, dipole (most likely M1) γ to (23/2 ⁻); γ to (21/2 ⁻); band member.
3025.3 ^c 6	(27/2 ⁻)		E GH	J ^π : ΔJ=1, dipole γ to (25/2 ⁻); γ to (23/2 ⁻); band member.
3094.9 ^e 6	(29/2 ⁺)	0.90 ps 14	E GH	Q _t =8.6 8 (2007Ch41). J ^π : ΔJ=2, E2 γ to (25/2 ⁺); band member.
3253.6 ^d 15	(27/2 ⁻)		E	J ^π : γ to (23/2 ⁻); band member.
3277.5 ^b 6	(29/2 ⁻)		E GH	J ^π : ΔJ=1, dipole γ to (27/2 ⁻); γ to (25/2 ⁻); band member.
3442.9 8			G	J ^π : γ to (29/2 ⁺) suggests (29/2,31/2,33/2 ⁺).
3627.0 ^c 8	(31/2 ⁻)		E G	J ^π : gammas to (27/2 ⁻) and (29/2 ⁻); band member.
3629.0 ^e 6	(33/2 ⁺)	<0.7 ps	E GH	Q _t >8.8 (2007Ch41). J ^π : ΔJ=2, E2 γ to (29/2 ⁺); band member.
3901.6 ^d 18	(31/2 ⁻)		E	J ^π : γ to (27/2 ⁻); band member.
3957.8 ^b 9	(33/2 ⁻)		E	J ^π : gammas to (29/2 ⁻) and (31/2 ⁻); band member.
4232.1 ^e 8	(37/2 ⁺)		E G	J ^π : γ to (33/2 ⁺); band member.
4359.9 ^c 10	(35/2 ⁻)		E	J ^π : gammas to (31/2 ⁻) and (33/2 ⁻); band member.
4605.6 ^d 21	(35/2 ⁻)		E	J ^π : γ to (31/2 ⁻); band member.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{189}Tl Levels (continued)

E(level) [†]	J^{π} [‡]	XREF	Comments
4728.8 ^b 12	(37/2 ⁻)	E	J^{π} : gammas to (33/2 ⁻) and (35/2 ⁻); band member.
4896.1 ^e 13	(41/2 ⁺)	E G	J^{π} : γ to (37/2 ⁺); band member.
5361.6 ^d 23	(39/2 ⁻)	E	J^{π} : γ to (35/2 ⁻); band member.
5606.1 ^e 17	(45/2 ⁺)	E	J^{π} : γ to (41/2 ⁺); band member.
6333.1 ^e 19	(49/2 ⁺)	E	J^{π} : γ to (45/2 ⁺); band member.
x^k	$J1 \approx (27/2)^{④}$	F	
326.3+x ^k 10	J1+2	F	
694.2+x ^k 12	J1+4	F	
1102.7+x ^k 12	J1+6	F	
1551.3+x ^k 13	J1+8	F	
2039.6+x ^k 13	J1+10	F	
2566.4+x ^k 14	J1+12	F	
3131.1+x ^k 14	J1+14	F	
3732.6+x ^k 15	J1+16	F	
4369.4+x ^k 16	J1+18	F	
5040.3+x ^k ? 19	J1+20	F	
y^l	$J2 \approx (25/2)^{④}$	F	
304.5+y ^l ? 10	J2+2	F	
649.3+y ^l 12	J2+4	F	
1034.3+y ^l 16	J2+6	F	
1461.3+y ^l 19	J2+8	F	
1927.5+y ^l 19	J2+10	F	
2432.3+y ^l 19	J2+12	F	
2973.7+y ^l 19	J2+14	F	
3552.8+y ^l 20	J2+16	F	
4167.0+y ^l 21	J2+18	F	
4815.4+y ^l ? 24	J2+20	F	

[†] From least-squares fit to $E\gamma$ data, assuming 1 keV uncertainty when not given. Reduced $\chi^2=0.91$.

[‡] The high-spin states ($J>4$) are based on 9/2⁻ isomer at 281 keV supported by $\gamma(\theta)$, $\gamma\gamma(\theta)$ and $\gamma(\text{lin pol})$ data for selected transitions and extensive shell-model calculations by 2009Sa09. Ascending spins with excitation energy are assumed in in-beam γ -ray data which follows from yrast type population of states in such studies. In some cases specific arguments are given.

From DSAM in $^{165}\text{Ho}(^{28}\text{Si},4n\gamma)$ (2007Ch41) for levels above 300 keV.

④ Proposed in 1998Re20 based on fitting of measured dynamic moment of inertia as a function of $\hbar\omega$ using a Harris parameterization. These assignments are consistent with the observation that the SD bands feed the normal-deformed states at and below spin 25/2.

& Band(A): $\pi 9/2[505], \alpha=+1/2$. Interpreted as oblate ($\beta_2 \approx 0.15$) band from $h_{9/2}$ proton orbital. This band is crossed by a strongly coupled band due to a pair of $i_{13/2}$ neutrons.

^a Band(a): $\pi 9/2[505], \alpha=-1/2$. See comment for $\alpha=+1/2$ signature partner.

^b Band(B): $\pi 9/2[505] \otimes \nu i_{13/2}^2, \alpha=+1/2$. The $\pi 9/2[505]$ band is crossed by $\nu i_{13/2}^2$ band, thus producing a sharp backbend.

^c Band(b): $\pi 9/2[505] \otimes \nu i_{13/2}^2, \alpha=-1/2$. See comment for $\alpha=+1/2$ signature partner.

^d Band(C): Possible $\pi 1/2[550]$ band. Interpreted as oblate hole band.

^e Band(D): $\pi 1/2[660], \alpha=+1/2$. Interpreted as decoupled prolate ($\beta_2 \approx 0.27$) intruder band from $\pi i_{13/2}$ orbital.

^f Band(E): $\pi 1/2[660]$. Interpreted as oblate intruder band from $\pi i_{13/2}$ orbital (2007Ch41, 1991Po15). 2009Sa09 propose $\pi 13/2[606]$, oblate band. But in 1996RiZZ the character of the 13/2⁺ state as oblate was not confirmed.

^g Band(F): $\pi 7/2[514]$ (oblate).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

 ^{189}Tl Levels (continued)

^h Band(G): $\pi 11/2[505]$ (prolate).

ⁱ Band(H): $\pi 1/2[541]$ (prolate).

^j Band(I): $\pi 1/2[400]$ band (prolate).

^k Band(J): SD-1 band. Percent population=0.1-0.2. SD-1 and SD-2 bands are interpreted (by [1998Re20](#)) as signature partners associated with $\pi i_{13/2}$ ($\Omega=5/2$) configuration.

^l Band(j): SD-2 band. Percent population=0.1-0.2. See comment for SD-2 band.

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Tl})$								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [§]	$\alpha^\&$	Comments
318.80?	(3/2 ⁺)	318.8 ^{@#} 2	100	0.0	(1/2 ⁺)			
463.57?	(3/2 ⁺)	463.7 ^{@#} 2	100	0.0	(1/2 ⁺)			
599.79	(9/2 ⁻)	318.8 [@] 2	100	281	(9/2 ⁻)	[M1]	0.332	
667.30	(11/2 ⁻)	386.1 2	100	281	(9/2 ⁻)	M1+E2	0.17 3	E_γ : 386.7 1 from ($^{24}\text{Mg},4n\gamma$) (1988Kr16) not used. Weighted average of all three values is 386.5 2 with reduced χ^2 =6.5.
667.53?	(3/2 ⁻)	667.4 [#] 2	100	0.0	(1/2 ⁺)			
744.70	(7/2 ⁻)	463.7 [@] 2	100	281	(9/2 ⁻)	[M1+E2]		
885.54?		217.5 [#] 4	34 6	667.53?	(3/2 ⁻)			
		422.1 [#] 2	100 16	463.57?	(3/2 ⁺)			
981.37	(13/2 ⁻)	314.0 1	57 9	667.30	(11/2 ⁻)	M1	0.346	B(M1)(W.u.)=0.10 +5-2 I_γ : from ε decay, 109 12 in ($^{24}\text{Mg},4n\gamma$) (1988Kr16) is in disagreement.
		700.2 2	100 13	281	(9/2 ⁻)	E2	0.01310	B(E2)(W.u.)=17 +8-4
1028.12	(13/2 ⁻)	428.3 2	$\approx$ 112	599.79	(9/2 ⁻)	[E2]	0.0413	
		747.1 2	100 15	281	(9/2 ⁻)			
1032.6?		365.1 [#] 4	100	667.53?	(3/2 ⁻)			
1062.50	(9/2 ⁻)	317.7 2	100 18	744.70	(7/2 ⁻)	[M1+E2]		
		781.6 2	69 10	281	(9/2 ⁻)			
1105.43	(11/2 ⁻)	361 [@] 1	$\approx$ 5.7	744.70	(7/2 ⁻)	[E2]	0.0652 11	
		437.8 4	8.7 13	667.30	(11/2 ⁻)	[M1+E2]		
		824.5 2	100 17	281	(9/2 ⁻)	[M1+E2]		
1147.51	(13/2 ⁺)	166.0 3	8.0 16	981.37	(13/2 ⁻)	[E1]	0.1208	B(E1)(W.u.)=1.6 $\times$ 10 ⁻⁵ 4
		480.2 1	100 3	667.30	(11/2 ⁻)	E1	0.01004	B(E1)(W.u.)=8.1 $\times$ 10 ⁻⁶ 6
1227.79	(11/2 ⁻)	165 1	$\approx$ 19	1062.50	(9/2 ⁻)			
		483.1 2	100 15	744.70	(7/2 ⁻)			
		560.3 [#] 4	42 6	667.30	(11/2 ⁻)			
1325.00	(13/2 ⁻)	657.4 2	100 20	667.30	(11/2 ⁻)	M1	0.0485	
		1044.3 2	50 8	281	(9/2 ⁻)	[E2]	0.00583	E_γ : γ not reported in in-beam γ -ray studies.
1332.27	(11/2 ⁻)	269.7 2	47 7	1062.50	(9/2 ⁻)	[M1+E2]		
		587.6 2	100 15	744.70	(7/2 ⁻)	[E2]	0.0193	
1368.9?		1050.1 [#] 4	100	318.80?	(3/2 ⁺)			
1388.78	(11/2 ⁻)	283.4 [#] 4	$\approx$ 8	1105.43	(11/2 ⁻)			
		326.2 4	18 2	1062.50	(9/2 ⁻)			
		644.1 2	100 16	744.70	(7/2 ⁻)			
1408.76	(15/2 ⁻)	427.1 2	54 14	981.37	(13/2 ⁻)	M1	0.1512	I_γ : 25% uncertainty is assumed by the evaluators.
		741.7 2	100 15	667.30	(11/2 ⁻)	(E2)	0.01160	E_γ, I_γ : 428.0 2 with I_γ =157 8 in ($^{24}\text{Mg},4n\gamma$) not used in averaging.
1420.94		821.2 2	100	599.79	(9/2 ⁻)			Mult.: ΔJ =2, Q from $\gamma(\theta)$, $\Delta J\pi$.
1461.0	(13/2 ⁻)	355.6 4	100	1105.43	(11/2 ⁻)	[M1+E2]		

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Tl})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [§]	$\alpha^\&$	Comments
1464.30	(13/2 ⁻)	864.5 2	100	599.79	(9/2 ⁻)			
1489.8?		1171 [#] 1	100	318.80?	(3/2 ⁺)			
1492.51	(11/2 ⁻)	430.0 2	100 15	1062.50	(9/2 ⁻)		0.08 7	
		748 1	≈13	744.70	(7/2 ⁻)			
1532.9	(11/2,13/2,15/2 ⁻)	427.5 2	≈100	1105.43	(11/2 ⁻)			
		787 [#] 1	≈10	744.70	(7/2 ⁻)			
1546.38	(15/2 ⁺)	398.9 1	100	1147.51	(13/2 ⁺)	M1+E2		
1553.2	(11/2,13/2 ⁻)	491.0 4	26 4	1062.50	(9/2 ⁻)			
		885.5 4	100 13	667.30	(11/2 ⁻)			
1614.9	(11/2,13/2 ⁻)	194.0 4	≈100	1420.94				
		1015 1	≈100	599.79	(9/2 ⁻)			
1645.66	(17/2 ⁻)	236.9 [@] 5		1408.76	(15/2 ⁻)			E_γ : γ not seen in ε decay. In in-beam γ -ray data this γ is doubly placed with only a small component from 1646 level.
		664.3 2	100 3	981.37	(13/2 ⁻)	E2	0.01468	B(E2)(W.u.)=37 +12-7 For B(E2)(W.u.) value, it is assumed that the 664.3 γ is the dominant transition from 1646 level.
1716.7?		1397.9 [#] 4	100	318.80?	(3/2 ⁺)			
1745.7		199.6 5		1546.38	(15/2 ⁺)			E_γ : γ only from ($^{28}\text{Si},4n\gamma$).
		336.7 5		1408.76	(15/2 ⁻)			
1752.6	(11/2,13/2 ⁻)	420.2 4	100 15	1332.27	(11/2 ⁻)			
		690.2 4	92 15	1062.50	(9/2 ⁻)			
1756.81	(17/2 ⁻)	292.6 4	17 2	1464.30	(13/2 ⁻)			
		336.3 4	19 4	1420.94				
		728.6 2	100 15	1028.12	(13/2 ⁻)			
1761.2	(11/2,13/2,15/2 ⁻)	429 [#] 1	≈100	1332.27	(11/2 ⁻)			
		613.2 4	≈170	1147.51	(13/2 ⁺)			
		1094.4 4	100 20	667.30	(11/2 ⁻)			
1783.2	(13/2 ⁻)	450.9 4	100	1332.27	(11/2 ⁻)	[M1+E2]		
1812.6	(11/2,13/2,15/2)	348.5 4	≈32	1464.30	(13/2 ⁻)			
		391.4 4	100 16	1420.94				
		784.6 4	≈68	1028.12	(13/2 ⁻)			
1829.73	(17/2 ⁺)	283.6 3	58 26	1546.38	(15/2 ⁺)	(M1)	0.457	B(M1)(W.u.)=0.033 17 Mult.: $\Delta J=1$, dipole from $\gamma(\theta)$, $\Delta J\pi$. I_γ : unweighted average from ($^{24}\text{Mg},4n\gamma$) and ($^{28}\text{Si},4n\gamma$), assuming 50% uncertainty in the value from the latter reaction.
		682.1 3	100 5	1147.51	(13/2 ⁺)	E2	0.01386	B(E2)(W.u.)=3.6 9
1845.0	(17/2 ⁻)	199		1645.66	(17/2 ⁻)	(D)		E_γ : γ only from ($^{37}\text{Cl},4n\gamma$).
		436		1408.76	(15/2 ⁻)			E_γ : from ($^{37}\text{Cl},4n\gamma$) only.
		863 1		981.37	(13/2 ⁻)			
1861.4	(11/2,13/2,15/2)	536.4 4	100 15	1325.00	(13/2 ⁻)			

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Tl})$ (continued)								
$E_i(\text{level})$	J_i^π	E_γ [†]	I_γ [†]	E_f	J_f^π	Mult. [§]	α ^{&}	Comments
1861.4	(11/2,13/2,15/2)	880.0 4	65 10	981.37	(13/2 ⁻)			
1865.0	(11/2,13/2,15/2 ⁻)	1197.7 4	100	667.30	(11/2 ⁻)			
1878.0	(11/2,13/2,15/2 ⁻)	730 1	≈45	1147.51	(13/2 ⁺)			
		896.0 4	85 15	981.37	(13/2 ⁻)			
		1211.4 4	100 15	667.30	(11/2 ⁻)			
1893.9	(11/2,13/2,15/2)	361 @ 1	100	1532.9	(11/2,13/2,15/2 ⁻)			
1959.6	(11/2,13/2,15/2)	811.9 [#] 4	26 4	1147.51	(13/2 ⁺)			
		978.2 4	≈100	981.37	(13/2 ⁻)			
1962.2	(11/2,13/2,15/2)	498 [#] 1	≈36	1464.30	(13/2 ⁻)			
		934.1 4	100 18	1028.12	(13/2 ⁻)			
1995.3	(17/2 ⁺)	448.8 3	100 9	1546.38	(15/2 ⁺)	(M1)	0.1325	
		848 [#]		1147.51	(13/2 ⁺)			
2006.3	(13/2 ⁻ ,15/2)	249.7 4	66 11	1756.81	(17/2 ⁻)			
		541.8 4	100 11	1464.30	(13/2 ⁻)			
2025.3	(11/2,13/2,15/2 ⁻)	919.9 4	100	1105.43	(11/2 ⁻)			
2062.0		317.0 5		1745.7				
2147.6	(19/2 ⁻)	303		1845.0	(17/2 ⁻)			
		502.1 @ 3	100	1645.66	(17/2 ⁻)	(M1)	0.0984	B(M1)(W.u.)=0.025 +6-4 For B(M1)(W.u.) value, it is assumed that the 502.1γ is the dominant transition from 2148 level. Mult.: suggested as stretched dipole in 1995Re18, but stretched E2 in 1991Po15.
2163.4	(19/2 ⁻)	319		1845.0	(17/2 ⁻)			
		518		1645.66	(17/2 ⁻)			
		754.7 5		1408.76	(15/2 ⁻)			
2174.5	(11/2,13/2,15/2 ⁻)	1027 1	≈50	1147.51	(13/2 ⁺)			
		1507.2 4	100 17	667.30	(11/2 ⁻)			
2185.0	(13/2 ⁻ ,15/2)	372.5 4	28 6	1812.6	(11/2,13/2,15/2)			
		428.1 4	≈167	1756.81	(17/2 ⁻)			
		720 1	≈50	1464.30	(13/2 ⁻)			
		860.0 4	100 17	1325.00	(13/2 ⁻)			
2213.4	(11/2,13/2,15/2 ⁻)	1108.0 4	100	1105.43	(11/2 ⁻)			
2237.1	(21/2 ⁺)	241.6 5		1995.3	(17/2 ⁺)			
		407.4 2	100 10	1829.73	(17/2 ⁺)	E2	0.0471	B(E2)(W.u.)=87 +14-11 For B(E2)(W.u.) value, it is assumed that the 407.4γ is the dominant transition from 2237 level.
2237.2		690.7 5		1546.38	(15/2 ⁺)			
2308.1?		562.5 2	100 5	1745.7		(D)		
		662 1		1645.66	(17/2 ⁻)			
2308.2	(19/2 ⁺)	479 1	100	1829.73	(17/2 ⁺)			
		761.7 5		1546.38	(15/2 ⁺)			

Adopted Levels, Gammas (continued)

 $\gamma(^{189}\text{Tl})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [§]	$\alpha^\&$	$I_{(\gamma+ce)}$	Comments
2420.3	(11/2,13/2,15/2)	956.0 4	100	1464.30	(13/2 ⁻)				
2500.7	(21/2 ⁻)	336.7 5		2163.4	(19/2 ⁻)				
		657		1845.0	(17/2 ⁻)				
		856		1645.66	(17/2 ⁻)				
2632.5	(25/2 ⁺)	395.4 3	100	2237.1	(21/2 ⁺)	E2	0.0509		B(E2)(W.u.)=4.2×10 ² 6
2649.6	(23/2 ⁻)	484		2163.4	(19/2 ⁻)	(E2)	0.0304		Mult.: ΔJ=2 from DCO ratio; RUL.
		502.1 @ 3	100	2147.6	(19/2 ⁻)	E2	0.0278		B(E2)(W.u.)>44
2668.6	(23/2 ⁻)	521		2147.6	(19/2 ⁻)				
2698.0	(23/2 ⁻)	197		2500.7	(21/2 ⁻)				
		535		2163.4	(19/2 ⁻)				
2788.4	(25/2 ⁻)	138.8 4	100 10	2649.6	(23/2 ⁻)	D			Mult.: most likely M1 with α(theory)=3.32.
		288		2500.7	(21/2 ⁻)				
3025.3	(27/2 ⁻)	236.9 @ 2	100 10	2788.4	(25/2 ⁻)	D			
		375.8 # 3	35 4	2649.6	(23/2 ⁻)				
3094.9	(29/2 ⁺)	462.4 3	100	2632.5	(25/2 ⁺)	E2	0.0341		B(E2)(W.u.)=4.5×10 ² +9-14
3253.6	(27/2 ⁻)	585		2668.6	(23/2 ⁻)				
3277.5	(29/2 ⁻)	252.2 3	100 9	3025.3	(27/2 ⁻)	D			
		489.2 5		2788.4	(25/2 ⁻)				
3442.9		348.0 5		3094.9	(29/2 ⁺)				
3627.0	(31/2 ⁻)	349.7 5		3277.5	(29/2 ⁻)				
		601		3025.3	(27/2 ⁻)				
3629.0	(33/2 ⁺)	534.1 3	100	3094.9	(29/2 ⁺)	E2	0.0240		B(E2)(W.u.)>2.8×10 ²
3901.6	(31/2 ⁻)	648		3253.6	(27/2 ⁻)				
3957.8	(33/2 ⁻)	331		3627.0	(31/2 ⁻)				
		680		3277.5	(29/2 ⁻)				
4232.1	(37/2 ⁺)	603.1 5		3629.0	(33/2 ⁺)				
4359.9?	(35/2 ⁻)	402 #		3957.8	(33/2 ⁻)				
		733 #		3627.0	(31/2 ⁻)				
4605.6	(35/2 ⁻)	704		3901.6	(31/2 ⁻)				
4728.8?	(37/2 ⁻)	369 #		4359.9?	(35/2 ⁻)				
		771 #		3957.8	(33/2 ⁻)				
4896.1	(41/2 ⁺)	664 1		4232.1	(37/2 ⁺)				
5361.6	(39/2 ⁻)	756		4605.6	(35/2 ⁻)				
5606.1	(45/2 ⁺)	710		4896.1	(41/2 ⁺)				
6333.1	(49/2 ⁺)	727		5606.1	(45/2 ⁺)				
326.3+x	J1+2	326.3 # 10		x	J1≈(27/2)			0.13 [‡] 8	
694.2+x	J1+4	367.9 6		326.3+x	J1+2			0.38 [‡] 7	
1102.7+x	J1+6	408.5 3		694.2+x	J1+4			1.09 [‡] 8	
1551.3+x	J1+8	448.6 3		1102.7+x	J1+6			1.00 [‡] 8	

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Tl})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	E_f	J_f^π	$I_{(\gamma+ce)}$
2039.6+x	J1+10	488.3 3	1551.3+x	J1+8	0.95 [‡] 8
2566.4+x	J1+12	526.8 3	2039.6+x	J1+10	0.94 [‡] 7
3131.1+x	J1+14	564.7 3	2566.4+x	J1+12	0.83 [‡] 10
3732.6+x	J1+16	601.5 6	3131.1+x	J1+14	0.50 [‡] 7
4369.4+x	J1+18	636.8 [#] 6	3732.6+x	J1+16	0.33 [‡] 8
5040.3+x?	J1+20	670.9 [#] 10	4369.4+x	J1+18	0.23 [‡] 7
304.5+y?	J2+2	304.5 [#] 10	y	J2 $\approx$ (25/2)	0.39 [‡] 8
649.3+y	J2+4	344.8 6	304.5+y?	J2+2	0.45 [‡] 8
1034.3+y	J2+6	385 1	649.3+y	J2+4	
1461.3+y	J2+8	427 1	1034.3+y	J2+6	0.97 [‡] 11
1927.5+y	J2+10	466.2 3	1461.3+y	J2+8	1.00 [‡] 9
2432.3+y	J2+12	504.8 3	1927.5+y	J2+10	0.86 [‡] 9
2973.7+y	J2+14	541.4 3	2432.3+y	J2+12	0.82 [‡] 8
3552.8+y	J2+16	579.1 6	2973.7+y	J2+14	0.54 [‡] 8
4167.0+y	J2+18	614.2 6	3552.8+y	J2+16	0.47 [‡] 9
4815.4+y?	J2+20	648.4 [#] 10	4167.0+y	J2+18	0.35 [‡] 7

[†] From weighted averages of all available data from ε decay and in-beam γ -ray data. In $^{156}\text{Gd}(^{37}\text{Cl},4n\gamma)$ from [1996RiZZ](#), the energies are given to nearest keV without uncertainties and no intensity data are available.

[‡] Relative $I(\gamma+ce)$ within the SD band.

[§] From DCO, $\gamma(\theta)$ and $\gamma(\theta, \text{pol})$ data in $^{165}\text{Ho}(^{28}\text{Si},4n\gamma)$ ([1991Po15](#)).

[&] From BrIcc code ([2008Ki07](#)) with “Frozen Orbitals” approximation.

[@] Multiply placed.

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

Adopted Levels, Gammas

Adopted Levels, Gammas (continued)

Adopted Levels, Gammas (continued)

Band(J): SD-1 band			Band(j): SD-2 band		
J1+20	5040.3+x		J2+20	4815.4+y	
	671			648	
J1+18	4369.4+x		J2+18	4167.0+y	
	637			614	
J1+16	3732.6+x		J2+16	3552.8+y	
	602			579	
J1+14	3131.1+x		J2+14	2973.7+y	
	565			541	
J1+12	2566.4+x		J2+12	2432.3+y	
	527			505	
J1+10	2039.6+x		J2+10	1927.5+y	
	488			466	
J1+8	1551.3+x		J2+8	1461.3+y	
	449			427	
J1+6	1102.7+x		J2+6	1034.3+y	
	408			385	
J1+4	694.2+x		J2+4	649.3+y	
	368			345	
J1+2	326.3+x		J2+2	304.5+y	
	326			304	
J1≈(27/2)	x		J2≈(25/2)	y	

^{189}Pb ε decay (39 s) 2009Sa09

Parent: ^{189}Pb : $E=0$; $J^\pi=(3/2^-)$; $T_{1/2}=39$ s 8; $Q(\varepsilon)=6772$ 16; $\% \varepsilon + \% \beta^+$ decay ≈ 100

^{189}Pb - J^π , $T_{1/2}$: From ^{189}Pb Adopted Levels.

^{189}Pb - $Q(\varepsilon)$: from 2017Wa10.

^{189}Pb - $\% \varepsilon + \% \beta^+$ decay: $\% \alpha \leq 0.40$ (from ^{189}Pb Adopted Levels).

Tentative level scheme according to 2009Sa09.

^{189}Pb source was formed in U(p,X) reaction (UC_x target) with a beam energy of 1.4 GeV. ^{189}Pb was also excited using a laser beam at resonant frequencies from RILIS at the ISOLDE facility at CERN.

Two experiments were performed:

1. Measured $\beta\gamma$ coin using $4\pi\beta$ plastic scintillator and three Ge detectors (one planar HPGe and two Ge detectors). The γ rays in ^{189}Pb were also identified in hyperfine laser spectroscopy from low-lying levels.
2. Measured E_γ , I_γ , $\gamma\gamma$ coin using two HPGe detectors with Be window. Hyperfine laser spectroscopy was also carried out. Comparison with rotor plus particle model calculations.

 ^{189}Tl Levels

Expected configurations are from 2009Sa09 based on axial-rotor coupled to one quasiparticle (Hartree-Fock+BCS) calculations for oblate and prolate deformations.

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	Comments
0.0	(1/2 ⁺)	Expected configuration $\pi 1/2[400]$ (prolate).
318.8? 2	(3/2 ⁺)	Expected configuration $\pi 1/2[400]$ (prolate).
462.8? 5	(3/2 ⁺)	Expected configuration= $\pi 3/2[402]$ (prolate).
667.4? 2	(3/2 ⁻)	Expected configuration= $\pi 3/2[532]$ (prolate).
884.9? 5		
1032.5? 5		
1368.9? 5		
1489.8? 11		
1716.7? 5		

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

[‡] From Adopted Levels.

 $\gamma(^{189}\text{Tl})$

$E_\gamma^\dagger$	$I_\gamma^\ddagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
217.5& 4	1.7 3	884.9?		667.4? (3/2 ⁻)		
318.8& 2	29§ 10	318.8?	(3/2 ⁺)	0.0 (1/2 ⁺)		
365.1& 4	2.3 3	1032.5?		667.4? (3/2 ⁻)		
422.1& 2	5.0 8	884.9?		462.8? (3/2 ⁺)		
463.7& 2	13§ 3	462.8?	(3/2 ⁺)	0.0 (1/2 ⁺)		
667.4& 2	9.6 15	667.4?	(3/2 ⁻)	0.0 (1/2 ⁺)		
1050.1& 4	2.8 4	1368.9?		318.8? (3/2 ⁺)		
1171& 1	≈ 2.6	1489.8?		318.8? (3/2 ⁺)		E_γ, I_γ : from $\gamma\gamma$ coin data.
1397.9& 4	1.0 2	1716.7?		318.8? (3/2 ⁺)		

[†] General uncertainty is quoted by 2009Sa09 as 0.2 keV for $I_\gamma > 3$ and 0.4 keV for weaker lines. Uncertainty of 1 keV is assigned by the evaluators when E_γ quoted to nearest keV.

[‡] General uncertainty is quoted by 2009Sa09 as 15%.

§ From hyperfine spectrum in laser spectroscopy. Doublet, one component from the decay of the high-spin isomer and the other

^{189}Pb ε decay (39 s) 2009Sa09 (continued)

$\gamma(^{189}\text{Tl})$ (continued)

from the decay of the low-spin isomer of ^{189}Pb .

& Placement of transition in the level scheme is uncertain.

^{189}Pb ε decay (39 s) 2009Sa09

Decay Scheme

 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)
- Coincidence

^{189}Pb ε decay (50 s) 2009Sa09

Parent: ^{189}Pb : $E=40$ 4; $J^\pi=(13/2^+)$; $T_{1/2}=50$ s 3; $Q(\varepsilon)=6772$ 16; $\% \varepsilon + \% \beta^+$ decay=100

^{189}Pb - $J^\pi, T_{1/2}$: From ^{189}Pb Adopted Levels.

^{189}Pb - $Q(\varepsilon)$: from 2017Wa10.

^{189}Pb - $\% \varepsilon + \% \beta^+$ decay: $\% \alpha$ is expected to be small, probably <1%.

^{189}Pb source was formed in U(p,X) reaction (UC_x target) with a beam energy of 1.4 GeV. ^{189}Pb was also excited using a laser beam at resonant frequencies from RILIS at the ISOLDE facility at CERN.

Two experiments were performed:

1. Measured $\beta\gamma$ coin using 4π β plastic scintillator and three Ge detectors (one planar HPGe and two Ge detectors). The γ rays in ^{189}Pb were also identified in hyperfine laser spectroscopy from low-lying levels.
2. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ coin using two HPGe detectors with Be window. The hyperfine laser spectroscopy was also carried out for some of the strong γ rays.

Comparison with rotor plus particle model calculations.

Decay of the high-spin isomer.

 ^{189}Tl Levels

Expected configurations and bands are from 2009Sa09 based on axial-rotor coupled to one quasiparticle (Hartree-Fock+BCS) calculations for oblate and prolate deformations.

E(level) [†]	J^π [‡]	$T_{1/2}$	Comments
281 @ 7	(9/2 ⁻)	1.4 min 1	$\% \varepsilon + \% \beta^+ \approx 100$ E(level): from Adopted Levels, see the comments therein. $T_{1/2}$: From Adopted Levels.
599.79 ^b 16	(9/2 ⁻)		
667.45 @ 13	(11/2 ⁻)		
744.71 & 16	(7/2 ⁻)		
981.59 @ 15	(13/2 ⁻)		
1028.12 ^b 16	(13/2 ⁻)		
1062.51 & 15	(9/2 ⁻)		
1105.46 ^a 18	(11/2 ⁻)		
1147.88 [#] 21	(13/2 ⁺)		
1227.80 25	(11/2 ⁻)		
1324.98 15	(13/2 ⁻)		
1332.28 & 20	(11/2 ⁻)		
1388.79 23	(11/2 ⁻)		
1408.82 @ 19	(15/2 ⁻)		
1420.94 22			
1461.1 ^a 5	(13/2 ⁻)		
1464.29 22	(13/2 ⁻)		
1492.52 25	(11/2 ⁻)		
1533.0 3	(11/2, 13/2, 15/2 ⁻)		J^π : (11/2 ⁻) if 787 γ to (7/2 ⁻) is proven correct.
1546.8 [#] 3	(15/2 ⁺)		
1553.2 3	(11/2, 13/2 ⁻)		
1614.9 5	(11/2, 13/2 ⁻)		
1646.1 @ 5	(17/2 ⁻)		
1752.6 4	(11/2, 13/2 ⁻)		
1756.81 ^b 21	(17/2 ⁻)		Band assignment is tentative.
1761.5 4	(11/2, 13/2, 15/2 ⁻)		
1783.2 & 5	(13/2 ⁻)		
1812.6 3	(11/2, 13/2, 15/2)		
1830.1 [#] 4	(17/2 ⁺)		

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^{189}Pb ε decay (50 s) 2009Sa09 (continued) ^{189}Tl Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$
1844.6 10	(17/2 ⁻)	1959.8 5	(11/2,13/2,15/2)	2174.7 4	(11/2,13/2,15/2 ⁻)
1861.5 3	(11/2,13/2,15/2)	1962.2 5	(11/2,13/2,15/2)	2185.0 3	(13/2 ⁻ ,15/2)
1865.2 5	(11/2,13/2,15/2 ⁻)	1995.8 5	(17/2 ⁺)	2213.5 5	(11/2,13/2,15/2 ⁻)
1878.2 3	(11/2,13/2,15/2 ⁻)	2006.3 4	(13/2 ⁻ ,15/2)	2420.3 5	(11/2,13/2,15/2)
1894.0 11	(11/2,13/2,15/2)	2025.4 5	(11/2,13/2,15/2 ⁻)		

[†] From least-squares fit to E_{γ} data using 281-keV level as fixed. Uncertainty of 7 keV in this energy is not reflected in the uncertainties of other level energies.

[‡] From Adopted Levels.

Band(A): $\pi 13/2[606]$ (oblate).

@ Band(B): $\pi 9/2[505]$ (oblate).

& Band(C): $\pi 7/2[514]$ (oblate).

^a Band(D): $\pi 11/2[505]$ (prolate).

^b Band(E): $\pi 1/2[541]$ (prolate).

 ε, β^+ radiations

The beta feedings and associated log ft values have been deduced by the evaluators. The feedings given by 2009Sa09 are given under comments.

Since this decay has a Q value of over 5 MeV and the only observed levels are below 2.5 MeV, the scheme is incomplete.

Therefore, the $\varepsilon + \beta^+$ intensities are upper limits and log ft values are lower limits.

E(decay)	E(level)	$I\beta^+$ [†]	$I\varepsilon$ [†]	Log ft	$I(\varepsilon + \beta^+)$ [†]	Comments
(4392 17)	2420.3	0.1	0.3 1	7.0 1	0.4 1	
(4599 17)	2213.5	0.1	0.3 1	7.1 1	0.4 1	
(4627 16)	2185.0	0.94 11	1.7 2	6.31 6	2.6 3	$I(\varepsilon + \beta^+)$: 2.5 1 (2009Sa09).
(4637 16)	2174.7	0.40 7	0.70 13	6.7 1	1.1 2	
(4787 17)	2025.4	0.22 4	0.35 6	7.0 1	0.57 10	
(4806 16)	2006.3	0.27 5	0.42 7	6.9 1	0.69 12	
(4816 17)	1995.8	0.25 2	0.38 3	6.98 5	0.63 5	Log ft : too low for $\Delta J=2$, $\Delta\pi=\text{no } \beta$ transition. $I(\varepsilon + \beta^+)$: 0.62 4 (2009Sa09).
(4850 17)	1962.2	0.25 4	0.36 6	7.0 1	0.61 10	
(4852 17)	1959.8	0.47 4	0.70 6	6.73 5	1.17 10	
(4918 17)	1894.0	0.32 4	0.45 6	6.93 7	0.77 10	
(4934 16)	1878.2	0.79 9	1.1 1	6.54 6	1.9 2	
(4947 17)	1865.2	0.29 6	0.39 8	7.0 1	0.68 14	
(4951 16)	1861.5	0.59 8	0.81 12	6.68 7	1.4 2	
(4967 17)	1844.6	0.079 11	0.28 4	9.10 7	0.36 5	$I(\varepsilon + \beta^+)$: 0.35 (2009Sa09).
(4982 16)	1830.1	0.47 4	0.63 6	6.79 5	1.1 1	Log ft : too low for $\Delta J=2$, $\Delta\pi=\text{no transition}$. $I(\varepsilon + \beta^+)$: 0.99 6 (2009Sa09).
(4999 16)	1812.6	0.82 13	1.1 2	6.6 1	1.9 3	
(5029 17)	1783.2	0.32 3	0.41 4	6.99 6	0.73 7	
(5051 16)	1761.5	0.66 9	0.84 11	6.68 7	1.5 2	Log ft : too low for $\Delta J=2$, $\Delta\pi=\text{no}$.
(5055 16)	1756.81	0.35 9	1.2 3	8.5 1	1.5 4	
(5059 16)	1752.6	0.48 9	0.62 11	6.8 1	1.1 2	
(5166 17)	1646.1	0.19 4	0.58 11	8.9 1	0.77 14	$I(\varepsilon + \beta^+)$: 0.74 (2009Sa09).
(5197 17)	1614.9	≈ 0.84	≈ 0.96	≈ 6.6	≈ 1.8	
(5259 16)	1553.2	0.57 10	0.63 11	6.8 1	1.2 2	
(5265 16)	1546.8	1.8 5	2.0 5	6.3 1	3.8 10	$I(\varepsilon + \beta^+)$: 3.7 3 (2009Sa09).
(5279 16)	1533.0	≈ 1.2	≈ 1.3	≈ 6.5	≈ 2.5	$I(\varepsilon + \beta^+)$: 3.2 2 (2009Sa09).
(5319 16)	1492.52	1.3 2	1.3 3	6.5 1	2.6 5	$I(\varepsilon + \beta^+)$: 2.5 2 (2009Sa09).

Continued on next page (footnotes at end of table)

^{189}Pb ε decay (50 s) 2009Sa09 (continued) ε, β^+ radiations (continued)

E(decay)	E(level)	$I\beta^+{}^\dagger$	$I\varepsilon{}^\dagger$	Log ft	$I(\varepsilon + \beta^+)^\dagger$	Comments
(5348 16)	1464.29	1.5 4	1.6 5	6.5 1	3.1 9	$I(\varepsilon + \beta^+)$: 3.0 2 (2009Sa09).
(5351 17)	1461.1	0.14 3	0.14 3	7.5 1	0.28 6	
(5403 16)	1408.82	2.2 3	2.2 3	6.32 7	4.4 6	$I(\varepsilon + \beta^+)$: 4.1 1 (2009Sa09).
(5423 16)	1388.79	1.4 2	1.3 2	6.54 7	2.7 4	$I(\varepsilon + \beta^+)$: 2.6 2 (2009Sa09).
(5480 16)	1332.28	1.5 4	1.5 3	6.5 1	3.0 7	$I(\varepsilon + \beta^+)$: 2.9 5 (2009Sa09).
(5487 16)	1324.98	2.4 5	2.2 5	6.3 1	4.6 10	$I(\varepsilon + \beta^+)$: 4.4 1 (2009Sa09).
(5584 16)	1227.80	1.9 3	1.7 3	6.5 1	3.6 6	$I(\varepsilon + \beta^+)$: 3.5 5 (2009Sa09).
(5664 16)	1147.88	5 2	4 1	6.1 2	9 3	$I(\varepsilon + \beta^+)$: 8.4 3 (2009Sa09).
(5707 16)	1105.46	5.3 12	4.3 10	6.1 1	9.6 22	$I(\varepsilon + \beta^+)$: 9.4 5 (2009Sa09).
(5749 16)	1062.51	0.8 5	1.5 9	8.6 3	2.3 14	$I(\varepsilon + \beta^+)$: 2.3 15 (2009Sa09).
(5784 16)	1028.12	2.1 4	1.6 3	6.5 1	3.7 7	$I(\varepsilon + \beta^+)$: 4.0 1 (2009Sa09).
(5830 16)	981.59	5.9 11	4.6 8	6.1 1	10.5 19	$I(\varepsilon + \beta^+)$: 9.5 7 (2009Sa09).
(6145 16)	667.45	7 3	4.3 20	6.2 2	11 5	$I(\varepsilon + \beta^+)$: 11 4 (2009Sa09).

 † Absolute intensity per 100 decays.

γ(¹⁸⁹Tl)

All the unplaced γ rays are arbitrarily assigned to the decay of the high-spin isomer.

I_γ normalization: Deduced from Σ(I(γ+ce)) of γ rays to 281 level)=100. Same value is obtained from analysis in 2009Sa09.

E _γ [†]	I _γ ^{‡a}	E _i (level)	J _i ^π	E _f	J _f ^π	Mult.	α [#]
165 [@] 1	≈0.9 [@]	1227.80	(11/2 ⁻)	1062.51	(9/2 ⁻)	[D,E2]	1.1 10
166.4 4	≈2	1147.88	(13/2 ⁺)	981.59	(13/2 ⁻)	[E1]	0.1200 19
194.0 4	≈1.7	1614.9	(11/2,13/2 ⁻)	1420.94		[D,E2]	0.7 7
249.7 4	0.6 1	2006.3	(13/2 ⁻ ,15/2)	1756.81	(17/2 ⁻)	[D,E2]	0.3 3
269.7 2	3.4 5	1332.28	(11/2 ⁻)	1062.51	(9/2 ⁻)	[M1+E2]	0.34 19
283.4 ^{b@c} 4	≈0.4 ^{b@}	1388.79	(11/2 ⁻)	1105.46	(11/2 ⁻)	[D,E2]	0.25 22
283.4 ^{b@} 4	≈0.9 ^{b@}	1830.1	(17/2 ⁺)	1546.8	(15/2 ⁺)	(M1)	0.459
292.6 4	0.9 1	1756.81	(17/2 ⁻)	1464.29	(13/2 ⁻)	[E2]	0.119
314.1 2	13 2	981.59	(13/2 ⁻)	667.45	(11/2 ⁻)	M1	0.346
317.7 [§] 2	11 2	1062.51	(9/2 ⁻)	744.71	(7/2 ⁻)	[M1+E2]	0.21 12
318.8 2	20 ^{&} 10	599.79	(9/2 ⁻)	281	(9/2 ⁻)	[M1]	0.332
326.2 4	0.9 1	1388.79	(11/2 ⁻)	1062.51	(9/2 ⁻)	[D,E2]	0.17 15
336.3 4	1.0 2	1756.81	(17/2 ⁻)	1420.94		[D,E2]	0.15 14
348.5 [§] 4	≈0.8	1812.6	(11/2,13/2,15/2)	1464.29	(13/2 ⁻)		
355.6 4	0.6 1	1461.1	(13/2 ⁻)	1105.46	(11/2 ⁻)	[M1+E2]	0.16 9
361 ^{b@} 1	≈1.7 ^{b@}	1105.46	(11/2 ⁻)	744.71	(7/2 ⁻)	[E2]	0.0652 11
361 ^b 1	≈1.7 ^b	1894.0	(11/2,13/2,15/2)	1533.0	(11/2,13/2,15/2 ⁻)	[D,E2]	0.13 11
372.5 4	0.5 1	2185.0	(13/2 ⁻ ,15/2)	1812.6	(11/2,13/2,15/2)	[D,E2]	0.12 10
386.2 2	100	667.45	(11/2 ⁻)	281	(9/2 ⁻)	M1+E2	0.13 8
391.4 4	2.5 4	1812.6	(11/2,13/2,15/2)	1420.94			
398.9 2	11 2	1546.8	(15/2 ⁺)	1147.88	(13/2 ⁺)	M1+E2	0.12 7
420.2 4	1.3 2	1752.6	(11/2,13/2 ⁻)	1332.28	(11/2 ⁻)	[D,E2]	0.09 8
427.1 2	≈3.5	1408.82	(15/2 ⁻)	981.59	(13/2 ⁻)	M1	0.1503
427.5 [@] 2	≈7 [@]	1533.0	(11/2,13/2,15/2 ⁻)	1105.46	(11/2 ⁻)	[D,E2]	0.08 7
428.1 [@] 4	≈3 [@]	2185.0	(13/2 ⁻ ,15/2)	1756.81	(17/2 ⁻)	[D,E2]	0.08 7
428.3 2	≈9	1028.12	(13/2 ⁻)	599.79	(9/2 ⁻)	[E2]	0.0413
429 ^{@c} 1	≈1 [@]	1761.5	(11/2,13/2,15/2 ⁻)	1332.28	(11/2 ⁻)	[D,E2]	0.08 7
430.0 2	5.4 8	1492.52	(11/2 ⁻)	1062.51	(9/2 ⁻)	[D,E2]	0.08 7
437.8 4	2.6 4	1105.46	(11/2 ⁻)	667.45	(11/2 ⁻)	[M1+E2]	0.09 6
^x 439.9 [§] 4	≈0.9						
449.0 4	≈1.4	1995.8	(17/2 ⁺)	1546.8	(15/2 ⁺)	(M1)	0.1323
450.9 [§] 4	≈1.7	1783.2	(13/2 ⁻)	1332.28	(11/2 ⁻)	[M1+E2]	0.08 5
463.7 2	33 ^{&} 3	744.71	(7/2 ⁻)	281	(9/2 ⁻)	[M1+E2]	0.08 5
480.3 2	37 6	1147.88	(13/2 ⁺)	667.45	(11/2 ⁻)	E1	0.01004
483.1 2	4.8 7	1227.80	(11/2 ⁻)	744.71	(7/2 ⁻)	[E2]	0.0306

$\gamma(^{189}\text{Tl})$ (continued)

E_γ †	I_γ ‡a	E_i (level)	J_i^π	E_f	J_f^π	Mult.	α #	Comments
491.0 4	0.6 1	1553.2	(11/2,13/2 ⁻)	1062.51	(9/2 ⁻)	[D,E2]	0.06 5	
498@c 1	≈0.4@	1962.2	(11/2,13/2,15/2)	1464.29	(13/2 ⁻)	[D,E2]	0.05 5	
536.4 4	2.0 3	1861.5	(11/2,13/2,15/2)	1324.98	(13/2 ⁻)	[D,E2]	0.05 4	
541.8 4	0.9 1	2006.3	(13/2 ⁻ ,15/2)	1464.29	(13/2 ⁻)	[D,E2]	0.04 4	
560.3c 4	2.0 3	1227.80	(11/2 ⁻)	667.45	(11/2 ⁻)	[D,E2]	0.04 4	
x562.7 4	1.3 2							Possible coincidence with 317.7 γ .
587.6 2	7.2 11	1332.28	(11/2 ⁻)	744.71	(7/2 ⁻)	[E2]	0.0193	
x611.2@ 4	≈0.9@							Coincidence with 317.7 γ .
613.2§ 4	≈1.7	1761.5	(11/2,13/2,15/2 ⁻)	1147.88	(13/2 ⁺)	[D,E2]	0.032 26	
644.1 2	5.1 8	1388.79	(11/2 ⁻)	744.71	(7/2 ⁻)	[E2]	0.0157	
657.2 2	10 2	1324.98	(13/2 ⁻)	667.45	(11/2 ⁻)	M1	0.0485	
664.5 4	1.9 3	1646.1	(17/2 ⁻)	981.59	(13/2 ⁻)	E2	0.01467	
682.1 4	1.4 2	1830.1	(17/2 ⁺)	1147.88	(13/2 ⁺)	E2	0.01386	
690.2 4	1.2 2	1752.6	(11/2,13/2 ⁻)	1062.51	(9/2 ⁻)	[D,E2]	0.024 19	
700.4 2	23 3	981.59	(13/2 ⁻)	281	(9/2 ⁻)	E2	0.01310	
720@ 1	≈0.9@	2185.0	(13/2 ⁻ ,15/2)	1464.29	(13/2 ⁻)	[D,E2]	0.021 17	
728.6 2	5.4 8	1756.81	(17/2 ⁻)	1028.12	(13/2 ⁻)	[E2]	0.01205	
730@ 1	≈0.9@	1878.2	(11/2,13/2,15/2 ⁻)	1147.88	(13/2 ⁺)	[D,E2]	0.021 17	
741.5 2	6.8 10	1408.82	(15/2 ⁻)	667.45	(11/2 ⁻)	(E2)	0.01161	
747.1 2	8.0 12	1028.12	(13/2 ⁻)	281	(9/2 ⁻)	[E2]	0.01143	
748@ 1	≈0.7@	1492.52	(11/2 ⁻)	744.71	(7/2 ⁻)	[E2]	0.0114	
x751.5 4	1.0 2							Coincidence with 386.2 γ .
x775.3 4	0.6 1							Possible coincidence with 463.7 γ .
781.6 2	7.6 11	1062.51	(9/2 ⁻)	281	(9/2 ⁻)	[M1+E2]	0.021 11	
784.6@ 4	≈1.7@	1812.6	(11/2,13/2,15/2)	1028.12	(13/2 ⁻)			
x785.3 4	≈1.7							Coincidences with 318.8 γ , 428.3 γ , 747.1 γ and possibly 372.5 γ .
787@c 1	≈0.7@	1533.0	(11/2,13/2,15/2 ⁻)	744.71	(7/2 ⁻)			
811.9c 4	0.6 1	1959.8	(11/2,13/2,15/2)	1147.88	(13/2 ⁺)	[D,E2]	0.016 13	
821.2 2	7.3 10	1420.94		599.79	(9/2 ⁻)	[D,E2]	0.015 12	
824.5 2	30 5	1105.46	(11/2 ⁻)	281	(9/2 ⁻)	[M1+E2]	0.018 9	
x848.4 4	0.6 1							
860.0 4	1.8 3	2185.0	(13/2 ⁻ ,15/2)	1324.98	(13/2 ⁻)	[D,E2]	0.014 11	
863@ 1	0.9@ 1	1844.6	(17/2 ⁻)	981.59	(13/2 ⁻)	[E2]	0.0085	
864.5 2	13 2	1464.29	(13/2 ⁻)	599.79	(9/2 ⁻)	[E2]	0.0085	
880.0 4	1.3 2	1861.5	(11/2,13/2,15/2)	981.59	(13/2 ⁻)	[D,E2]	0.013 10	
885.5 4	2.3 3	1553.2	(11/2,13/2 ⁻)	667.45	(11/2 ⁻)	[D,E2]	0.013 10	
896.0 4	1.7 3	1878.2	(11/2,13/2,15/2 ⁻)	981.59	(13/2 ⁻)	[D,E2]	0.012 10	
919.9 4	1.4 2	2025.4	(11/2,13/2,15/2 ⁻)	1105.46	(11/2 ⁻)	[D,E2]	0.012 9	
934.1 4	1.1 2	1962.2	(11/2,13/2,15/2)	1028.12	(13/2 ⁻)	[D,E2]	0.011 9	

$\gamma(^{189}\text{Tl})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^{\ddagger a}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	$\alpha^\#$	Comments
$^{x947.2}_{44}$	1.7 3							
956.0 4	1.1 2	2420.3	(11/2,13/2,15/2)	1464.29	(13/2 ⁻)	[D,E2]	0.011 8	
$^{978.2}_{44} @$	$\approx 2.3 @$	1959.8	(11/2,13/2,15/2)	981.59	(13/2 ⁻)	[D,E2]	0.010 8	
$^{x981.4}_{44}$	2.2 3							
$^{x1005.5}_{44}$	1.6 2							
$^{x1012.8}_{42}$	3.7 6							
$^{1015}_{41} @$	$\approx 1.7 @$	1614.9	(11/2,13/2 ⁻)	599.79	(9/2 ⁻)	[D,E2]	0.009 7	
$^{1027}_{41} @$	$\approx 0.9 @$	2174.7	(11/2,13/2,15/2 ⁻)	1147.88	(13/2 ⁺)	[D,E2]	0.009 7	
$^{x1041.3}_{44}$	1.2 2							
1044.3 2	5.0 8	1324.98	(13/2 ⁻)	281	(9/2 ⁻)	[E2]	0.00583 9	
1094.4 4	1.0 2	1761.5	(11/2,13/2,15/2 ⁻)	667.45	(11/2 ⁻)			
1108.0 4	1.0 2	2213.5	(11/2,13/2,15/2 ⁻)	1105.46	(11/2 ⁻)	[D,E2]	0.007 6	
$^{x1117.2}_{44}$	1.6 2							
$^{x1138.0}_{42}$	4.1 6							Coincidence with 386.2 γ .
$^{x1179.3}_{44}$	2.5 4							
1197.7 4	1.7 3	1865.2	(11/2,13/2,15/2 ⁻)	667.45	(11/2 ⁻)	[D,E2]	0.006 5	
1211.4 4	2.0 3	1878.2	(11/2,13/2,15/2 ⁻)	667.45	(11/2 ⁻)	[D,E2]	0.006 5	
$^{x1250.4}_{44}$	1.3 2							
$^{x1253.9}_{44}$	1.9 3							
$^{x1272.8}_{42}$	4.4 7							
$^{x1314.4}_{44}$	1.7 3							
$^{x1369.8}_{44}$	1.2 2							Possible coincidence with 386.2 γ and 480.3 γ .
$^{x1491.9}_{44}$	0.7 1							
1507.2 4	1.8 3	2174.7	(11/2,13/2,15/2 ⁻)	667.45	(11/2 ⁻)	[D,E2]	0.0036 23	
$^{x1523.7}_{44}$	1.9 3							
$^{x1555.3}_{44}$	1.8 3							
$^{x1579.5}_{44}$	1.7 3							

[†] General uncertainty is quoted by 2009Sa09 as 0.2 keV for $I_\gamma > 3$ and 0.4 keV for weaker lines. Uncertainty of 1 keV is assigned by the evaluators when E_γ quoted to nearest keV.

[‡] General uncertainty is quoted by 2009Sa09 as 15%.

[§] The γ ray mixed with a line from daughter activity.

[&] From hyperfine spectrum in laser spectroscopy. Doublet, one component from the decay of the high-spin isomer and the other from the decay of the low-spin isomer of ^{189}Pb .

[@] From $\gamma\gamma$ coin data.

[#] From BrIcc code (2008Ki07) with “Frozen Orbitals” approximation.

^a For absolute intensity per 100 decays, multiply by 0.40 3.

^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.

^{189}Pb ε decay (50 s) 2009Sa09

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)
 ● Coincidence
 ○ Coincidence (Uncertain)

Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiply placed: intensity suitably divided

¹⁸⁹Pb ε decay (50 s) 2009Sa09

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)
- Coincidence
- Coincidence (Uncertain)

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
@ Multiply placed: intensity suitably divided

^{189}Pb ε decay (50 s) 2009Sa09

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)
- Coincidence
- Coincidence (Uncertain)

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
 @ Multiply placed: intensity suitably divided

^{193}Bi α decay (63.6 s) 1985Co06

Parent: ^{193}Bi : $E=0.0$; $J^\pi=(9/2^-)$; $T_{1/2}=63.6$ s 30; $Q(\alpha)=6307$ 5; $\% \alpha$ decay=2.2 11

^{193}Bi - $E, J^\pi, T_{1/2}$: From ^{193}Bi Adopted Levels in the ENSDF database (cf. 2006Ac01 evaluation).

^{193}Bi - $Q(\alpha)$: From 2017Wa10.

^{193}Bi - $\% \alpha$ decay: $\% \alpha=2.2$ 11 (2005De01). Other: 3.5 15 (from 1990AnZR as quoted in 1993An19, and also in 2006Ac01 evaluation).

Sources from ^{14}N bombardments of Ir, ^{16}O bombardments of Re, and ^{20}Ne bombardments of ^{181}Tl ; mass separation; measured $E\alpha$, $I\alpha$, time-sequential α and γ spectra. Others: 2000Sc46 ($\alpha(\theta, \text{temp})$); 1998Kr23, 1981Le23, 1974Le02.

 ^{189}Tl Levels

<u>E(level)</u>	<u>J^π[†]</u>	<u>$T_{1/2}$</u>	<u>Comments</u>
0.0	(1/2 ⁺)		
281 7	(9/2 ⁻)	1.4 min 1	$T_{1/2}$: From Adopted Levels.

[†] From Adopted Levels.

 α radiations

<u>$E\alpha$</u>	<u>E(level)</u>	<u>$I\alpha$[†]</u>	<u>HF[‡]</u>	<u>Comments</u>
5899 5	281	95.8 5	2.7 14	$E\alpha$: other values: 5892 5 (1967Tr06), 5910 5 (1966Si11), 5900 10 (1972Ga27, 1974Le02), and 5950 20 (1970Ta14).
6174 5	0.0	4.2 5	9.5×10^2 50	$E\alpha$: other value: 6180 20 (1972Ga27, 1974Le02). Transition originally assigned to ^{193}Bi α decay (3.2 s) and reassigned to this decay by 1985Co06 on the basis of half-life (90 s 48).

[†] For intensity per 100 α decay, multiply by 0.022 11.

[‡] $r_0=1.506$ 10, from interpolation of radii for neighboring even-even nuclei.

^{193}Bi α decay (3.2 s) [1985Co06](#)

Parent: ^{193}Bi : $E=308.7$; $J^\pi=(1/2^+)$; $T_{1/2}=3.2$ s 5; $Q(\alpha)=6307.5$; $\% \alpha$ decay=84 16

^{193}Bi -E, J^π , $T_{1/2}$: From ^{193}Bi Adopted Levels in the ENSDF database (cf. [2006Ac01](#) evaluation).

^{193}Bi -Q(α): From [2017Wa10](#).

^{193}Bi - $\% \alpha$ decay: $\% \alpha=84.16$ (^{193}Bi Adopted Levels in the ENSDF database, cf. [2006Ac01](#) evaluation).

Sources from ^{14}N bombardments of Ir, ^{16}O bombardments of Re, and ^{20}Ne bombardments of ^{181}Ta ; mass separation; measured $E\alpha$, $I\alpha$, time-sequential α and γ spectra.

Other measurements: [1966Si11](#), [1970Ta14](#), [1972Ga27](#), [1974Le02](#).

^{189}Tl Levels

<u>E(level)</u>	<u>J^π[†]</u>
0.0	(1/2 ⁺)

[†] From Adopted Levels.

α radiations

<u>$E\alpha$</u>	<u>E(level)</u>	<u>$I\alpha$[†]</u>	<u>HF[‡]</u>	<u>Comments</u>
6475.5	0.0	100	0.9 2	$E\alpha$: other value: 6480 10 (1972Ga27 , 1974Le02).

[†] For intensity per 100 α decay, multiply by 0.84 16.

[‡] $r_0=1.506$ 10, from interpolation of radii for neighboring even-even nuclei.

$^{156}\text{Gd}(^{37}\text{Cl},4n\gamma)$ 1996RiZZ

Other reaction: $^{159}\text{Tb}(^{34}\text{S},4n\gamma)$ from 1988GoZN.

1996RiZZ (also 1995Re18): $^{156}\text{Gd}(^{37}\text{Cl},4n\gamma)$, $E=171$ MeV. Gammasphere array "Early Implementation Phase". Measured E_γ and $\gamma\gamma$. Details of this study are not available.

1988GoZN: $^{159}\text{Tb}(^{34}\text{S},4n\gamma)$: two cascades are built on $9/2^-$ isomeric state: 386.4-314.4-502-502-665-237 and 386.4-480.2-399.0-283.3-407.6-396-463. Level energies relative to 0 for the $(9/2^-)$ isomer are: 386.4, $11/2^-$; 700.5, $13/2^-$; 866.6, $13/2^+$; 1203, $17/2^-$; 1265.6, $15/2^+$; 1549, $17/2^+$; 1705; 1828.8; 1956.6; 2353; 2370; 2607; 2816. The 700.5 level also deexcites by a g.s. transition; 1549 also by a 682.4γ and 1828.8 level only by a 563.2γ . Except for 563.2γ from 1828 level, all the others γ rays are in 1996RiZZ but some are differently ordered in the negative parity cascade.

1996RiZZ state that their level scheme does not show the complete information on levels based on $13/2^+$ state, only the strongest cascade is presented.

 ^{189}Tl Levels

$E(\text{level})^\dagger$	$J^\pi@$	$T_{1/2}$	Comments
$0^\dagger$	$1/2^+$		
257.4 ^{& 14}	$9/2^-$	1.4 min <i>I</i>	$\% \epsilon + \% \beta^+ = 98$ 2; $\% \text{IT} < 4$ E(level): 257.6 keV proposed in 1996RiZZ for the $(9/2^-)$ isomer based on connection of high-spin states to low-spin states is not confirmed by ϵ decay study of 2009Sa09 from their $\gamma\gamma$ coincidence data.
317.9 ^{? 8}	$3/2^+$		
587.1 ^{? 8}	$(5/2^+)$		
643.3 ^{#a 14}	$11/2^-$		
747.6 ^{? 11}			
957.5 ^{#& 15}	$13/2^-$		
1038.4 ^{? 11}	$(7/2^-)$		
1122.9 ^{# 16}	$13/2^+$		
1384.5 ^{#a 15}	$15/2^-$		
1501.4 ^{?f 15}	$(9/2^-)$		
1521.8 ^{# 18}	$15/2^+$		
1621.4 ^{#& 16}	$(17/2^-)$		
1805.0 ^{# 18}	$17/2^+$		
1820.4 ^{# 16}	$17/2^-$		
1938.4 ^{?f 18}	$(13/2^-)$		
1970.6 ^{#e 19}	$17/2^+$		
2123.2 ^{#d 17}	$(19/2^-)$		
2139.7 ^{#a 16}	$19/2^-$		
2212.3 ^{#e 19}	$21/2^+$		
2422.4 ^{?f 21}	$(17/2^-)$		
2477.4 ^{#& 16}	$21/2^-$		
2608.3 ^{#e 22}	$25/2^+$		
2624.6 ^{#c 17}	$(23/2^-)$		
2644.2 ^{#d 19}	$(23/2^-)$		
2674.5 ^{#a 17}	$23/2^-$		
2765.0 ^{#b 18}	$(25/2^-)$		
2962.4 ^{?f 23}	$(21/2^-)$		
3002.0 ^{#c 19}	$(27/2^-)$		
3070.3 ^{#e 24}	$29/2^+$		
3229.2 ^{#d 22}	$(27/2^-)$		
3254.0 ^{#b 19}	$(29/2^-)$		

Continued on next page (footnotes at end of table)

$^{156}\text{Gd}(^{37}\text{Cl}, 4n\gamma)$ **1996RiZZ (continued)** ^{189}Tl Levels (continued)

E(level) [†]	J ^π @	E(level) [†]	J ^π @	E(level) [†]	J ^π @
3559.4 ^{‡f} 25	(25/2 ⁻)	4207 ^{#e} 3	37/2 ⁺	4868 ^{‡f} 3	
3603.0 ^{#c} 20	(31/2 ⁻)	4336.0 ^{#c} 21	(35/2 ⁻)	4871 ^{#e} 3	41/2 ⁺
3604 ^{#e} 3	33/2 ⁺	4432 [‡] 3		4913 [‡] 4	
3877.2 ^{#d} 24	(31/2 ⁻)	4581 ^{#d} 3	(35/2 ⁻)	5337 ^{#d} 3	(39/2 ⁻)
3934.0 ^{#b} 20	(33/2 ⁻)	4621 [‡] 3		5581 ^{#e} 3	45/2 ⁺
4195 ^{‡f} 3	(29/2 ⁻)	4705.0 ^{#b} 22	(37/2 ⁻)	6308 ^{#e} 4	49/2 ⁺

[†] From least-squares fit to E_γ data, assuming 1 keV uncertainty for each γ ray.

[‡] Level not included in the Adopted Levels since the placements of 269, 318, 430, 451, 463, 587 and 781 γ rays shown in band 5 in figure 1 of **1996RiZZ** are not confirmed from γγ coin data by **2009Sa09** in their ε decay study, where all these γ rays were seen. **2009Sa09** assign these γ rays to high-spin levels. For this reason, levels and gamma rays shown for band 5 in **1996RiZZ** are not listed in Adopted Levels.

[#] A value of 23 keV should be added to level energy in order to match with the corresponding level in Adopted Levels. This difference arises due to the value of 258 keV for the (9/2⁻) isomer given in **1996RiZZ** which has been proven incorrect by **2009Sa09** on the basis of γγ coin data.

@ As proposed in **1996RiZZ** based on DCO ratios and band assignments. But DCO ratios are not listed in the reports. In the Adopted Levels, all assignments are given in parentheses due to lack of strong supporting arguments.

& Band(A): π9/2[505], α=+1/2. Interpreted as oblate (β₂≈0.15) band from h_{9/2} proton orbital. This band is crossed by a strongly coupled band due to a pair of i_{13/2} neutrons.

^a Band(a): π9/2[505], α=-1/2. See comment for α=+1/2 signature partner.

^b Band(B): π9/2[505]⊗vi_{13/2}², α=+1/2. The π9/2[505] band is crossed by vi_{13/2}² band, thus producing a sharp backbend.

^c Band(b): π9/2[505]⊗vi_{13/2}², α=-1/2. See comment for α=+1/2 signature partner.

^d Band(C): Possible π1/2[550] band. Interpreted as oblate hole band.

^e Band(D): π1/2[660], α=+1/2. Interpreted as decoupled prolate (β₂≈0.27) intruder band from πi_{13/2} orbital.

^f Band(E): Possible 1/2[541] intruder band (?). This band from **1996RiZZ** is not included in the Adopted Levels since low-lying and low-spin sections of the level scheme proposed in **1996RiZZ** have not been confirmed by **2009Sa09** in β decay study.

 $\gamma(^{189}\text{Tl})$

E _γ	E _i (level)	J _i ^π	E _f	J _f ^π	E _γ	E _i (level)	J _i ^π	E _f	J _f ^π
140	2765.0	(25/2 ⁻)	2624.6	(23/2 ⁻)	318	317.9?	3/2 ⁺	0?	1/2 ⁺
165	1122.9	13/2 ⁺	957.5	13/2 ⁻	319	2139.7	19/2 ⁻	1820.4	17/2 ⁻
189 [‡]	4621?		4432?		331	3934.0	(33/2 ⁻)	3603.0	(31/2 ⁻)
197	2674.5	23/2 ⁻	2477.4	21/2 ⁻	338	2477.4	21/2 ⁻	2139.7	19/2 ⁻
199	1820.4	17/2 ⁻	1621.4	(17/2 ⁻)	349	3603.0	(31/2 ⁻)	3254.0	(29/2 ⁻)
237	1621.4	(17/2 ⁻)	1384.5	15/2 ⁻	369 [§]	4705.0	(37/2 ⁻)	4336.0	(35/2 ⁻)
237	3002.0	(27/2 ⁻)	2765.0	(25/2 ⁻)	386	643.3	11/2 ⁻	257.4	9/2 ⁻
237 [‡]	4432?		4195?	(29/2 ⁻)	395 [†]	1038.4?	(7/2 ⁻)	643.3	11/2 ⁻
242	2212.3	21/2 ⁺	1970.6	17/2 ⁺	396	2608.3	25/2 ⁺	2212.3	21/2 ⁺
252	3254.0	(29/2 ⁻)	3002.0	(27/2 ⁻)	399	1521.8	15/2 ⁺	1122.9	13/2 ⁺
269 [†]	587.1?	(5/2 ⁺)	317.9?	3/2 ⁺	402 [§]	4336.0	(35/2 ⁻)	3934.0	(33/2 ⁻)
283	1805.0	17/2 ⁺	1521.8	15/2 ⁺	407	2212.3	21/2 ⁺	1805.0	17/2 ⁺
288	2765.0	(25/2 ⁻)	2477.4	21/2 ⁻	427	1384.5	15/2 ⁻	957.5	13/2 ⁻
291 [†]	1038.4?	(7/2 ⁻)	747.6?		430 [†]	747.6?		317.9?	3/2 ⁺
292 [‡]	4913?		4621?		436	1820.4	17/2 ⁻	1384.5	15/2 ⁻
303	2123.2	(19/2 ⁻)	1820.4	17/2 ⁻	437 [‡]	1938.4?	(13/2 ⁻)	1501.4?	(9/2 ⁻)
314	957.5	13/2 ⁻	643.3	11/2 ⁻	449	1970.6	17/2 ⁺	1521.8	15/2 ⁺

Continued on next page (footnotes at end of table)

$^{156}\text{Gd}(^{37}\text{Cl},4n\gamma)$ **1996RiZZ (continued)** $\gamma(^{189}\text{Tl})$ (continued)

E_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	Comments
451 [†]	1038.4?	(7/2 ⁻)	587.1?	(5/2 ⁺)		
462	3070.3	29/2 ⁺	2608.3	25/2 ⁺		
463 [†]	1501.4?	(9/2 ⁻)	1038.4?	(7/2 ⁻)		
480	1122.9	13/2 ⁺	643.3	11/2 ⁻		
484 [‡]	2422.4?	(17/2 ⁻)	1938.4?	(13/2 ⁻)		
484	2624.6	(23/2 ⁻)	2139.7	19/2 ⁻		Mult.: $\Delta J=2$, Q transition based on DCO measurements as communicated to the evaluators by W. Reviol in a priv. comm. on Jan 30, 2011.
489	3254.0	(29/2 ⁻)	2765.0	(25/2 ⁻)		
502	2123.2	(19/2 ⁻)	1621.4	(17/2 ⁻)	D	Mult.: $\Delta J=1$, dipole (1995Re18) based on DCO ratios of 303 and 199 γ cascade in parallel to the 502 γ .
502	2624.6	(23/2 ⁻)	2123.2	(19/2 ⁻)		
518	2139.7	19/2 ⁻	1621.4	(17/2 ⁻)		
521	2644.2	(23/2 ⁻)	2123.2	(19/2 ⁻)		
534	3604	33/2 ⁺	3070.3	29/2 ⁺		
535	2674.5	23/2 ⁻	2139.7	19/2 ⁻		
540 [‡]	2962.4?	(21/2 ⁻)	2422.4?	(17/2 ⁻)		
585	3229.2	(27/2 ⁻)	2644.2	(23/2 ⁻)		
587 [†]	587.1?	(5/2 ⁺)	0?	1/2 ⁺		
597 [‡]	3559.4?	(25/2 ⁻)	2962.4?	(21/2 ⁻)		
601	3603.0	(31/2 ⁻)	3002.0	(27/2 ⁻)		
603	4207	37/2 ⁺	3604	33/2 ⁺		
636 [‡]	4195?	(29/2 ⁻)	3559.4?	(25/2 ⁻)		
648	3877.2	(31/2 ⁻)	3229.2	(27/2 ⁻)		
657	2477.4	21/2 ⁻	1820.4	17/2 ⁻		
664	1621.4	(17/2 ⁻)	957.5	13/2 ⁻		
664	4871	41/2 ⁺	4207	37/2 ⁺		
673 ^{‡§}	4868?		4195?	(29/2 ⁻)		
680	3934.0	(33/2 ⁻)	3254.0	(29/2 ⁻)		
682	1805.0	17/2 ⁺	1122.9	13/2 ⁺		
700	957.5	13/2 ⁻	257.4	9/2 ⁻		
704	4581	(35/2 ⁻)	3877.2	(31/2 ⁻)		
710	5581	45/2 ⁺	4871	41/2 ⁺		
727	6308	49/2 ⁺	5581	45/2 ⁺		
733 [§]	4336.0	(35/2 ⁻)	3603.0	(31/2 ⁻)		
741	1384.5	15/2 ⁻	643.3	11/2 ⁻		
755	2139.7	19/2 ⁻	1384.5	15/2 ⁻		
756	5337	(39/2 ⁻)	4581	(35/2 ⁻)		
771 [§]	4705.0	(37/2 ⁻)	3934.0	(33/2 ⁻)		
781 [†]	1038.4?	(7/2 ⁻)	257.4	9/2 ⁻		
848 [§]	1970.6	17/2 ⁺	1122.9	13/2 ⁺		
856	2477.4	21/2 ⁻	1621.4	(17/2 ⁻)		
863	1820.4	17/2 ⁻	957.5	13/2 ⁻		

[†] Placement in the level scheme is suspect in view of $\gamma\gamma$ coin data from **2009Sa09**, which did not confirm placements of 269, 318, 430, 451, 463, 587 and 781 γ rays in the lower section of sequence 5 in figure 1 of **1996RiZZ**. Thus this γ ray is not included in the Adopted Gammas.

[‡] This γ not included in Adopted Levels, Gammas dataset due to uncertain and unconfirmed nature of the lower section of the sequence 5 in figure 1 of **1996RiZZ**.

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

$^{156}\text{Gd}(^{37}\text{Cl}, 4n\gamma): \text{SD}$ 1998Re20

1998Re20 (also 2000Re10, 1998Re04): $^{156}\text{Gd}(^{37}\text{Cl}, 4n\gamma)$ E=172 MeV. Measured E_γ , I_γ , $\gamma\gamma$ coin using Gammasphere array of 102 Compton-suppressed Ge detectors. Deduced SD bands.

 ^{189}Tl Levels

SD-1 and SD-2 bands are interpreted (by 1998Re20) as signature partners associated with $\pi i_{13/2}$ ($\Omega=5/2$) configuration.

E(level)	$J^\pi^\dagger$	E(level)	$J^\pi^\dagger$	E(level)	$J^\pi^\dagger$
$x^\ddagger$	$J1 \approx (27/2)$	$3732.6+x^\ddagger$ 15	$J1+16$	$1927.5+y^\#$ 18	$J2+10$
$326.3+x^\ddagger$ 10	$J1+2$	$4369.4+x^\ddagger$ 16	$J1+18$	$2432.3+y^\#$ 19	$J2+12$
$694.2+x^\ddagger$ 12	$J1+4$	$5040.3+x^\ddagger$ 19	$J1+20$	$2973.7+y^\#$ 19	$J2+14$
$1102.7+x^\ddagger$ 12	$J1+6$	$y^\#$	$J2 \approx (25/2)$	$3552.8+y^\#$ 20	$J2+16$
$1551.3+x^\ddagger$ 12	$J1+8$	$304.5+y^\#$ 10	$J2+2$	$4167.0+y^\#$ 21	$J2+18$
$2039.6+x^\ddagger$ 13	$J1+10$	$649.3+y^\#$ 12	$J2+4$	$4815.4+y^\#$ 23	$J2+20$
$2566.4+x^\ddagger$ 13	$J1+12$	$1034.3+y^\#$ 15	$J2+6$		
$3131.1+x^\ddagger$ 13	$J1+14$	$1461.3+y^\#$ 18	$J2+8$		

† Proposed in 1998Re20 based on fitting of measured dynamic moment of inertia as a function of $\hbar\omega$ using a Harris parameterization. These assignments are consistent with the observation that the SD bands feed the normal-deformed states at and below spin 25/2.

‡ Band(A): SD-1 band (1998Re20). Percent population=0.1-0.2.

$^\#$ Band(a): SD-2 band (1998Re20). Percent population=0.1-0.2.

 $\gamma(^{189}\text{Tl})$

$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	$I_{(\gamma+ce)}^\ddagger$
$304.5^\S$ 10	$304.5+y$	$J2+2$	y	$J2 \approx (25/2)$	0.39 8
$326.3^\S$ 10	$326.3+x$	$J1+2$	x	$J1 \approx (27/2)$	0.13 8
344.8 6	$649.3+y$	$J2+4$	$304.5+y$	$J2+2$	0.45 8
367.9 6	$694.2+x$	$J1+4$	$326.3+x$	$J1+2$	0.38 7
385 1	$1034.3+y$	$J2+6$	$649.3+y$	$J2+4$	
408.5 3	$1102.7+x$	$J1+6$	$694.2+x$	$J1+4$	1.09 8
427 1	$1461.3+y$	$J2+8$	$1034.3+y$	$J2+6$	0.97 11
448.6 3	$1551.3+x$	$J1+8$	$1102.7+x$	$J1+6$	1.00 8
466.2 3	$1927.5+y$	$J2+10$	$1461.3+y$	$J2+8$	1.00 9
488.3 3	$2039.6+x$	$J1+10$	$1551.3+x$	$J1+8$	0.95 8
504.8 3	$2432.3+y$	$J2+12$	$1927.5+y$	$J2+10$	0.86 9
526.8 3	$2566.4+x$	$J1+12$	$2039.6+x$	$J1+10$	0.94 7
541.4 3	$2973.7+y$	$J2+14$	$2432.3+y$	$J2+12$	0.82 8
564.7 3	$3131.1+x$	$J1+14$	$2566.4+x$	$J1+12$	0.83 10
579.1 6	$3552.8+y$	$J2+16$	$2973.7+y$	$J2+14$	0.54 8
601.5 6	$3732.6+x$	$J1+16$	$3131.1+x$	$J1+14$	0.50 7
614.2 6	$4167.0+y$	$J2+18$	$3552.8+y$	$J2+16$	0.47 9
636.8 6	$4369.4+x$	$J1+18$	$3732.6+x$	$J1+16$	0.33 8
$648.4^\S$ 10	$4815.4+y?$	$J2+20$	$4167.0+y$	$J2+18$	0.35 7
$670.9^\S$ 10	$5040.3+x?$	$J1+20$	$4369.4+x$	$J1+18$	0.23 7

† $\Delta(E_\gamma)$ assigned by the evaluators, based on a general comment by 1998Re20 that it varies from 0.3 to 1 keV.

‡ Relative intensities within each SD band, read (by the evaluators) from intensity plot given by 1998Re20.

§ Placement of transition in the level scheme is uncertain.

$^{165}\text{Ho}(^{28}\text{Si},4n\gamma)$ **1991Po15,2007Ch41**

1991Po15: E=130-145 MeV. Target=600 $\mu\text{g}/\text{cm}^2$ and 1.7 mg/cm^2 on Au backing. "Chateau de Cristal" array consisting of 12 Compton-suppressed detectors and 38 BaF_2 counters acting as an inner ball. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma(\theta)$, $\gamma\gamma(\theta)$ (DCO) and $\gamma\gamma(\theta,\text{pol})$. Deduced high-spin levels, $J\pi$, multipolarity.

2007Ch41: E=138 MeV. Measured $E\gamma$, lifetimes by recoil-distance method using array of 12 Compton-suppressed HPGe detectors at NSC facility in New Delhi. Target was about 1 mg/cm^2 self-supporting ^{165}Ho . Stopper foil was about 10 mg/cm^2 gold. Target-stopper distance ranged from 14 to 10000 μm in 24 unequal steps. The partial level scheme and $J\pi$ assignments were taken from **1991Po15**.

2015Ho14: $^{106}\text{Pd}(^{86}\text{Kr},p2n\gamma), E(^{86}\text{Kr})=355$ MeV. Experiment was performed at the K130 cyclotron facility in Jyvaskyla. The recoiling nuclei were transported through the RITU separator, followed by detection of events using the GREAT spectrometer consisting of a multiwire proportional counter (MWPC), two double-sided silicon strip detectors (DSSDs), three Clover Ge detectors, and a planar Ge detector. The goal of this experiment was the measurement of new levels in ^{189}Pb , however, angular intensity ratios $R(\theta)$ were obtained for four transitions forming a dipole cascade in ^{189}Tl . They are given in the comments for the relevant γ transitions. Based on the measured $R(\theta)$ for transitions of known multipolarity in ^{189}Tl , **2015Ho14** establish average $R(\theta)=0.54$ 4 for stretched dipole, and 1.07 3 for stretched quadrupole transition.

 ^{189}Tl Levels

Q_t =transition quadrupole moment (**2007Ch41**) extracted from lifetime measurements.

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}^{\#}$	Comments
281 @& 7	9/2 ⁻	1.4 min 1	$\%e+\%b^+=98$ 2; $\%IT<4$ E(level), $T_{1/2}$: from Adopted Levels based on α decay studies.
667.01 @& 16	11/2 ⁻	37.8 ps 35	
980.99 @& 16	13/2 ⁻	1.9 ps 6	$Q_t=2.3$ 3 (2007Ch41).
1146.82 @b 24	13/2 ⁺	209 ps 12	
1324.6 4	13/2 ⁻		
1408.2 @& 3	15/2 ⁻		
1545.4 @b 3	15/2 ⁺		
1645.18 @& 25	17/2 ⁻	1.80 ps 42	$Q_t=2.7$ 3 (2007Ch41).
1745.0 4			
1828.6 @b 4	17/2 ⁺	9.0 ps 11	$Q_t=1.1$ 1 (2007Ch41).
1994.5 @a 5	(17/2 ⁺)		
2062.0 7			
2147.1 @& 6	21/2 ⁻	7.1 ps 14	$Q_t=2.5$ 3 (2007Ch41) with assumed E2 for 502.0 γ . J^π : proposed as (21/2 ⁻) in 1991Po15 and 2007Ch41 . In 1996RiZZ and 1995Re18 , it is proposed as (19/2 ⁻) from stretched dipole character of 502 γ .
2162.9& 6	(19/2 ⁻)		
2236.0 @a 5	21/2 ⁺	8.6 ps 12	$Q_t=3.8$ 3 (2007Ch41).
2236.1 6	(17/2)		
2307.0? 6			
2307.2 @b 6	(19/2 ⁺)		
2631.2 @a 6	25/2 ⁺	2.08 ps 28	$Q_t=7.8$ 5 (2007Ch41).
2649.0 @& 8	25/2 ⁻	<6.1 ps	$Q_t>2.8$ (2007Ch41). J^π : (23/2 ⁻) in Adopted Levels.
2788.5 @& 9	27/2 ⁻		J^π : (25/2 ⁻) in Adopted Levels.
3025.4 @& 10	29/2 ⁻		J^π : (27/2 ⁻) in Adopted Levels.
3093.7 @a 6	29/2 ⁺	0.90 ps 14	$Q_t=8.6$ 8 (2007Ch41).
3277.6 @& 10	31/2 ⁻		J^π : (29/2 ⁻) in Adopted Levels.
3441.7 8			
3627.3 @& 11	33/2 ⁻		J^π : from 2007Ch41 . $J=(33/2, 35/2)$ in 1991Po15 . $J\pi=(31/2-)$ in Adopted Levels.

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$^{165}\text{Ho}(^{28}\text{Si},4n\gamma)$ **1991Po15,2007Ch41 (continued)** ^{189}Tl Levels (continued)

E(level) [†]	$J^{\pi\ddagger}$	$T_{1/2}^{\#}$	Comments
3628.1 @ ^a 8	33/2 ⁺	<0.7 ps	Q _t >8.8 (2007Ch41).
4231.2 @ ^a 10	(37/2 ⁺)		
4895.2 ^a 14			

[†] From a least-square fit to E_γ data using 281-keV level as fixed. Uncertainty of 7 keV in this energy is not reflected in the uncertainties of other level energies.

[‡] As proposed in 1991Po15, unless otherwise stated.

[#] From recoil-distance Doppler-shift method (2007Ch41) for levels above the 281-keV isomer.

@ Level shown populated in 2007Ch41 (Figure 1 in the paper).

& Band(A): $\pi h_{9/2}$ oblate.

^a Band(B): $\pi i_{13/2}$ prolate.

^b Band(C): $\pi i_{13/2}$ oblate.

 $\gamma(^{189}\text{Tl})$

DCO ratios, A₂ and A₄ coefficients and POL values are from 1991Po15.

E _γ [†]	I _γ	E _i (level)	J^{π}_i	E _f	J^{π}_f	Mult. [§]	$\alpha^{\&}$	I _(γ+ce) [‡]	Comments
139.5 5	5	2788.5	27/2 ⁻	2649.0	25/2 ⁻	D		20	A ₂ =-0.3 1 Mult.: most likely M1, α(theory)=3.32. R(θ)=0.56 6 (2015Ho14).
165.9 5		1146.82	13/2 ⁺	980.99	13/2 ⁻				
199.6 5		1745.0		1545.4	15/2 ⁺				
236.9 ^a 5	^a	1645.18	17/2 ⁻	1408.2	15/2 ⁻				
236.9 ^a 5	^a	3025.4	29/2 ⁻	2788.5	27/2 ⁻	D		22	DCO=0.3 1; A ₂ =-0.25 12
241.6 5		2236.0	21/2 ⁺	1994.5	(17/2 ⁺)				
252.2 3		3277.6	31/2 ⁻	3025.4	29/2 ⁻	D		11	DCO=0.3 1; A ₂ =-0.31 14
283.3 5		1828.6	17/2 ⁺	1545.4	15/2 ⁺	D		7	DCO=0.3 1; A ₂ =-0.28 5
314.0 2	22	980.99	13/2 ⁻	667.01	11/2 ⁻	M1	0.346	30	DCO=0.20 5; A ₂ =-0.32 5 Pol=-0.08 4. R(θ)=0.51 5 (2015Ho14).
317.0 5		2062.0		1745.0					
336.7 5		1745.0		1408.2	15/2 ⁻				
348.0 5		3441.7		3093.7	29/2 ⁺				
349.7 5		3627.3	33/2 ⁻	3277.6	31/2 ⁻				
386.0 2	62	667.01	11/2 ⁻	281	9/2 ⁻	M1+E2	0.13 8	70	DCO=0.15 5; A ₂ =-0.68 7 Pol=+0.05 5.
395.2 3	15	2631.2	25/2 ⁺	2236.0	21/2 ⁺	E2	0.0510	16	DCO=1.0 2; A ₂ =+0.31 14 Pol=+0.09 5.
398.6 2	18	1545.4	15/2 ⁺	1146.82	13/2 ⁺	M1+E2	0.12 7	20	DCO=0.2 1; A ₂ =-0.68 9 Pol=+0.06 6.
407.3 3	14	2236.0	21/2 ⁺	1828.6	17/2 ⁺	E2	0.0471	15	DCO=1.0 2; A ₂ =+0.20 14 Pol=+0.11 5.
427.3 5	4	1408.2	15/2 ⁻	980.99	13/2 ⁻	M1	0.1503	5	DCO=0.3 1 Pol=-0.06 3.
449.2 5		1994.5	(17/2 ⁺)	1545.4	15/2 ⁺				
462.5 3	12	3093.7	29/2 ⁺	2631.2	25/2 ⁺	E2	0.0341	12	DCO=1.1 2 Pol=+0.15 5.
479 @ 1		2307.2	(19/2 ⁺)	1828.6	17/2 ⁺			10	

Continued on next page (footnotes at end of table)

$^{165}\text{Ho}(^{28}\text{Si},4n\gamma)$ 1991Po15,2007Ch41 (continued) $\gamma(^{189}\text{Tl})$ (continued)

E_γ [†]	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [§]	α ^{&}	$I_{(\gamma+ce)}$ [‡]	Comments
479.8 2	40	1146.82	13/2 ⁺	667.01	11/2 ⁻	E1	0.0101	40	DCO=0.40 11; A ₂ =-0.19 5 Pol=+0.25 7.
489.2 5 501.9 ^a 5	30 ^a	3277.6 2147.1	31/2 ⁻ 21/2 ⁻	2788.5 1645.18	27/2 ⁻ 17/2 ⁻			30	Mult.: E2 proposed in 1991Po15 but ΔJ=1, dipole in 1995Re18 based on DCO ratios for the 303 and 199 cascade of transitions in parallel to the 502γ.
501.9 ^a 5	19 ^a	2649.0	25/2 ⁻	2147.1	21/2 ⁻	E2	0.0279	20	DCO=1.3 3; A ₂ =+0.15 4 Pol=+0.29 8 for 501.9+502.2. R(θ)=1.08 3 (2015Ho14).
534.4 5	8	3628.1	33/2 ⁺	3093.7	29/2 ⁺	E2	0.0240	8	DCO=1.0 3 Pol=+0.13 5.
562.0 [#] 5 603.1 5 657.6 3	10	2307.0? 4231.2 1324.6	(37/2 ⁺) 13/2 ⁻	1745.0 3628.1 667.01	33/2 ⁺ 11/2 ⁻	M1	0.0485	10	A ₂ =-0.17 8 E _γ : A 657γ placed from a different level in 1996RiZZ which requires it to be E2 from ΔJπ, but negative value of POL suggests M1. This γ may be a doublet. Pol=-0.18 6.
662 [#] 1 664 1 664.2 2	34	2307.0? 4895.2 1645.18	17/2 ⁻	1645.18 4231.2 980.99	17/2 ⁻ (37/2 ⁺) 13/2 ⁻	E2	0.0147	35	DCO=0.9 2; A ₂ =+0.26 3 Pol=+0.17 5.
681.8 3	15	1828.6	17/2 ⁺	1146.82	13/2 ⁺	E2	0.0139	15	DCO=1.0 3; A ₂ =+0.41 17 Pol=+0.13 5.
690.7 [#] 5 700.0 2	30	2236.1 980.99	(17/2) 13/2 ⁻	1545.4 281	15/2 ⁺ 9/2 ⁻	E2	0.0131	30	DCO=1.0 2; A ₂ =+0.26 9 Pol=+0.27 11. R(θ)=1.04 5 (2015Ho14).
741.1 5 754.7 5 761.7 [@] 5	7 10	1408.2 2162.9 2307.2	15/2 ⁻ (19/2 ⁻) (19/2 ⁺)	667.01 1408.2 1545.4	11/2 ⁻ 15/2 ⁻ 15/2 ⁺			7	DCO=0.9 3

[†] From 1991Po15, $\Delta(E_\gamma)=0.2$ keV for $I_\gamma \geq 20$, 0.3 keV for $I_\gamma=10-20$, 0.5 keV for $I_\gamma < 10$ and doublets or when I_γ is unlisted, and 1 keV when E_γ stated to nearest keV, based on a general statement in 1991Po15 that these are 0.2-0.5 keV.

[‡] From 1991Po15, uncertainty=30% for $I_\gamma < 30$, 20% for $30 < I_\gamma < 60$, and 10% for $I_\gamma > 60$, based on a general statement in 1991Po15 that these are 10-30%. The evaluators estimate I_γ values from expected multiplicities and corresponding conversion coefficients.

[§] From DCO values and $\gamma(\text{lin pol})$ (1991Po15), except as noted. For mult=M1 or D, small E2 or quadrupole admixture is expected in $\Delta J=1$ transitions. Mult=D here is assigned M1(+E2) in 1991Po15.

[&] From BrIcc code (2008Ki07) with "Frozen Orbitals" approximation.

[@] This γ not reported in 1996RiZZ but present in 2007Ch41.

[#] This γ not shown in the level scheme of 1996RiZZ.

^a Multiply placed with intensity suitably divided.

$^{169}\text{Tm}(^{24}\text{Mg},4n\gamma)$ 1988Kr16

Includes $^{165}\text{Ho}(^{28}\text{Si},4n\gamma)$ and $^{175}\text{Lu}(^{20}\text{Ne},6n\gamma)$.

1988Kr16: $^{169}\text{Tm}(^{24}\text{Mg},4n\gamma)$, E=115-135 MeV; $^{165}\text{Ho}(^{28}\text{Si},4n\gamma)$, E=140 MeV; $^{175}\text{Lu}(^{20}\text{Ne},6n\gamma)$, E=128 MeV; Ge detectors with anti-Compton shields, measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma(\theta)$.

 ^{189}Tl Levels

E(level) [†]	J^π	$T_{1/2}$	Comments
281.7 [‡]	9/2 ⁻	1.4 min <i>I</i>	$\% \epsilon + \% \beta^+ = 98$ 2; $\% \text{IT} < 4$ E(level), $T_{1/2}$: from Adopted Levels.
667.61 [‡]	11/2 ⁻		
981.49 [‡]	13/2 ⁻		
1147.77 ^{&} 13	13/2 ⁺		
1325.01 22			
1409.49 [‡] 15	(15/2 ⁻)		
1483.7 [#] 4			E(level): rearrangement of the 502-664-502 cascade as 664-502-502 in Adopted Levels, Gammas dataset defines a level at 1645, instead of the 1484 level here.
1546.66 ^{&} 16	15/2 ⁺		
1738.72? 19			E(level): level not included in Adopted Levels, Gammas dataset.
1830.36 ^{&} 25	17/2 ⁺		
1995.2 4			
2109.3 3			E(level): corresponding level is probably 2308.1 in Adopted Levels.
2148.0 [#] 4			
2237.9 [@] 4	(21/2 ⁺)		
2308.3 4			
2626.1 5			
2633.5 [@] 5	(25/2 ⁺)		
2650.2 [#] 5			
2788.8 [#] 6			
3025.7 [#] 6			
3095.7 [@] 6	(29/2 ⁺)		
3278.0 [#] 7			
3629.7 [@] 7	(33/2 ⁺)		

[†] From a least-square fit to $E\gamma$ data using 281-keV level as fixed. Uncertainty of 7 keV in this energy is not reflected in the uncertainties of other level energies.

[‡] Band(A): 9/2⁻ band.

[#] Band(B): γ cascade.

[@] Band(C): (21/2⁺) band.

[&] Band(D): 13/2⁺ band.

 $\gamma(^{189}\text{Tl})$

E_γ [†]	I_γ [‡]	$E_i(\text{level})$	J^π_i	E_f	J^π_f	Comments
138.6 3	6.2 ^b 6	2788.8		2650.2		
165.9 3	4.4 ^b 9	1147.77	13/2 ⁺	981.49	13/2 ⁻	
199.0 ^{&} 3	4.6 5	2308.3		2109.3		E_γ : this γ deexcites a 1745 or an 1845 level in Adopted Levels, Gammas dataset.
236.9 2	10.0 ^b 10	3025.7		2788.8		
252.3 3	6.5 6	3278.0		3025.7		

Continued on next page (footnotes at end of table)

$^{169}\text{Tm}(^{24}\text{Mg},4n\gamma)$ **1988Kr16** (continued) $\gamma(^{189}\text{Tl})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^\ddagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [§]	Comments
283.8 3	8 4	1830.36	17/2 ⁺	1546.66	15/2 ⁺	D	$I_\gamma(0^\circ)/I_\gamma(90^\circ)=0.46$ 14.
313.9 1	31 3	981.49	13/2 ⁻	667.61	11/2 ⁻	D	$I_\gamma(0^\circ)/I_\gamma(90^\circ)=0.45$ 5.
317.8 ^{&} 3	2.7 ^b 3	2626.1		2308.3			E_γ : this γ deexcites a 2163 level in Adopted Levels, Gammas dataset.
329.5 ^{ad} 3	2.5	1738.72?		1409.49	(15/2 ⁻)		
375.8 ^d 3	3.5 4	3025.7		2650.2			
386.7 1	100.0 20	667.61	11/2 ⁻	281	9/2 ⁻	D	$I_\gamma(0^\circ)/I_\gamma(90^\circ)=0.34$ 2.
395.6 3	7.4 ^b 7	2633.5	(25/2 ⁺)	2237.9	(21/2 ⁺)		
398.9 1	34 7	1546.66	15/2 ⁺	1147.77	13/2 ⁺	D	$I_\gamma(0^\circ)/I_\gamma(90^\circ)=0.35$ 2.
407.5 2	15.0 15	2237.9	(21/2 ⁺)	1830.36	17/2 ⁺	Q	$I_\gamma(0^\circ)/I_\gamma(90^\circ)=1.05$ 10.
428.0 2	15.7 8	1409.49	(15/2 ⁻)	981.49	13/2 ⁻	D	$I_\gamma(0^\circ)/I_\gamma(90^\circ)=0.40$ 10.
448.5 3	6.6 ^b 6	1995.2		1546.66	15/2 ⁺	D	$I_\gamma(0^\circ)/I_\gamma(90^\circ)=0.38$ 12.
462.2 3	6.6 9	3095.7	(29/2 ⁺)	2633.5	(25/2 ⁺)	Q	$I_\gamma(0^\circ)/I_\gamma(90^\circ)=1.37$ 7.
480.2 1	55.0 16	1147.77	13/2 ⁺	667.61	11/2 ⁻	D	$I_\gamma(0^\circ)/I_\gamma(90^\circ)=0.71$ 4. Mult.: E1 implied by $\Delta J\pi$.
502.2 ^{c&} 3	36 ^c 4	1483.7		981.49	13/2 ⁻		$I_\gamma(0^\circ)/I_\gamma(90^\circ)=1.46$ 7 for doublet; mult=D+Q.
502.2 ^{c&} 3	36 ^c 4	2650.2		2148.0			
534.0 3	4.4 ^b 4	3629.7	(33/2 ⁺)	3095.7	(29/2 ⁺)		
562.6 [#] 2	13.8 7	2109.3		1546.66	15/2 ⁺		E_γ : this γ placed from a 2308.1 level in Adopted Levels, Gammas dataset.
657.4 [@] 2	12.4 6	1325.01		667.61	11/2 ⁻		
664.3 ^{&} 1	25.6 8	2148.0		1483.7		Q	$I_\gamma(0^\circ)/I_\gamma(90^\circ)=1.38$ 9.
682.5 3	9.4 5	1830.36	17/2 ⁺	1147.77	13/2 ⁺	Q	$I_\gamma(0^\circ)/I_\gamma(90^\circ)=1.6$ 3.
700.4 1	26.0 10	981.49	13/2 ⁻	281	9/2 ⁻	Q	$I_\gamma(0^\circ)/I_\gamma(90^\circ)=1.34$ 16.
742.0 2	10.0 10	1409.49	(15/2 ⁻)	667.61	11/2 ⁻	Q	$I_\gamma(0^\circ)/I_\gamma(90^\circ)=1.9$ 5.
757.1 ^d 2	11.0 ^b 10	1738.72?		981.49	13/2 ⁻		E_γ : probably corresponds to 754.7+761.7 doublet in 1991Po15 , first from a 2163 level and the second from a 2308 level in Adopted Levels, Gammas dataset.

[†] Uncertainty quoted in **1988Kr16** is 0.1-0.3. The evaluators assign 0.1 keV for $I_\gamma > 20$, 0.2 keV for $I_\gamma = 10-20$ and 0.3 keV for $I_\gamma < 10$ and for doublets.

[‡] At 90° and $E(^{24}\text{Mg})=125$ MeV.

[§] From $I_\gamma(0^\circ)/I_\gamma(90^\circ)$ data from $^{165}\text{Ho}(^{28}\text{Si},4n\gamma)$ at 140 MeV. Mult=D corresponds to $\Delta J=1$ transition and is assigned M1 in **1988Kr16**, except E1 for 480.2 γ . The mult=Q corresponds to $\Delta J=2$ transition and is assigned E2 in **1988Kr16**.

[&] The γ transition is ordered differently in **1996RiZZ** and/or **1991Po15**, and in Adopted Levels, Gammas. The 502-664-502 cascade in **1988Kr16** is ordered as 502-502-664 in Adopted Levels. 318-199 cascade is placed in a different location in Adopted Levels following the level scheme from **1996RiZZ**.

[@] Placement different in **1996RiZZ**, but same in **1991Po15**.

[#] Placement different in **1991Po15**, γ not reported in **1996RiZZ**.

^a This γ is not confirmed in later studies (**1996RiZZ**, **1991Po15**).

^b From $\gamma\gamma$ coin data.

^c Multiply placed with undivided intensity.

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

Adopted Levels, Gammas

$Q(\beta^-) = -7779$ 25; $S(n) = 8100$ 18; $S(p) = 2800$ 30; $Q(\alpha) = 5915$ 4 2017Wa10

$S(2n) = 19000$ 15, $S(2p) = 4304$ 20, $Q(\epsilon p) = 5069$ 19 (2017Wa10).

1974Le02 (also 1972Ga27): identification and production of ^{189}Pb in $^{182}\text{W}(^{16}\text{O}, 9n)$; $^{181}\text{Ta}(^{19}\text{F}, 11n)$ and $^{155}\text{Gd}(^{40}\text{Ar}, 6n)$ reactions, measured half-life and $\% \alpha$ decay mode. A preliminary report on the production of ^{189}Pb is quoted in 1967Es05 from a priv. comm. in 1966 from A. Siivola, with $T_{1/2} \approx 50$ s.

2009Se13, 2007De09: $U(p, X)$ $E = 1.4$ GeV; measured electromagnetic moments, and mean square charge radii using the Resonance Ionization Laser Ion Source (RILIS) at the ISOLDE (CERN) online mass separator. Uranium carbonite was used as the target.

Mean Square Charge Radii taken from 2007De09; uncertainty is taken from 2009Se13. 2006Se18 is from the same group.

Mass measurement: 2000Ra23 (also 1999Sc46).

 ^{189}Pb LevelsCross Reference (XREF) Flags

A	^{189}Pb IT decay (22.2 μs)	D	$^{106}\text{Pd}(^{86}\text{Kr}, ^3n\gamma)$
B	^{193}Po α decay (388 ms)	E	$^{158}\text{Gd}(^{36}\text{Ar}, 5n\gamma)$
C	^{193}Po α decay (245 ms)		

E(level) [†]	J^π	$T_{1/2}$	XREF	Comments
0.0	(3/2 ⁻)	39 s 8	B E	$\% \epsilon + \% \beta^+ \approx 100$; $\% \alpha \leq 0.40$ (2013Sa43) $\mu = -1.081$ 9 (2009Se13, 2014StZZ) $Q = +0.5$ 18 (2009Se13) RMS charge radius $\langle r^2 \rangle^{1/2} = 5.4177$ fm 24 (2013An02 evaluation). $\delta \langle r^2 \rangle (^{189}\text{Pb} - ^{208}\text{Pb}) = -0.890$ fm ² 10 (2007De09, 2009Se13); uncertainty from isotope shift is 0.008 fm ² . Other $\% \alpha \approx 0.2$ (1974Le02). $T_{1/2}$: from 2009Sa09. J^π : 13/2 ⁺ and 3/2 ⁻ isomers are expected from the systematics of ^{187}Pb and ^{191}Pb . μ, Q : laser resonance ionization spectroscopy (2009Se13).
40 [‡] 4	(13/2 ⁺)	50 s 3	A CDE	$\% \epsilon + \% \beta^+ \approx 100$; $\% \alpha \approx 0.4$ (1974Ho26) $\mu = -1.19$ 1 (2009Se13, 2014StZZ) $Q = -1.3$ 35 (2009Se13) E(level): from alpha-decay energy difference (2013Sa43). $\delta \langle r^2 \rangle (^{189m}\text{Pb} - ^{208}\text{Pb}) = -0.918$ fm ² 10 (2007De09, 2009Se13); uncertainty from isotope shift is 0.008 fm ² . μ, Q : laser resonance ionization spectroscopy (2009Se13). $T_{1/2}$: from 2009Sa09. Other: 51 s 3 (1974Le02, 1972Ga27). J^π : see J^π comment for g.s.; $i_{13/2}$ state.
549.0 10	(3/2 ⁻)		B	J^π : E0+M1+E2 γ to (3/2 ⁻).
677.60 23	(13/2 ⁺)		A CDE	J^π : E0+M1+E2 γ to (13/2 ⁺).
858.80 [‡] 10	(17/2 ⁺)		A DE	J^π : E2 γ to (13/2 ⁺); band member.
950.56 [@] 17	(15/2 ⁺)		A DE	J^π : γ to (13/2 ⁺); band member.
1181.59 [#] 15	(17/2 ⁺)	<6.9 ns	A DE	J^π : E0+M1+E2 γ to (17/2 ⁺).
1327.25 [‡] 13	(21/2 ⁺)		A DE	J^π : E2 γ to (17/2 ⁺); band member.
1340.11 [@] 17	(19/2 ⁺)		A DE	J^π : γ s to (15/2 ⁺) and (17/2 ⁺); band member.
1607.45 [#] 15	(21/2 ⁺)	<2.8 ns	A DE	J^π : gammas to (21/2 ⁺) and (17/2 ⁺); band member.
1813.0 [@] 4	(23/2 ⁺)		A D	J^π : γ to (19/2 ⁺); band member.
1865.43 [‡] 16	(25/2 ⁺)		A DE	J^π : γ to (21/2 ⁺); band member.
2137.83 [#] 16	(25/2 ⁺)	<2.1 ns	A DE	J^π : E0+M1+E2 γ to (25/2 ⁺) level.
2280.36 23	(27/2 ⁺)		A DE	J^π : M2 γ from (31/2 ⁻); γ to (25/2 ⁺).
2474.53 ^{&} 18	(31/2 ⁻)	22.2 μs +69-14	A D	$\% \text{IT} = 100$ J^π : E3 γ to (25/2 ⁺).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{189}Pb Levels (continued)

<u>E(level)[†]</u>	<u>J^π</u>	<u>XREF</u>	<u>Comments</u>
			E(level): this isomer is interpreted as bandhead of a shears structure with neutrons (in i13/2 orbital) coupled to protons at $\approx 60^\circ$ (2009Dr03). T _{1/2} : deduced from fitting of single exponential decay functions to the decay curves of both the 468 and 819 transitions in IT decay (2005Ba51).
2476.4 5		E	J ^π : γ to (25/2 ⁺) suggests (25/2,27/2,29/2 ⁺).
2654.3? 4	(33/2)	D	J ^π : $\Delta J=1$, dipole γ to (31/2 ⁻).
2680.93& 20	(33/2 ⁻)	D	J ^π : M1 γ to (31/2 ⁻); band member.
3069.7& 3	(35/2 ⁻)	D	J ^π : (M1) γ to (33/2 ⁻); band member.
3142.4 7		E	
3229.0? 11	(33/2 ⁻)	D	J ^π : $\Delta J=1$, dipole γ to (31/2 ⁻).
3488.4?& 5	(37/2 ⁻)	D	J ^π : (M1) γ to (35/2 ⁻); band member.
3923.4?& 6	(39/2 ⁻)	D	J ^π : (M1) γ to (37/2 ⁻); band member.
4336.6?& 6	(41/2 ⁻)	D	J ^π : (M1) γ to (39/2 ⁻); band member.
4671.7?& 9	(43/2 ⁻)	D	J ^π : (M1) γ to (41/2 ⁻); band member.

[†] From least-squares fit to E_γ data, keeping the energy of the 40-keV level as fixed, its uncertainty of 4 keV is not carried over in the energies of the higher levels.

[‡] Band(A): $\nu(i_{13/2})^{-3}$ band.

Band(B): band based on (17/2⁺), $\alpha=+1/2$.

@ Band(b): band based on (15/2⁺), $\alpha=-1/2$.

& Band(C): Magnetic-rotational (shears) dipole band. In comparison to structure of neighboring nuclides, this band is proposed as based on $\pi[s_{1/2}^{-2}h_{9/2}i_{13/2}]_{11-} \otimes \nu i_{13/2}^{-1}$ configuration.

 $\gamma(^{189}\text{Pb})$

<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>
549.0	(3/2 ⁻)	549 1	100	0.0	(3/2 ⁻)	E0+M1+E2 [‡]	0.40 19	α: From α(K)exp=0.34 16 (2002Va13) and multiplied by 1.2 to include higher shells.
677.60	(13/2 ⁺)	637.4 3	100	40	(13/2 ⁺)	E0+M1+E2 [‡]	0.49 19	α: From α(K)exp=0.41 16 (2009Dr03) and multiplied by 1.2 to include higher shells.
858.80	(17/2 ⁺)	818.8 1	100	40	(13/2 ⁺)	E2		
950.56	(15/2 ⁺)	910.6 3	100	40	(13/2 ⁺)			
1181.59	(17/2 ⁺)	230.9 2	56 22	950.56	(15/2 ⁺)			
		323.5 3	33 11	858.80	(17/2 ⁺)	E0+M1+E2	1.5 5	
		503.8 3	91 20	677.60	(13/2 ⁺)			
		1142.1 6	100 18	40	(13/2 ⁺)			
1327.25	(21/2 ⁺)	468.4 1	100	858.80	(17/2 ⁺)	E2	0.0344	
1340.11	(19/2 ⁺)	389.7 2	88 25	950.56	(15/2 ⁺)			
		481.2 2	100 38	858.80	(17/2 ⁺)			
1607.45	(21/2 ⁺)	267.4 3	25 5	1340.11	(19/2 ⁺)			
		279.7 2	9 2	1327.25	(21/2 ⁺)			
		425.9 1	100 20	1181.59	(17/2 ⁺)	[E2]	0.0438	B(E2)(W.u.)>0.16
1813.0	(23/2 ⁺)	473.0 5	100	1340.11	(19/2 ⁺)			
1865.43	(25/2 ⁺)	538.2 1	100	1327.25	(21/2 ⁺)			
2137.83	(25/2 ⁺)	272.4 2	17 2	1865.43	(25/2 ⁺)	E0+M1+E2	1.50 20	
		325.0 5	6 3	1813.0	(23/2 ⁺)			
		530.3 1	100 21	1607.45	(21/2 ⁺)	E2	0.0255	B(E2)(W.u.)>0.052
		810.8 2	61 4	1327.25	(21/2 ⁺)	E2	0.01012	B(E2)(W.u.)>0.0038

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Adopted Levels, Gammas (continued) $\gamma(^{189}\text{Pb})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [†]	$\alpha^\S$	Comments
2280.36	(27/2 ⁺)	142.4 2	100	2137.83	(25/2 ⁺)			
2474.53	(31/2 ⁻)	193.9 3	7 2	2280.36	(27/2 ⁺)	M2	7.04	B(M2)(W.u.)=0.0050 +16-22
		336.7 1	100 10	2137.83	(25/2 ⁺)	E3	0.395	B(E3)(W.u.)=24 +4-9
		609.3 3	19 3	1865.43	(25/2 ⁺)	(E3)	0.0542	B(E3)(W.u.)=0.073 +15-27
2476.4		611.0 4	100	1865.43	(25/2 ⁺)			
2654.3?	(33/2)	179.8& 3	100	2474.53	(31/2 ⁻)	D		
2680.93	(33/2 ⁻)	206.4 1	100	2474.53	(31/2 ⁻)	M1	1.199	Mult.: from $\alpha(\text{K})$ exp deduced from K-x ray and γ intensities.
3069.7	(35/2 ⁻)	388.8 2	100	2680.93	(33/2 ⁻)	(M1)	0.211	
3142.4		666.0 5	100	2476.4				
3229.0?	(33/2 ⁻)	754.5& 10	100	2474.53	(31/2 ⁻)	D		
3488.4?	(37/2 ⁻)	418.7 3	100	3069.7	(35/2 ⁻)	(M1)	0.1731	
3923.4?	(39/2 ⁻)	435.0 3	100	3488.4?	(37/2 ⁻)	(M1)	0.1563	
4336.6?	(41/2 ⁻)	413.2 3	100	3923.4?	(39/2 ⁻)	(M1)	0.179	
4671.7?	(43/2 ⁻)	335.1 6	100	4336.6?	(41/2 ⁻)	(M1)	0.316	Due to poor statistics, firm coincidence evidence of the placement of the 335.1-keV γ ray from recoil-isomer-tagged prompt $\gamma\gamma$ spectra is lacking. Present placement is based on systematic arguments.

[†] From IT decay and $^{158}\text{Gd}(^{36}\text{Ar}, 5n\gamma)$ for levels up to 2476 keV, and for 3142 level. Other levels above 2476 keV are only from $^{106}\text{Pd}(^{86}\text{Kr}, 3n\gamma)$.

[‡] From ce data in ^{193}Po α decay.

[§] Theoretical values from BrIcc code with “Frozen Orbitals” approximation.

& Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

^{189}Pb IT decay (22.2 μs) [2005Ba51,2009Dr03](#)

Parent: ^{189}Pb : $E=2475.53$ 18; $J^\pi=(31/2^-)$; $T_{1/2}22.2 \mu\text{s} +69-14$; %IT decay=100

[2005Ba51](#): $^{158}\text{Gd}(^{36}\text{Ar},5n\gamma)$: $E=178$ MeV. Target=0.43 mg/cm² 92.9% enriched ^{158}Gd . Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, particle- γ coin with 10 Compton-suppressed Ge detectors and parallel-grid avalanche counter (PGAC). Fragment mass analyzer (FMA) used to accept evaporation residues recoiling from target according to their mass/charge ratio. Reaction products detected by PGAC via energy loss (ΔE) and focal-plane-position signals. $^{164}\text{Er}(^{29}\text{Si},4n\gamma)$: $E=140$ MeV. Target=2.5 mg/cm² 73.6% enriched ^{164}Er . Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(t)$, lifetimes with six Compton-suppressed Ge detectors and two planar low energy photon spectrometer (LEPS) detectors of the CAESAR array.

[2009Dr03](#): ^{164}Er beam produced at $E=145$ MeV by 14UD Pelletron accelerator at Australian National University. Target=700 $\mu\text{g/cm}^2$. A spectrometer, consisting of the fusion product separator SOLITAIRE, an annular array of six cooled Si(Li) electron detectors, a single large-volume Ge detector and a single LEPS detector, were used to measure both γ rays and conversion electrons. CAESAR array of Ge detectors was used in complementary experiments.

 ^{189}Pb Levels

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$T_{1/2}$	Comments
40 4	(13/2 ⁺)		E(level): from Adopted Levels, based on α -decay data in 2013Sa43 .
677.60 23	(13/2 ⁺)		
858.80 ^a 10	(17/2 ⁺)		
950.56 ^{&} 17	(15/2 ⁺)		
1181.59 [@] 15	(17/2 ⁺)	<6.9 [#] ns	In-out transition intensity imbalance of -13 10 at this level.
1327.25 ^a 13	(21/2 ⁺)	<2.1 [#] ns	
1340.11 ^{&} 17	(19/2 ⁺)		
1607.45 [@] 15	(21/2 ⁺)	<2.8 [#] ns	
1813.0 ^{&} 4	(23/2 ⁺)		In-out transition intensity imbalance of 26 15 at this level.
1865.43 ^a 16	(25/2 ⁺)		
2137.83 [@] 16	(25/2 ⁺)	<2.1 [#] ns	
2280.36 23	(27/2 ⁺)		
2474.53 18	(31/2 ⁻)	22.2 $\mu\text{s} +69-14$	E(level): this isomer is interpreted as bandhead of a shears structure with neutrons (in i13/2 orbital) coupled to protons at $\approx 60^\circ$. $T_{1/2}$: deduced from fitting of single exponential decay functions to the decay curves of both the 468 and 819 transitions (2005Ba51).

[†] From least-squares fit to $E\gamma$ data, keeping the energy of the 40-keV level as fixed, its uncertainty of 4 keV is not carried over in the energies of the higher levels.

[‡] Assignments are as given in [2005Ba51](#) and [2009Dr03](#), based on multiplicities from conversion data, systematics of neighboring isotopes and isotones, and transition strengths.

[#] Estimated from $\gamma\gamma(t)$.

[@] Band(A): Band based on (17/2⁺), $\alpha=+1/2$. [2005Ba51](#) compared this band with 9/2[624] band in ^{187}Pb .

[&] Band(a): Band based on (15/2⁺), $\alpha=-1/2$. [2005Ba51](#) compared this band with 9/2[624] band in ^{187}Pb .

^a Band(B): $\nu i_{13/2}^{-3}$ band.

 $\gamma(^{189}\text{Pb})$

The $\alpha(\text{exp})$ values have been determined from intensity balance considerations.

$I\gamma$ normalization: From summed $I(\gamma+\text{ce})$ of γ rays to 40-keV level=100, deduced using GABS normalization code.

$E_\gamma^\dagger$	$I_\gamma^\ddagger^\text{@}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	$\alpha^\text{&}$	Comments
142.4 2	7 1	2280.36	(27/2 ⁺)	2137.83	(25/2 ⁺)	[M1+E2]	2.5 10	% $I\gamma=5.1$ 7
193.9 3	4 1	2474.53	(31/2 ⁻)	2280.36	(27/2 ⁺)	M2	7.04	% $I\gamma=2.9$ 6

Continued on next page (footnotes at end of table)

^{189}Pb IT decay (22.2 μs) 2005Ba51,2009Dr03 (continued) $\gamma(^{189}\text{Pb})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^{\ddagger@}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	$\alpha^\&$	Comments
								$\alpha(\text{K})\text{exp}=5.3\ 11$; $\alpha(\text{L})\text{exp}<2.6\ 9$; $\alpha(\text{M})\text{exp}<1.2$; $\text{K/L}>2.0\ 8$ $\alpha(\text{K})\text{exp}$, $\alpha(\text{L})\text{exp}$, $\alpha(\text{M})\text{exp}$ from 2009Dr03. L-conversion line contaminated by K lines of 267 γ and 272 γ , and M conversion line contaminated by K line of 279 γ .
230.9 2	6.2 24	1181.59	(17/2 ⁺)	950.56	(15/2 ⁺)	[M1+E2]	0.6 3	%I γ =4.6 17
267.4 3	14 3	1607.45	(21/2 ⁺)	1340.11	(19/2 ⁺)	[M1+E2]	0.37 21	%I γ =10.3 20
272.4 2	11 2	2137.83	(25/2 ⁺)	1865.43	(25/2 ⁺)	E0+M1+E2 [§]	1.50 20	%I γ =8.1 12 $\alpha(\text{exp})=1.50\ 20$ (2005Ba51)
279.7 2	5 1	1607.45	(21/2 ⁺)	1327.25	(21/2 ⁺)	[M1+E2]	0.33 19	%I γ =3.7 8
323.5 3	3.6 12	1181.59	(17/2 ⁺)	858.80	(17/2 ⁺)	E0+M1+E2 [§]	1.5 5	%I γ =2.6 9 $\alpha(\text{exp})=1.5\ 5$ (2005Ba51)
325.0 5	4 2	2137.83	(25/2 ⁺)	1813.0	(23/2 ⁺)	[M1+E2]	0.22 13	%I γ =2.9 15
336.7 1	58 6	2474.53	(31/2 ⁻)	2137.83	(25/2 ⁺)	E3	0.395	%I γ =43 9 $\alpha(\text{K})\text{exp}=0.113\ 16$; $\alpha(\text{L})\text{exp}=0.181\ 26$; $\alpha(\text{M})\text{exp}<0.086$; $\text{K/L}=0.62\ 12$ $\alpha(\text{K})\text{exp}$, $\alpha(\text{L})\text{exp}$, $\alpha(\text{M})\text{exp}$ from 2009Dr03. Other: $\alpha(\text{exp})=0.30\ 30$ (2005Ba51).
389.7 2	7 2	1340.11	(19/2 ⁺)	950.56	(15/2 ⁺)	[E2]	0.0552	%I γ =5.1 14
425.9 1	55 11	1607.45	(21/2 ⁺)	1181.59	(17/2 ⁺)	[E2]	0.0438	%I γ =40 4
468.4 1	79 4	1327.25	(21/2 ⁺)	858.80	(17/2 ⁺)	E2	0.0344	%I γ =58 20 $\alpha(\text{K})\text{exp}=0.023\ 3$ (2009Dr03)
473.0 5	4 2	1813.0	(23/2 ⁺)	1340.11	(19/2 ⁺)	[E2]	0.0336	%I γ =2.9 15
481.2 2	8 3	1340.11	(19/2 ⁺)	858.80	(17/2 ⁺)	[M1+E2]	0.08 5	%I γ =5.9 21
503.8 3	10.0 22	1181.59	(17/2 ⁺)	677.60	(13/2 ⁺)	[E2]	0.0288	%I γ =7.3 16
530.3 1	66 14	2137.83	(25/2 ⁺)	1607.45	(21/2 ⁺)	E2	0.0255	%I γ =48 22 $\alpha(\text{K})\text{exp}=0.021\ 4$ (2009Dr03)
538.2 1	32 3	1865.43	(25/2 ⁺)	1327.25	(21/2 ⁺)	E2	0.0247	%I γ =23.5 19 $\alpha(\text{K})\text{exp}=0.018\ 3$ (2009Dr03)
609.3 3	11 2	2474.53	(31/2 ⁻)	1865.43	(25/2 ⁺)	(E3)	0.0542	%I γ =8.1 14 $\alpha(\text{K})\text{exp}=0.020\ 6$ (2009Dr03)
637.4 3	8 3	677.60	(13/2 ⁺)	40	(13/2 ⁺)	E0+M1+E2 [§]	0.49 19	%I γ =5.9 21 $\alpha(\text{K})\text{exp}=0.41\ 16$ (2009Dr03) $\alpha(\text{exp})$: $\alpha(\text{K})\text{exp}$ multiplied by a factor of 1.2 to include higher shells. Other: $\alpha(\text{exp})=0.40\ 35$ (2005Ba51).
810.8 2	40.0 24	2137.83	(25/2 ⁺)	1327.25	(21/2 ⁺)	E2	0.01012	%I γ =29.4 17 $\alpha(\text{K})\text{exp}=0.012\ 3$ (2009Dr03)
818.8 1	100	858.80	(17/2 ⁺)	40	(13/2 ⁺)	E2	0.00991	%I γ =73 3 $\alpha(\text{K})\text{exp}=0.008\ 2$ (2009Dr03)
910.6 3	12 2	950.56	(15/2 ⁺)	40	(13/2 ⁺)	[M1+E2]	0.015 8	%I γ =8.8 14
1142.1 6	11 2	1181.59	(17/2 ⁺)	40	(13/2 ⁺)	[E2]	0.00516	%I γ =8.1 14

[†] From 2005Ba51. Values from 2009Dr03 are in agreement, but given to only the nearest keV.

[‡] Values are from 2005Ba51 in out-of-beam measurements, and scaled down by a factor of five by the evaluators so as to renormalize to 100 for the intensity of the 818 γ -ray. Intensities per 100 decays of the isomer, deduced using GABS code, are listed as %I γ in continuation records. Intensities from in-beam measurements are given in a separate dataset.

[§] Measured $\alpha(\text{exp})$ implies E0 admixture.

[&] Theoretical values from BrIcc code with "Frozen Orbitals" approximation. For mult=[M1+E2], given value overlaps those for pure M1 and pure E2.

[@] For absolute intensity per 100 decays, multiply by 0.73 3.

^{189}Pb IT decay (22.2 μs) 2005Ba51,2009Dr03

Decay Scheme

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

Legend

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

$^{189}_{82}\text{Pb}_{107}$

^{193}Po α decay (388 ms) [2002Va13,1993Wa04](#)

Parent: ^{193}Po : $E=0$; $J^\pi=(3/2^-)$; $T_{1/2}=388$ ms 40; $Q(\alpha)=7094$ 4; $\% \alpha$ decay ≤ 100

^{193}Po - $T_{1/2}$: From ^{193}Po Adopted Levels in the ENSDF database (Nov 2015 update).

^{193}Po - $Q(\alpha)$: From [2017Wa10](#).

^{193}Po - $\% \alpha$ decay: $\% \alpha \leq 100$ (from ^{193}Po Adopted Levels in the ENSDF database, Nov 2015 update).

[2002Va13](#): ^{193}Po produced by $^{166}\text{Er}(^{32}\text{S},5n)$ $E_{\text{lab}}(^{32}\text{S}) = 169$ MeV; implanted into position sensitive silicon strip detector to register the decayed α -particles; Ge detectors for γ and X-rays; Silicon detectors for conversion electrons; E_α , E_γ , $E(\text{ce})$, $\alpha\gamma$ and α -ce coincidences measured.

[1993Wa04](#): ^{193}Po source produced by <240 MeV Ne beam on 2.1 mg/cm 2 ^{182}W target; LISOL separator; Silicon surface-barrier detector and silicon PIPS-type detectors; E_α , $T_{1/2}$ measured.

See also, [1995Mo14](#), [1981Le23](#), [1977De32](#).

 ^{189}Pb Levels

<u>$E(\text{level})^\dagger$</u>	<u>$J^\pi^\dagger$</u>
0.0	$(3/2^-)$
549 1	$(3/2^-)$

† From [2002Va13](#). Same J^π values are in Adopted Levels.

 α radiations

<u>E_α</u>	<u>$E(\text{level})$</u>	<u>$I_\alpha^\dagger$</u>	<u>$\text{HF}^\ddagger$</u>	<u>Comments</u>
6420 20	549	0.7 3	2.8 13	E_α, I_α : From 2002Va13 .
6948 4	0.0	99.3 3	2.1 2	E_α : weighted average of 6949 10 (2002Va13), 6946 20 (1995Mo14), 6949 5 (1993Wa04) and 6940 20 (1981Le23). Other: 6940 (1977De32). I_α : 99.3 25 in 2002Va13 . Uncertainty of 0.3 is assigned by evaluators based on $100 - (I_\alpha = 0.7 \text{ 3 to } 549 \text{ level})$.

† For intensity per 100 α decay, multiply by ≤ 1 .

‡ Deduced by evaluators using $r_0(^{189}\text{Pb})=1.511 \text{ 8}$, from $r_0(^{188}\text{Pb})=1.511 \text{ 8}$ and $r_0(^{190}\text{Pb})=1.511 \text{ 6}$ ([1998Ak04](#)).

 $\gamma(^{189}\text{Pb})$

<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>α</u>	<u>$I_{(\gamma+\text{ce})}^\dagger$</u>	<u>Comments</u>
549 1	72 10	549	$(3/2^-)$	0.0	$(3/2^-)$	E0+M1+E2	0.40 19	99.3 3	$I_{(\gamma+\text{ce})}$: from I_α . I_γ : from $I(\gamma+\text{ce})$ and $\alpha(\text{exp})$. Mult.: $\alpha(\text{exp})=0.34 \text{ 16}$ (2002Va13). $\alpha(\text{exp})$: $\alpha(\text{K})\text{exp}$ multiplied by a factor of 1.2 to include higher shells.

† Absolute intensity per 100 decays.

^{193}Po α decay (388 ms) 2002Va13,1993Wa04

Decay Scheme

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

^{193}Po α decay (245 ms) 2002Va13,1993Wa04

Parent: ^{193}Po : $E=95.7$; $J^\pi=(13/2^+)$; $T_{1/2}=245$ ms 11; $Q(\alpha)=7094.4$; $\% \alpha$ decay ≤ 100

^{193}Po -E, J^π : From 2013Sa43 from $E\alpha$ values and decay pattern in $^{197}\text{Rn} \rightarrow ^{193}\text{Po} \rightarrow ^{189}\text{Pb} \rightarrow ^{185}\text{Hg} \rightarrow ^{181}\text{Pt}$ α -decay chain.

The same values are given in ^{193}Po Adopted Levels in the ENSDF database (Nov 2015 update). Energy of this state is listed as 100 keV 6 in 2017Au03 from energy difference in α decay.

^{193}Po - $T_{1/2}$: From ^{193}Po Adopted Levels in the ENSDF database (Nov 2015 update).

^{193}Po - $Q(\alpha)$: From 2017Wa10.

^{193}Po - $\% \alpha$ decay: $\% \alpha \leq 100$ (from ^{193}Po Adopted Levels in the ENSDF database; Nov 2015 update).

2002Va13: ^{193}Po produced by $^{166}\text{Er}(^{32}\text{S},5n)$; implanted into position sensitive silicon strip detector to register the decayed α -particles; Ge detectors for γ and X-rays; Silicon detectors for conversion electrons; $E\alpha$, $E\gamma$, $E(\text{ce})$, $\alpha\gamma$ and α -ce coincidences measured.

1993Wa04: α -sources ^{193}Po produced by <240 MeV Ne beam on 2.1 mg/cm² ^{182}W target; LISOL separator; Silicon surface-barrier detector and silicon PIPS-type detectors; $E\alpha$, $T_{1/2}$ measured.

See also, 2005Uu02, 1995Mo14, 1981Le23, 1967Si09.

 ^{189}Pb Levels

E(level)	J^π	Comments
40 4	(13/2 ⁺)	E(level): from 2013Sa43. J^π : from ^{189}Pb Adopted Levels.
677 1	(13/2 ⁺)	E(level), J^π : from 2013Sa43. The same J^π value in Adopted Levels.

 α radiations

$E\alpha$	E(level)	$I\alpha^\dagger$	$HF^\ddagger$	Comments
6375 15	677	0.8 3	1.1 5	$E\alpha, I\alpha$: from 2002Va13.
7002 4	40	99.2 3	2.0 1	$E\alpha$: weighted average of 7004 10 (2002Va13), 6991 20 (1995Mo14), 7004 5 (1993Wa04), 7000 20 (1981Le23) and 6980 20 (1967Si09). Other: 6995 keV (1977De32). $I\alpha$: 99.2 35 in 2002Va13. Uncertainty of 0.3 is assigned by evaluators based on 100-($I\alpha=0.8$ 3 to 677 level).

[†] For intensity per 100 α decay, multiply by ≤ 1 .

[‡] Deduced by evaluators using $r_0(^{189}\text{Pb})=1.511$ 8, from $r_0(^{188}\text{Pb})=1.511$ 8 and $r_0(^{190}\text{Pb})=1.511$ 6 (1998Ak04).

 $\gamma(^{189}\text{Pb})$

E_γ	$I_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	α	$I_{(\gamma+ce)}^\dagger$	Comments
637 1	67 9	677	(13/2 ⁺)	40	(13/2 ⁺)	E0+M1+E2	0.49 19	99.2 3	$I_{(\gamma+ce)}$: from $I\alpha$. I_γ : from $I(\gamma+ce)$ and $\alpha(\text{exp})$. Mult.: $\alpha(\text{exp})=1.1$ 4 (2002Va13). $\alpha(\text{exp})$: from Adopted Gammas, based on $\alpha(K)\text{exp}=0.41$ 16 (2009Dr03).

[†] Absolute intensity per 100 decays.

^{193}Po α decay (245 ms) 2002Va13,1993Wa04

Decay Scheme

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

$^{106}\text{Pd}(^{86}\text{Kr}, 3n\gamma)$ 2015Ho14

2015Ho14: $E(^{86}\text{Kr})=355$ MeV from K130 cyclotron facility at Jyvaskyla. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, recoil-isomer-tagged prompt $\gamma\gamma$ and prompt- delayed and delayed-delayed $\gamma\gamma$ spectra, and angular intensity ratios using JUROGAM-II array of 39 Compton-suppressed HPGe detectors. Recoiling nuclei were transported through the RITU separator, followed by detection of events using GREAT spectrometer consisting of a multiwire proportional counter (MWPC), two double-sided silicon strip detectors (DSSDs), three Clover Ge detectors, and a planar Ge detector; the Ge detector system of the GREAT spectrometer was used to detect γ rays from isomer decay as well as those from β^- decay of implanted nuclei. Recoil-isomer tagging and recoil-gated γ detection techniques were used. Deduced a dipole band above the $31/2^-$, 22- μs isomer, conversion coefficients, multipolarities, configuration, and alignments. Comparison with structure of neighboring nuclei.

 ^{189}Pb Levels

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$T_{1/2}$	Comments
40 4	$13/2^+$	50 s 3	$\% \epsilon + \% \beta^+ \approx 100$; $\% \alpha \leq 0.40$ Half-life and decay modes are from ^{189}Pb Adopted Levels.
677.5 8	$13/2^+$		
858.9 7	$17/2^+$		
950.7 7	$15/2^+$		
1181.9 7	$17/2^+$		
1327.2 10	$21/2^+$		
1340.3 9	$19/2^+$		
1607.6 9	$21/2^+$		
1813.1 11	$23/2^+$		
1865.5 11	$25/2^+$		J^π : negative parity in level-scheme Figure 5 of 2015Ho14 seems a misprint.
2137.8 10	$25/2^+$		
2280.2 13	$27/2^+$		
2474.5 [#] 12	$31/2^-$	22.2 μs +69-14	$\% \text{IT}=100$ $T_{1/2}$: from Adopted Levels. J^π : (33/2) in Adopted Levels.
2654.3? 12	(33/2 ⁺)		
2680.9 [#] 12	$33/2^-$		
3069.7 [#] 12	$35/2^{(-)}$		
3229.0? 16	(33/2 ⁻)		
3488.4? [#] 13	$37/2^{(-)}$		
3923.4? [#] 13	(39/2 ⁻)		
4336.6? [#] 13	(41/2 ⁻)		
4671.7? [#] 15	(43/2 ⁻)		

[†] From least-squares fit by evaluators to $E\gamma$ values, assuming 1 keV uncertainty when not listed, and fixing the energy of the $13/2^+$ isomer at 40 keV. Energies listed in 2015Ho14 are relative to zero for the $13/2^+$ isomer.

[‡] Assignments are from 2015Ho14, based on those in 2009Dr03 for levels up to the $31/2^-$ isomer at 2474.5 keV.

[#] Band(A): Magnetic-rotational (shears) dipole band. In comparison to structure of neighboring nuclides, this band is proposed as based on $\pi[s_{1/2}^{-2}h_{9/2}i_{13/2}]_{11-} \otimes \nu i_{13/2}^{-1}$ configuration.

 $\gamma(^{189}\text{Pb})$

$R(\theta)$ =angular intensity ratio obtained from recoil-tagged $\gamma\gamma$ matrix. Based on presently measured $R(\theta)$ for four transitions of known multipolarity in ^{189}Tl , 2015Ho14 establish average $R(\theta)=0.54$ 4 for stretched dipole, and 1.07 3 for stretched quadrupole transition.

Relative K x ray and Gamma-ray intensities

$E(\text{x ray})$ or $E\gamma$	$I(\text{x ray})$ or $I\gamma$
75.0, $K_{\alpha 1}$	4356 81
84.9, $K_{\beta 1}$	1277 50
206.4	4120 100
413.2	1367 56

$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\ddagger}$	$E_i(\text{level})$	J_i^{π}	E_f	J_f^{π}	Mult. [§]	α^a	Comments
418.7 435.0		4564 83 1804 72						
142		2280.2	27/2 ⁺	2137.8	25/2 ⁺			
179.8 ^b 3	16.6 4	2654.3?	(33/2 ⁺)	2474.5	31/2 ⁻	D		R(θ)=0.49 6.
194		2474.5	31/2 ⁻	2280.2	27/2 ⁺	M2 ^{&}		
206.4 1	99.9 16	2680.9	33/2 ⁻	2474.5	31/2 ⁻	M1	1.199	$\alpha(\text{K})_{\text{exp}}=1.11$ 4 (2015Ho14) Mult.: from $\alpha(\text{K})_{\text{exp}}$ deduced from K-x ray and γ intensities obtained from recoil-isomer tagged $\gamma\gamma$ matrix with a gate on the 389-keV transition. In this procedure, theoretical x-ray intensities from the internal conversion of the 419-, 435-, and 413-keV γ -rays was subtracted from the total x-ray intensity, with the assumption of M1 for 413, 419 and 435 γ rays. If E1 is assumed for all these three γ rays, then $\alpha(\text{K})_{\text{exp}}=1.35$ 4 (2015Ho14) for 206.4 γ , inconsistent with either the E1 or M1 for this transition.
231		1181.9	17/2 ⁺	950.7	15/2 ⁺			R(θ)=0.56 5.
267		1607.6	21/2 ⁺	1340.3	19/2 ⁺			
272		2137.8	25/2 ⁺	1865.5	25/2 ⁺			
280		1607.6	21/2 ⁺	1327.2	21/2 ⁺			
324		1181.9	17/2 ⁺	858.9	17/2 ⁺			
325		2137.8	25/2 ⁺	1813.1	23/2 ⁺			
335.1 ^b 6	18.3 9	4671.7?	(43/2 ⁻)	4336.6?	(41/2 ⁻)	(M1) [#]	0.316	Due to poor statistics, firm coincidence evidence of the placement of the 335.1-keV γ ray from recoil-isomer-tagged prompt $\gamma\gamma$ spectra is lacking. Present placement is based on systematic arguments. R(θ)=0.38 13.
337		2474.5	31/2 ⁻	2137.8	25/2 ⁺	E3 ^{&}		
388.8 2	100.0 17	3069.7	35/2 ⁽⁻⁾	2680.9	33/2 ⁻	(M1) [#]	0.211	R(θ)=0.49 6.
390		1340.3	19/2 ⁺	950.7	15/2 ⁺			
413.2 3	16.7 7	4336.6?	(41/2 ⁻)	3923.4?	(39/2 ⁻)	(M1) [@]	0.179	R(θ)=0.69 24.
418.7 3	39.6 10	3488.4?	37/2 ⁽⁻⁾	3069.7	35/2 ⁽⁻⁾	(M1) [@]	0.1731	R(θ)=0.44 10.
426		1607.6	21/2 ⁺	1181.9	17/2 ⁺			
435.0 3	24.7 8	3923.4?	(39/2 ⁻)	3488.4?	37/2 ⁽⁻⁾	(M1) [@]	0.1563	R(θ)=0.62 17.
468		1327.2	21/2 ⁺	858.9	17/2 ⁺			
473		1813.1	23/2 ⁺	1340.3	19/2 ⁺			
481		1340.3	19/2 ⁺	858.9	17/2 ⁺			
504		1181.9	17/2 ⁺	677.5	13/2 ⁺			
530		2137.8	25/2 ⁺	1607.6	21/2 ⁺			
538		1865.5	25/2 ⁺	1327.2	21/2 ⁺			
609		2474.5	31/2 ⁻	1865.5	25/2 ⁺	(E3) ^{&}		
637		677.5	13/2 ⁺	40	13/2 ⁺			
754.5 ^b 10	19.8 9	3229.0?	(33/2 ⁻)	2474.5	31/2 ⁻	D		R(θ)=0.36 20.
811		2137.8	25/2 ⁺	1327.2	21/2 ⁺			
819		858.9	17/2 ⁺	40	13/2 ⁺			
911		950.7	15/2 ⁺	40	13/2 ⁺			
1142		1181.9	17/2 ⁺	40	13/2 ⁺			

[†] For γ rays from levels up to 2474.5 keV, 2015Ho14 quote values from 2009Dr03. For higher levels, values are from Table I of 2015Ho14.

 $^{106}\text{Pd}(^{86}\text{Kr}, 3n\gamma)$ **2015Ho14 (continued)**

 $\gamma(^{189}\text{Pb})$ (continued)

[‡] Intensities listed here are from Table I of [2015Ho14](#) divided by a factor of 10.

[§] Stretched dipole from $R(\theta)$, except when noted otherwise.

[&] From Adopted Gammas.

[@] From stretched dipole, and analysis of K-conversion coefficient for 206.4 γ . See comment for 206.4 γ from 2681 level. Also possible transition in a magnetic-dipole rotational band.

[#] From stretched dipole from $R(\theta)$, and transition intensity balance arguments. Also possible transition in a magnetic-dipole rotational band.

^a Theoretical values from BrIcc code with “Frozen Orbitals” approximation.

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

$^{158}\text{Gd}(^{36}\text{Ar},5n\gamma), ^{164}\text{Er}(^{29}\text{Si},4n\gamma)$ 2005Ba51

Includes $^{157}\text{Gd}(^{36}\text{Ar},4n\gamma)$ from 1995Sp01.

First experiment: $^{158}\text{Gd}(^{36}\text{Ar},5n\gamma)$: E=178 MeV. Measured E_γ , I_γ , $\gamma\gamma$, particle- γ coin with 10 Compton-suppressed Ge detectors and parallel-grid avalanche counter (PGAC). Fragment mass analyzer (FMA) used to accept evaporation residues recoiling from target according to their mass/charge ratio. Reaction products detected by PGAC via energy loss (ΔE) and focal-plane-position signals.

Second experiment: $^{164}\text{Er}(^{29}\text{Si},4n\gamma)$: E=140 MeV. Measured E_γ , I_γ , $\gamma\gamma$, $\gamma\gamma(t)$, lifetimes with six Compton-suppressed Ge detectors and two planar low-energy photon spectrometer (LEPS) detectors of the CAESAR array.

1995Sp01: $^{157}\text{Gd}(^{36}\text{Ar},4n\gamma)$ E=173 MeV. Measured E_γ and $\gamma\gamma$ using EUROBALL array. 609-538-468-818 γ cascade reported.

 ^{189}Pb Levels

E(level) [†]	J^π [‡]	$T_{1/2}$	Comments
40 & 4	(13/2 ⁺)		E(level): from Adopted Levels.
677.51 23	(13/2 ⁺)		
858.82 & 10	(17/2 ⁺)		
950.46 @ 17	(15/2 ⁺)		
1181.42 # 16	(17/2 ⁺)	<6.9 ns	
1327.23 & 13	(21/2 ⁺)	<2.1 ns	
1340.04 @ 13	(19/2 ⁺)		
1607.33 # 15	(21/2 ⁺)	<2.8 ns	
1865.41 & 16	(25/2 ⁺)		
2137.73 # 16	(25/2 ⁺)	<2.1 ns	
2280.1 3	(27/2)		
2476.4 5			
3142.4 7			

[†] Deduced by evaluators from least-squares fit to E_γ data, keeping the energy of the 40-keV level as fixed, its uncertainty of 4 keV is not carried over in the energies of the higher levels. Note that level in 2005Ba51 are given relative to the isomeric level at 40 keV.

[‡] Assignments are based on systematics of neighboring isotopes and isotones, multipolarities of transitions and related transition strengths.

Band(A): Band based on (17/2⁺), $\alpha=+1/2$. 2005Ba51 compared this band with 9/2[624] band in ^{187}Pb .

@ Band(a): Band based on (15/2⁺), $\alpha=-1/2$. 2005Ba51 compared this band with 9/2[624] band in ^{187}Pb .

& Band(B): $\nu i_{13/2}^{-3}$ band.

 $\gamma(^{189}\text{Pb})$

E_γ	I_γ @	$E_i(\text{level})$	J_i^π	E_f	J_f^π
142.4 2	7.0 24	2280.1	(27/2)	2137.73	(25/2 ⁺)
(230.9 [†] & 2)		1181.42	(17/2 ⁺)	950.46	(15/2 ⁺)
^x 264 [†] &					
(267.4 [†] & 3)		1607.33	(21/2 ⁺)	1340.04	(19/2 ⁺)
(272.4 [†] & 2)		2137.73	(25/2 ⁺)	1865.41	(25/2 ⁺)
^x 279 [†] &					
(279.7 [†] & 2)		1607.33	(21/2 ⁺)	1327.23	(21/2 ⁺)
389.7 2	≈8	1340.04	(19/2 ⁺)	950.46	(15/2 ⁺)
^x 394 [†] &					
425.9 1	≈8	1607.33	(21/2 ⁺)	1181.42	(17/2 ⁺)
468.4 1	75 8	1327.23	(21/2 ⁺)	858.82	(17/2 ⁺)

Continued on next page (footnotes at end of table)

$^{158}\text{Gd}(^{36}\text{Ar}, 5n\gamma), ^{164}\text{Er}(^{29}\text{Si}, 4n\gamma)$ **2005Ba51 (continued)** $\gamma(^{189}\text{Pb})$ (continued)

E_γ	I_γ @	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
$^{x470}\&$						E_γ : seen in coin with a 854 line.
(481.2 $^{\dagger}\&$ 1)		1340.04	(19/2 $^+$)	858.82	(17/2 $^+$)	
(503.8 $^{\dagger}\&$ 3)		1181.42	(17/2 $^+$)	677.51	(13/2 $^+$)	E_γ : possibly masked by 502 transitions from ^{189}Tl in mass gate.
530.3 1	≈ 8	2137.73	(25/2 $^+$)	1607.33	(21/2 $^+$)	
538.2 1	24.0 24	1865.41	(25/2 $^+$)	1327.23	(21/2 $^+$)	
$^{x602}\&$						
611.0 4	20 4	2476.4		1865.41	(25/2 $^+$)	
637.4 3	20 2	677.51	(13/2 $^+$)	40	(13/2 $^+$)	
666.0 5	12 4	3142.4		2476.4		
810.8 2	9 2	2137.73	(25/2 $^+$)	1327.23	(21/2 $^+$)	
818.8 1	100	858.82	(17/2 $^+$)	40	(13/2 $^+$)	
$^{x854}\&$						
910.6 3	22.0 22	950.46	(15/2 $^+$)	40	(13/2 $^+$)	
1142.1 6	20 6	1181.42	(17/2 $^+$)	40	(13/2 $^+$)	

† Prominent line in coin with A=189 recoils, but assignment to a nuclide could not be made. The 264 γ was seen in recoil- $\gamma\gamma$ data to be in coin with 279, 394 and 602 lines, but not seen in coin with any of the ^{189}Pb γ rays in the work of 2005Ba51. Possibly prompt transition feeding the isomer.

‡ Seen in coin with 264 γ , but no coin with any of the other ^{189}Pb γ rays in the present study. This may be a prompt transition feeding the 22- μs isomer.

§ Observed in isomer decay.

$^{\&}$ Isotopic assignment uncertain.

$^{\textcircled{a}}$ Values are from in-beam measurements. All values scaled down by a factor of five so as to renormalize the decay scheme to an intensity of 100 for the 818 γ -ray.

x γ ray not placed in level scheme.

Adopted Levels, Gammas

$Q(\beta^-) = -8640$ 30; $S(n) = 10941$ 24; $S(p) = -462$ 23; $Q(\alpha) = 7268.2$ 27 [2017Wa10](#)

$Q(\epsilon p) = 4980$ 40, $S(2n) = 19824$ 23, $S(2p) = 2198$ 22 ([2017Wa10](#)).

^{189}Bi identified by [1973Ga08](#) and [1974Le02](#) in $^{159}\text{Tb}(^{40}\text{Ar}, X)$ $E = 300$ MeV reaction. Later decay studies of ^{189}Bi : [1984ScZQ](#), [1985Co06](#), [1993An19](#), [1995Ba75](#), [1997Wa05](#), [2001An11](#), [2003Ke08](#).

 ^{189}Bi LevelsCross Reference (XREF) Flags

- A** ^{193}At α decay (28 ms)
B ^{193}At α decay (21 ms)
C ^{193}At α decay (27 ms)
D $^{109}\text{Ag}(^{82}\text{Kr}, ^2n\gamma), (^{83}\text{Kr}, 3n\gamma)$

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$T_{1/2}$	XREF	Comments
0.0	$(9/2^-)$	688 ms 5	ABCD	$\% \alpha \approx 100$ (1997Wa05) J^π : M1 γ from $(7/2^-)$; $\pi h_{9/2}$ state. $T_{1/2}$: from α -decay (2007DoZW , Fig. 3, based on measured values of 689 ms 2 for decay curve for 6672 α and 681 ms 8 for 7107 α). Other measurements: 580 ms 25 (2003Ke08); 667 ms 13 (2002Hu14); 728 ms 40, ≈ 1000 ms, 1.4 s $+10-8$ (1997Wa05), 680 ms 30 (1984ScZQ), < 1.5 s (1973Ga08). Weighted average of all the values, except that of 2007DoZW is 658 ms 20, which is in reasonable agreement with the value of 688 ms 5 adopted here from 2007DoZW .
99.6 5	$(7/2^-)$	< 10 ns	AB	J^π : favored α decay from $(7/2^-)$ parent. $T_{1/2}$: from $\alpha\gamma(t)$ (2003Ke08).
184 8	$(1/2^+)$	5.0 ms 1	A	$\% \alpha = 83$ 5 (2003Ke08); $\% \text{IT} = 17$ 5 (2003Ke08) Other $\% \alpha = 50-100$ (1985Co06). $E(\text{level})$: average of values from ^{193}At α -decay: 187 9 (2003Ke08), 182 8 (1997Wa05). Others: 190 40 (1995Ba75), 220 30 (1993An19), 92 7 (1985Co06). J^π : favored α decay from $(1/2^+)$ parent; $s_{1/2}$ state. $T_{1/2}$: from 7287 α decay curve (1999An52 and 2007DoZW , same value obtained in the two independent measurements). Other measurements: 4.6 ms $+8-6$ (2003Ke08), 5.2 ms 6 (1997Wa05), 4.8 ms 5 (1997An09), 7.0 ms 20 (1995Ba75 , 1997Wa05), 4 ms 2 (1993An19), ≈ 5 ms (1984ScZQ) and 5.4 ms 2 (2007DoZW , from 7107 α). The uncertainty of 0.2 ms in 1995Ba75 was a misprint, it should have been 2.0 ms as explained in 1997Wa05 , a later paper by the same group as 1995Ba75 . Weighted average of all the values listed above also gives 5.0 ms 1, same as that from 1999An52 and 2007DoZW .
357.6 5	$(13/2^+)$	0.88 ms 5	CD	$\% \text{IT} \approx 100$ $E(\text{level})$: from $^{193\text{m}}\text{At}$ α decay (2003Ke08). $\pi 1i_{13/2}$ proton state. J^π : M2 γ to $(9/2^-)$ (2001An11). Favored α decay from $(13/2^+)$ parent. $T_{1/2}$: from 357 $\gamma(t)$ (2002Hu14). Other: ≈ 0.55 ms (2003Ke08), ≥ 0.36 ms 12 from $^{189\text{m}}\text{Bi}$ α -decay (2001An11), and 0.888 ms 32 (2007DoZW).
778 [#] 1	$(17/2^+)$		D	
1091 [#] 2	$(21/2^+)$		D	
1466 [#] 2	$(25/2^+)$		D	
1912 [#] 2	$(29/2^+)$		D	
2422 [#] 2	$(33/2^+)$		D	
2973 [#] 3	$(37/2^+)$		D	

[†] From E_γ data, assuming 1 keV uncertainty when not stated.

[‡] From systematics of neighboring nuclides, except when noted otherwise.

[#] Band(A): Band built on $\pi 1_{13/2}$ intruder orbital.

Adopted Levels, Gammas (continued)

$\gamma(^{189}\text{Bi})$										Comments
$E_i(\text{level})$	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult.	δ	α	$I_{(\gamma+ce)}$	
99.6	(7/2 ⁻)	99.6 5	100	0.0	(9/2 ⁻)	M1(+E2)	<0.6	9.8 5		B(M1)(W.u.)>0.00015 E _γ : from $^{193\text{m}}\text{At}$ decay (2003Ke08). Mult.: from $\alpha(\text{K})\text{exp}=8.7\ 20$ (2003Ke08).
184	(1/2 ⁺)	(84 8)		99.6	(7/2 ⁻)	[E3]		55×10 ¹ 27	100	B(E3)(W.u.)=1.3 5 E _γ : from level-energy difference.
357.6	(13/2 ⁺)	357.6 5	100	0.0	(9/2 ⁻)	M2		0.969		B(M2)(W.u.)=9.3×10 ⁻⁵ 5 Mult.: from $\alpha(\text{K})\text{exp}=0.9\ 1$ (2001An11, from number of K-x rays and γ rays in the decay of ^{189}Bi isomer at 357.6 keV)). E _γ : from $^{193\text{m}}\text{At}$ α decay (2003Ke08). Other: E _γ =357 from $^{189\text{m}}\text{Bi}$ decay (2001An11), identified by the γ -transition having the same excitation function as the 6672 keV α -line of $^{189\text{g}}\text{Bi}$, and in coincidence with Bi K-x rays.
778	(17/2 ⁺)	420		357.6	(13/2 ⁺)					
1091	(21/2 ⁺)	313		778	(17/2 ⁺)					
1466	(25/2 ⁺)	375		1091	(21/2 ⁺)					
1912	(29/2 ⁺)	446		1466	(25/2 ⁺)					
2422	(33/2 ⁺)	510		1912	(29/2 ⁺)					
2973	(37/2 ⁺)	551		2422	(33/2 ⁺)					

Adopted Levels, Gammas

Band(A): Band built on $\pi i_{13/2}$ intruder orbital

$^{189}_{83}\text{Bi}_{106}$

^{193}At α decay (28 ms) 2003Ke08

Parent: ^{193}At : $E=0$; $J^\pi=(1/2^+)$; $T_{1/2}=28\text{ ms}+5-4$; $Q(\alpha)=7572.7$; $\% \alpha$ decay ≈ 100

^{193}At - $Q(\alpha)$: From 2017Wa10.

^{193}At - $E, J^\pi, T_{1/2}$: From ^{193}At Adopted Levels in the ENSDF database (cf. 2006Ac01 evaluation), where values are taken from 2003Ke08.

^{193}At - $\% \alpha$ decay: $\% \alpha \approx 100$.

2003Ke08: ^{193}At produced in $^{141}\text{Pr}(^{56}\text{Fe}, 4n\gamma)$ reaction, at $E=264\text{--}272\text{ MeV}$; recoil fragment mass separation; measurement using recoil-tagged α - α and α - γ coincidences, and considering α -decay links to levels in the daughter nuclides ^{189}Bi and ^{185}Tl .

2005Ke10, 2005Uu03 and 2007DoZW are conference reports from the same group as 2003Ke08.

 ^{189}Bi Levels

<u>$E(\text{level})^\dagger$</u>	<u>$J^\pi^\dagger$</u>	<u>$T_{1/2}^\dagger$</u>	Comments
0.0	(9/2 ⁻)	688 ms 5	
99.6 5	(7/2 ⁻)		
184 8	(1/2 ⁺)	5.0 ms 1	$\%IT=17.5$ (2003Ke08); $\% \alpha=83.5$ (2003Ke08) $E(\text{level})$: average of values from ^{193}At α -decay: 187.9 (2003Ke08), 182.8 (1997Wa05). Others: 190.40 (1995Ba75), 220.30 (1993An19), 92.7 (1985Co06). J^π : hindrance factor of ≈ 1.2 suggests favored α decay with the same J^π values for this level and the ^{193}At g.s. parent. $T_{1/2}$: Other: 4.6 ms $+8-6$ (from $E_\alpha=7295$, 2003Ke08).

[†] From Adopted Levels.

 α radiations

<u>E_α</u>	<u>$E(\text{level})$</u>	<u>$I_\alpha^\ddagger$</u>	<u>$HF^\dagger$</u>	Comments
7235 5	184	100	≈ 1.2	HF: 0.69 13 (2003Ke08).

[†] Deduced by evaluators using $r_0(^{189}\text{Bi})=1.550\text{ 50}$, interpolated from $r_0(^{190}\text{Po})=1.590\text{ 11}$ (from $T_{1/2}$ and I_α data in 2006An36), and $r_0(^{188}\text{Pb})=1.511\text{ 8}$ (1998Ak04). Values from 2003Ke08 are given under comments.

[‡] For α intensity per 100 decays, multiply by ≈ 1 .

 $\gamma(^{189}\text{Bi})$

<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>$I_{(\gamma+ce)}$</u>	Comments
(84 8)	184	(1/2 ⁺)	99.6	(7/2 ⁻)	[E3]	$55 \times 10^{1\text{ 27}}$	17 5	E_γ : from level-energy difference. $I_{(\gamma+ce)}$: from $\%IT=17.5$ (2003Ke08). E3 branch of 17% 5 from the 187-keV isomer from 2003Ke08.

^{193}At α decay (28 ms) 2003Ke08

Decay Scheme

^{193}At α decay (21 ms) 2003Ke08

Parent: ^{193}At : $E=5\ 10$; $J^\pi=(7/2^-)$; $T_{1/2}=21\ \text{ms}\ 5$; $Q(\alpha)=7572\ 7$; $\% \alpha$ decay ≈ 100

^{193}At - $Q(\alpha)$: From 2017Wa10.

^{193}At - $E, J^\pi, T_{1/2}$: From ^{193}At Adopted Levels in the ENSDF database (cf. 2006Ac01) evaluation, where values are taken from 2003Ke08. Energy of this state is given as 8 keV 9 in 2017Au03. Note that the measured value of half-life in 2003Ke08 was 31.8 ms +15-13, but was adjusted to account for assumed feeding by an E3 transition from a 27-ms ($13/2^+$) level to the ($7/2^-$) level in the parent. See 2003Ke08 for details.

^{193}At - $\% \alpha$ decay: $\% \alpha \approx 100$.

2003Ke08: ^{193}At produced in $^{141}\text{Pr}(^{56}\text{Fe}, 4n\gamma)$ reaction, at $E=264\text{--}272\ \text{MeV}$; recoil fragment mass separation; measurement using recoil-tagged α - α and α - γ coincidences, and considering α -decay links to levels in the daughter nuclides ^{189}Bi and ^{185}Tl .

1995Le15: source produced by $^{141}\text{Pr}(^{56}\text{Fe}, 4n)$ $E=265\ \text{MeV}$. Gas-filled mass separator. Measured position-correlated α events. Half-life measured as $\approx 40\ \text{ms}$, $E_\alpha=7.34\text{--}7.40\ \text{MeV}$ in coin with 680-ms ^{189}Bi decay. 2005Ke10, 2005Uu03 and 2007DoZW are conference reports from the same group as 2003Ke08.

 ^{189}Bi Levels

E(level)	$J^\pi^\dagger$	$T_{1/2}^\dagger$	Comments
0	($9/2^-$)	658 ms 22	
99.6 5	($7/2^-$)	<10 ns	J^π : hindrance factor of ≈ 1.8 suggests favored α decay with the same J^π values for this level and the 5-keV level in ^{193}At parent. $T_{1/2}$: from $\alpha\gamma(t)$ (2003Ke08).

† From Adopted Levels.

 α radiations

E_α	E(level)	$I_\alpha^\ddagger$	HF †	Comments
7325 5	99.6	98 2	≈ 1.8	HF: 1.1 3 (2003Ke08).
7423 5	0	2 2	$1.9 \times 10^2\ 19$	HF: 64 64 (2003Ke08).

† Deduced by evaluators using $r_0(^{189}\text{Bi})=1.550\ 50$, interpolated from $r_0(^{190}\text{Po})=1.590\ 11$ (from $T_{1/2}$ and I_α data in 2006An36), and $r_0(^{188}\text{Pb})=1.511\ 8$ (1998Ak04). Values from 2003Ke08 are given under comments.

‡ For α intensity per 100 decays, multiply by ≈ 1 .

 $\gamma(^{189}\text{Bi})$

E_γ	$I_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	δ	α	$I_{(\gamma+ce)}^\dagger$	Comments
99.6 5	9.1 5	99.6	($7/2^-$)	0	($9/2^-$)	M1(+E2)	<0.6	9.8 5	98 2	E_γ : from 2003Ke08, seen in coin with α particles. $I_{(\gamma+ce)}$: from $I_\alpha=98\ 2$ per 100 α decays. I_γ : from $I(\gamma+ce)$ and α . Mult.: from $\alpha(K)\text{exp}=8.7\ 20$ (2003Ke08), from I_γ and $I(K\ \text{x-ray})$.

† Absolute intensity per 100 decays.

^{193}At α decay (21 ms) 2003Ke08

Decay Scheme

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

^{193}At α decay (27 ms) 2003Ke08

Parent: ^{193}At : $E=39\ 7$; $J^\pi=(13/2^+)$; $T_{1/2}=27\ \text{ms} +4-3$; $Q(\alpha)=7572\ 7$; $\% \alpha\ \text{decay}=24\ 10$

$^{193}\text{At}-Q(\alpha)$: From 2017Wa10.

$^{193}\text{At}-E, J^\pi, T_{1/2}$: From ^{193}At Adopted Levels in the ENSDF database (cf. 2006Ac01 evaluation), where values are taken from 2003Ke08. Energy of this state is given as 42 keV 9 in 2017Au03.

$^{193}\text{At}-\% \alpha\ \text{decay}$: $\% \alpha=24\ 10$ (2003Ke08); $13/2^+$ to $7/2^-$, E3 transition of $\approx 34\ \text{keV}$ in ^{193}At is expected to be 76% 10 (2003Ke08).

2003Ke08: ^{193}At produced in $^{141}\text{Pr}(^{56}\text{Fe}, 4n\gamma)$ reaction, at $E=264-272\ \text{MeV}$; recoil fragment mass separation; measurement using recoil-tagged $\alpha\alpha$ and $\alpha\gamma$ coincidences, and considering α -decay links to levels in the daughter nuclides ^{189}Bi and ^{185}Tl .

2005Ke10, 2005Uu03 and 2007DoZW are conference reports from the same group as 2003Ke08.

 ^{189}Bi Levels

<u>E(level)[†]</u>	<u>J^π[‡]</u>	<u>$T_{1/2}$[‡]</u>	Comments
0	(9/2 ⁻)	658 ms 22	J^π : hindrance factor of 1.8 9 suggests favored α decay with the same J^π values for this level and the 39-keV level in ^{193}At parent. $T_{1/2}$: other: $\approx 0.55\ \text{ms}$ (2003Ke08).
357.6 5	(13/2 ⁺)	0.88 ms 5	

[†] From E_γ value.

[‡] From Adopted Levels.

 α radiations

<u>E_α</u>	<u>E(level)</u>	<u>I_α[‡]</u>	<u>HF[†]</u>	Comments
7106 5	357.6	100	1.8 9	HF: 1.0 4 (2003Ke08).

[†] Deduced by evaluators using $r_0(^{189}\text{Bi})=1.550\ 50$, interpolated from $r_0(^{190}\text{Po})=1.590\ 11$ (from $T_{1/2}$ and I_α data in 2006An36), and $r_0(^{188}\text{Pb})=1.511\ 8$ (1998Ak04). Values from 2003Ke08 are given under comments.

[‡] For α intensity per 100 decays, multiply by 0.24 10.

 $\gamma(^{189}\text{Bi})$

<u>E_γ</u>	<u>I_γ[†]</u>	<u>$E_i(\text{level})$</u>	<u>J^π_i</u>	<u>E_f</u>	<u>J^π_f</u>	<u>Mult.</u>	<u>α</u>	<u>$I_{(\gamma+ce)}$[†]</u>	Comments
357.6 5	50.8 4	357.6	(13/2 ⁺)	0	(9/2 ⁻)	M2	0.969	100	E_γ : from 2003Ke08, seen in coin with α particles. $I_{(\gamma+ce)}$: from $I_\alpha=100$ per 100 α decays. I_γ : from $I_{(\gamma+ce)}$ and α . Mult.: from $\alpha(K)\text{exp}=0.9\ 1$ (2001An11, from number of K-x rays and γ rays in the decay of ^{189}Bi isomer at 357.6 keV).

[†] For absolute intensity per 100 decays, multiply by 0.24 10.

^{193}At α decay (27 ms) 2003Ke08

Decay Scheme

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

$^{109}\text{Ag}(^{82}\text{Kr},2n\gamma),(^{83}\text{Kr},3n\gamma)$ 2004Hu15,2002Hu14

2004Hu15 (also 2007DoZW): E=340 MeV. Measured E_γ , I_γ , $\gamma\gamma$ with the Jurosphere II array comprised of 27

Compton-suppressed HPGe detectors. Delayed γ -rays were detected at the RITU focal plane with a HPGe detector, which was replaced by a more efficient setup of BGO detectors for the $^{109}\text{Ag}(^{83}\text{Kr},3n\gamma)$ experiment. The fusion-evaporation residues were selected by the gas-filled separator RITU and identified event by event using their α -decay characteristics in order to apply the Recoil Decay Tagging (RDT) technique.

2004Hu15 state that many γ transitions were also observed in coin with the α decay of the $1/2^+$ isomer of ^{189}Bi , but no levels could be established due to the lack of counting statistics and $\gamma\gamma$ coincidences.

2002Hu14: $^{109}\text{Ag}(^{82}\text{Kr},2n\gamma),^{109}\text{Ag}(^{83}\text{Kr},3n\gamma)$, E=337 MeV; Position sensitive detectors; Jurosphere II array of Ge detectors, Ge detector with a BGO wall; Recoil decay tagging technique. Measured half-life of the $13/2^+$ isomer.

The data are from 2004Hu15 unless otherwise stated.

 ^{189}Bi Levels

E(level)	J^π [†]	$T_{1/2}$	Comments
0	$9/2^-$		
357	$13/2^+$	0.88 ms 5	$T_{1/2}$: from 357 γ (t) (2002Hu14).
777 [‡]	$17/2^+$		
1090 [‡]	$21/2^+$		
1465 [‡]	$25/2^+$		
1911 [‡]	$(29/2^+)$		
2421 [‡]	$(33/2^+)$		
2972 [‡]	$(37/2^+)$		

[†] As assigned in 2004Hu15 based on systematics of neighboring nuclei for the g.s. and $13/2^+$ isomer, and from band structure and limited $\gamma(\theta)$ data for higher levels. All assignments are given in parentheses in Adopted Levels.

[‡] Band(A): Band based on $17/2^+$. Band built on $\pi i_{13/2}$ intruder orbital.

 $\gamma(^{189}\text{Bi})$

E_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	α	Comments
^x 180							
^x 239							
313	1090	$21/2^+$	777	$17/2^+$	[†]		
^x 337 [‡]							
^x 348 [‡]							
357	357	$13/2^+$	0	$9/2^-$	M2	0.969	Mult.: from Adopted Gammas.
375	1465	$25/2^+$	1090	$21/2^+$	[†]		
420	777	$17/2^+$	357	$13/2^+$			
446	1911	$(29/2^+)$	1465	$25/2^+$	[†]		
^x 450							
^x 463							
510	2421	$(33/2^+)$	1911	$(29/2^+)$			
551	2972	$(37/2^+)$	2421	$(33/2^+)$			
^x 628 [‡]							

[†] Assigned as $\Delta J=2$, E2 in 2004Hu15 based on $\gamma(\theta)$ data; but no details of the $\gamma(\theta)$ are provided in the paper.

[‡] Transition feeds the $13/2^+$ isomer.

^x γ ray not placed in level scheme.

Adopted Levels, Gammas

S(n)=8949 30; S(p)=1516 25; Q(α)=7694 15 [2017Wa10](#)

S(2n)=20390 40, S(2p)=1013 23, Q(ϵ p)=9104 24 ([2017Wa10](#)).

[1999An52](#), [2001Hu21](#): ^{189}Po produced by $^{142}\text{Nd}(^{52}\text{Cr},5n)$, E=239-307 MeV, identified by the α -decay to the excited state of ^{185}Pb . Target: 290 $\mu\text{g}/\text{cm}^2$ $^{142}\text{NdF}_3$ enriched to 99.8%. Velocity filter SHIP.

[2005An17](#): Cross section for production of ^{189}Po in heavy-ion reactions.

[2005Va04](#): activity produced by $^{142}\text{Nd}(^{52}\text{Cr},5n)$, E=5.27 MeV/nucleon; $^{142}\text{Nd}(^{50}\text{Cr},3n)$, E=5.04 MeV/nucleon; 99.8% enriched $^{142}\text{Nd}_2\text{F}_3$ target; Detectors: velocity filter (SHIP), 16-strip position sensitive silicon detector for α -particles; 6 silicon detectors for conversion electrons; four-fold segmented Clover detector for γ . Measured E(α), I(α), E(γ), $\alpha\gamma$ -coin, $\alpha(\text{ce})$ coin, α_{tot} .

 ^{189}Po LevelsCross Reference (XREF) Flags

A ^{193}Rn α decay (1.15 ms)

E(level)	J^π	$T_{1/2}$	XREF	Comments
0.0	(5/2 ⁻)	3.5 ms 5	A	<p>$\% \alpha \approx 100$ (2005Va04)</p> <p>$\% \alpha$: only α decay observed by 2005Va04 (and 1999An52) with Eα=7259 15, 7309 20 and 7532 20. In 1999An52, the possibility of an additional α decay from an additional isomeric level is mentioned, and based on a comparison with ^{191}Po, it was suggested that the decay energy and half-life should be similar to decay from the ground state. 2005Va04, from the same experimental group, presented potential energy surface calculations suggesting there should be only one state from which α decay can occur. Although this is referred to as an isomeric state, it is likely that what is meant is the ground state.</p> <p>J^π: particle-plus-rotor model calculations produce a negative-parity prolate minimum for 7/2[514] configuration (2005Va04). However, (5/2⁻) is supported by favored α decay to 278, (5/2⁻) state in ^{185}Pb which has possible configuration=$\nu 5/2[512]$.</p> <p>$T_{1/2}$: from α decay curve (2005Va04). Other: 5 ms <i>I</i> (1999An52). 2005Va04 and 1999An52 are from the same group. The evaluators assume that half-life and α decay energies as reported in 2005Va04 supersede those in 1999An52.</p>
194	(3/2 ⁻ , 5/2 ⁻ , 7/2 ⁻)		A	<p>J^π: (M1) γ to the (5/2⁻).</p>

 $\gamma(^{189}\text{Po})$

$E_i(\text{level})$	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult.	α	Comments
194	(3/2 ⁻ , 5/2 ⁻ , 7/2 ⁻)	194	100	0.0	(5/2 ⁻)	(M1)	1.69	Mult.: from ce data in ^{193}Rn α decay (2006An36) and prompt character of the transition.

^{193}Rn α decay (1.15 ms) 2006An36

Parent: ^{193}Rn : $E=0$; $T_{1/2}=1.15$ ms 27; $Q(\alpha)=8040$ 12; $\% \alpha$ decay ≈ 100

^{193}Rn - $E, J^\pi, T_{1/2}$: From ^{193}Rn Adopted Levels in the ENSDF database (Dec 2016 update).

^{193}Rn - $Q(\alpha)$: From 2017Wa10.

^{193}Rn - $\% \alpha$ decay: $\% \alpha \approx 100$ for ^{193}Rn decay (2006An36).

2006An36: ^{193}Rn produced and identified in $^{144}\text{Sm}(^{52}\text{Cr}, 3n)$ reaction at $E=252$ MeV; $^{144}\text{SmF}_3$ rotating target onto a carbon backing. UNILAC heavy-ion facility at GSI, with SHIP velocity filter for separating evaporation residues.

Several different types of detectors were used by 2006An36. The decays of the evaporation residues were measured by implanting residues in a thick 16-strip position-sensitive silicon detector (PSSD) with a typical FWHM ≈ 20 keV for α particles in 6-8 MeV range. An array of six silicon detectors of similar shape (BOX detectors), mounted upstream of PSSD detector, was used to measure the energies of α , β and conversion electrons. Three thin time-of-flight detectors in front of the PSSD and BOX detectors permitted identification of reaction products from the scattered beam particles; and distinction between the decay events and implantation events through anti-coincidence technique. An additional thick Si detector was installed as a veto detector behind the PSSD detector in an anti-coincidence mode. This allowed distinction between the decays and the punch-through events (from high-energy protons and α particles produced in the reactions on the carbon backing). For γ rays, a four-fold segmented 'Clover' Ge detector was used behind the PSSD detectors for prompt and delayed γ (residues) coin and/or $\alpha\gamma$ coin measurements. Measured α , γ , $\alpha\gamma$ coin, α (residues) coin, γ (residues) coin.

 ^{189}Po Levels

E(level)	J^π [†]	$T_{1/2}$ [†]	Comments
0	(5/2 ⁻)	3.5 ms 5	
194	(3/2 ⁻ , 5/2 ⁻ , 7/2 ⁻)		J^π : (M1) γ to the (5/2 ⁻). The α hindrance factor of 1.9 suggests favored α decay, and similar J^π values for this level and the ^{193}Rn g.s. parent.

[†] From Adopted Levels.

 α radiations

E_α	E(level)	I_α [†]	HF [‡]	Comments
7685 15	194	74 20	1.6 6	HF: 1 (2006An36).
7875 20	0	26 12	17 9	HF: ≈ 11 (2006An36).

[†] For α intensity per 100 decays, multiply by ≈ 1 .

[‡] Deduced by evaluators using $r_0(^{189}\text{Po})=1.588$ 14, extrapolated from $r_0(^{190}\text{Po})=1.590$ 11 (from $T_{1/2}$ and I_α data in 2006An36), and $r_0(^{192}\text{Po})=1.585$ 16 from ^{196}Rn α decay dataset in the ENSDF database (June 2012 update). Values from 2006An36 are given under comments.

 $\gamma(^{189}\text{Po})$

E_γ	I_γ [†]	E_i (level)	J_i^π	E_f	J_f^π	Mult.	α	$I_{(\gamma+ce)}$ [†]	Comments
194	28 8	194	(3/2 ⁻ , 5/2 ⁻ , 7/2 ⁻)	0	(5/2 ⁻)	(M1)	1.69	74 20	α : Theoretical conversion coefficient from BrIcc code. $I_{(\gamma+ce)}$: from $I_\alpha=74$ 20 per 100 α decays. I_γ : from $I(\gamma+ce)$ and α . Mult.: from $\alpha(K)\text{exp}\approx 2$ (from ce data, 2006An36).

[†] Absolute intensity per 100 decays.

^{193}Rn α decay (1.15 ms) 2006An36

Decay Scheme

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

REFERENCES FOR A=189

- 1950CH11 T.C.Chu - Phys.Rev. 79, 582 (1950).
New Radioactive Isotopes of Iridium.
- 1951LI19 M.Lindner - Phys.Rev. 84, 240 (1951).
Characteristics of Some Radionuclides of Tungsten, Rhenium, and Osmium Formed by Second-Order Thermal Neutron Capture.
- 1951TU09 S.E.Turner, L.O.Morgan - Phys.Rev. 81, 881 (1951).
Products of the High Energy Helium Ion and Deuteron Bombardment of Tungsten.
- 1952MU40 K.Murakawa, S.Suwa - Phys.Rev. 87, 1048 (1952).
Hyperfine Structure in the Spectra of Iridium and Osmium.
- 1954LO36 H.R.Loeliger, L.R.Sarles - Phys.Rev. 95, 291 (1954).
Magnetic Moment of Os^{189} .
- 1955SM42 W.G.Smith, J.M.Hollander - Phys.Rev. 98, 1258 (1955).
Radiochemical Study of Neutron-Deficient Chains in the Noble Metal Region.
- 1957CH34 K.F.Chackett, G.A.Chackett - J.Inorg.Nuclear Chem. 4, 225 (1957).
The Addition Products of Heavy-Ion Bombardment of Tantalum.
- 1958SC30 G.Scharff-Goldhaber, D.E.Alburger, G.Harbottle et al. - Phys.Rev. 111, 913 (1958); Erratum Phys.Rev. 112, 2139 (1958).
Studies of Decay Schemes in the Osmium-Iridium Region. I. Isomers Os^{190m} (10 min) and Os^{189m} (5.7 hr).
- 1959KA09 W.R.Kane - Thesis, Harvard University (1959); AECU-4170 (1959).
Photoelectric and Internal Conversion Spectra of Neutron Deficient Iridium Isotopes.
- 1960AL20 G.Albouy, M.M.Gusakow, N.Poffe - J.Phys.Radium 21, 751 (1960).
Nouveaux Isotopes de Periode Courte Obtenus par Spallation de l'Or.
- 1960MA28 T.B.Malysheva, B.A.Khotin, A.K.Lavrukchina et al. - Izvest.Akad.Nauk SSSR, Ser.Fiz. 24, 1109 (1960); Columbia Tech.Transl. 24, 1113 (1961).
Investigation of New Neutron-Deficient Platinum Isotopes.
- 1960MO19 A.M.Morozov, V.V.Remaev, P.A.Yampolskii - Zhur.Eksp'tl.i Teoret.Fiz. 39, 973 (1960); Soviet Phys.JETP 12, 674 (1961).
Five New Millisecond Isomers Produced by 19.2-MeV Protons.
- 1960NE04 J.O.Newton - Phys.Rev. 117, 1529 (1960).
Auger Transitions in Re^{183} and the M3 Isomer in Os^{189} .
- 1960PO07 N.Poffe, G.Albouy, R.Bernas et al. - J.Phys.Radium 21, 343 (1960); AEC-tr-4662 (1961).
Reactions (p,xn) Induites dans l'Or par des Protons de 155 MeV.
- 1961AN02 G.Andersson, R.Ringh - Arkiv Fysik 18, 385 (1961).
39 min Au^{190} , 20 min Hg^{190} , and 10 min Hg^{189} .
- 1961KR02 L.N.Kryukova, V.V.Muraveva, L.Duda et al. - Izvest.Akad.Nauk SSSR, Ser.Fiz. 25, 1257 (1961); Columbia Tech.Transl. 25, 1269 (1962).
Investigation of the Conversion Electron Spectrum of Neutron-Deficient Platinum Isotopes.
- 1961RE02 D.H.Rester, M.S.Moore, F.E.Durham et al. - Nuclear Phys. 22, 104 (1961).
Internal Conversion Electrons from Coulomb Excitation of Heavy Elements.
- 1962BL12 P.Blichert-Toft - Phys.Letters 3, 130 (1962).
 γ - γ Coincidence Measurements on Re^{189} .
- 1962CR02 G.Crasemann, G.T.Emery, W.R.Kane - Bull.Am.Phys.Soc. 7, No.4, 353, XA13 (1962).
A New Isotope: 23-hr Re^{189} .
- 1962GR27 E.P.Grigorev, B.S.Dzhelepov, V.Zvolska et al. - Izvest.Akad.Nauk SSSR, Ser.Fiz. 26, 120 (1962); Columbia Tech.Transl. 26, 118 (1963).
Conversion Electrons of Short-Life Pt and W Isotopes.
- 1962HA24 B.Harmatz, T.H.Handley, J.W.Mihelich - Phys.Rev. 128, 1186 (1962).
Properties of Nuclear Levels in a Number of Odd-A Nuclei (151 < A < 191).
- 1962KR04 L.N.Kryukova, V.V.Muraveva, V.S.Shpinel et al. - Izv.Akad.Nauk SSSR, Ser.Fiz. 26, 1492 (1962); Columbia Tech.Transl. 26, 1518 (1963).
Levels of Ir^{189} Excited in Electron Capture Decay of Pt^{189} .
- 1962MU04 K.Murakawa - J.Phys.Soc.Jpn. 17, 891 (1962).
Quadrupole Coupling in the Hyperfine Structure of the Spectra of Ta and Os I.
- 1963CR06 B.Crasemann, G.T.Emery, W.R.Kane et al. - Phys.Rev. 132, 1681 (1963).
Properties of Radioactive Re^{189} .
- 1963FL07 J.Fleggenheimer, G.B.Baro, M.Viirsoo - Radiochim.Acta 2, 7 (1963); Nucl.Sci.Abstr. 18, 842, Abstr.6250 (1964).
The W^{189} - Re^{189} Decay Chain.
- 1963GR22 G.R.Grant, L.Yaffe - Can.J.Chem. 41, 2533 (1963).
The Spallation of Iridium with Protons of Energies 9-87 MeV.
- 1963KA17 M.Karras, G.Andersson, M.Nurmia - Arkiv Fysik 23, 57 (1963).
Search for Alpha Activity in Neutron Deficient Isotopes of Pb, Tl, Hg, Pt, and Te.
- 1963MC18 F.K.McGowan, P.H.Stelson, R.L.Robinson et al. - ORNL-3425, p.26 (1963).
Coulomb Excitation of Nuclear States in the Isotopes of Osmium.
- 1963PR12 J.M.Prospiero - Thesis, Princeton University (1963); PUC-1963-95 (1963).

REFERENCES FOR A=189(CONTINUED)

- 1963RE13 *Studies of Radioactive Decay in the Region of Deformed Nuclei.*
V.V.Remaev, V.T.Gritsyna, Y.S.Korda - Zh.Eksperim.i Teor.Fiz. 44, 1147 (1963); Soviet Phys.JETP 17, 775 (1963).
Two New Short-Lived Isomers Ir^{187m} and Ir^{189m}.
- 1963TH07 K.M.Thomas - Thesis, Ohio State University (1963), DABBB 24B 1219 (1963).
Radioactive Decay of Os¹⁸⁷ + He⁴ and Os¹⁶⁷ + He³.
- 1964KR03 L.N.Kryukova, V.V.Muraveva, N.V.Forafontov et al. - Izv.Akad.Nauk SSSR, Ser.Fiz. 28, 98(1964); Bull.Acad.Sci.USSR, Phys.Ser. 28, 94(1965).
Investigation of the Decay Schemes of Pt¹⁸⁹ and Ir¹⁸⁹ by Observation of e-γ Coincidences.
- 1964LE07 H.R.Lewis, Jr., R.A.Naumann et al. - Phys.Rev. 134, B322 (1964).
Study of the Pt¹⁸⁹ → Ir¹⁸⁹ → Os¹⁸⁹ Decay Chain.
- 1965BL06 P.H.Blichert-Toft - Arkiv Fysik 28, 415 (1965).
A Decay of Re¹⁸⁹ to Os¹⁸⁹.
- 1965JA12 J.Jastrzebski, H.Abou-Leila, N.N.Perrin - Nucl.Phys. 70, 392 (1965).
Lifetime of the First Excited State in Ir¹⁸⁹.
- 1965KA07 P.Kauranen, H.Ihochi - J.Inorg.Nucl.Chem. 27, 1451(1965).
The Decay of ¹⁸⁹W.
- 1965KI06 P.Kilcher - J.Phys.(Paris) 26, 591 (1965).
Etude des Transitions dans le Platine 189.
- 1965QA01 S.M.Qaim - J.Inorg.Nucl.Chem. 27, 759 (1965).
Light Radioisotopes of Platinum Formed in the Interactions of Tantalum With Nitrogen Ions.
- 1966BAZY G.B.Baro, J.Flegenheimer, M.Viirsoo - REPORT CNEA-175,1 (1966).
Dos Nuevos Radioisotopos de Renio y Tungsteno. (New Rhenium and Tungsten Radioisotopes).
- 1966FO13 A.Fourrier, J.Jastrzebski, P.Kilcher et al. - Compt.Rend. 263B, 1182(1966).
Etude de la Chaîne Radioactive de Nombre de Masse 189.
- 1966KR08 L.N.Kryukova, V.O.Kordyukovich, A.A.Sorokin - Izv.Akad.Sci.SSSR, Ser.Fiz. 30, 1360 (1966); Bull.Acad.Sci.USSR, Phys.Ser. 30, 1420 (1967).
Lifetimes of Low-Lying Excited States of Ir¹⁸⁹.
- 1966NA01 R.A.Naumann, R.F.Petry, J.S.Evans - Bull.Am.Phys.Soc. 11, No.3, 408, KB5 (1966); and Oral Report.
Identification and Half-Life of Au¹⁸⁹.
- 1966SI11 A.Siivola - Priv.Comm., quoted by 1967Tr06 (1967).
1966SY01 G.I.Sychikov, O.D.Kovrigin, G.D.Latyshev et al. - Izv.Akad.Nauk SSSR, Ser.Fiz. 30, 162 (1966); Bull.Acad.Sci.USSR, Phys.Ser. 30, 169 (1967).
Conversion Electron Spectrum of the Iridium Fraction from Proton-Bombarded Gold.
- 1967AL17 K.F.Alexander - Arkiv Fysik 36, 257(1967).
Identification of Short-Lived Activities Produced in Heavy-Ion Reactions.
- 1967CO20 T.W.Conlon - Nucl.Phys. A100, 545 (1967).
High-Resolution Studies of the Gamma Rays from Isomeric States with Half-Lives of 10μs-30ms in Nuclei with Z = 63-83.
- 1967ES05 P.Eskola - Ark.Fys. 36, 477 (1967).
Compilation of Data on Alpha Activities with Z > 50, N < 126.
- 1967HE06 C.Heiser, K.F.Alexander, H.F.Brinckmann et al. - Nucl.Phys. A96, 327(1967).
Isomere Zustände in ¹⁸⁷Au und ¹⁸⁹Au.
- 1967HR01 A.Z.Hryniewicz, B.Sawicka, J.Styczen et al. - Acta Phys.Polon. 31, 437 (1967).
Coulomb Excitation of ¹⁸⁹Os Nucleus.
- 1967JH02 S.Jha, W.R.Owens, M.C.Gregory et al. - Phys.Letters 25B, 115 (1967).
The Mossbauer Effect in ¹⁹¹Ir and ¹⁸⁹Os.
- 1967NA02 R.A.Naumann, R.F.Petry, J.S.Evans - Nucl.Phys. A94, 151(1967).
The Half-Life and Decay of ¹⁸⁹Au.
- 1967SI09 A.Siivola - Nucl.Phys. A101, 129 (1967).
¹⁹³⁻²⁰⁰Po Isotopes Produced Through Heavy Ion Bombardments.
- 1967TR06 W.Treytl, K.Valli - Nucl.Phys. A97, 405 (1967).
Alpha Decay of Neutron Deficient Astatine Isotopes.
- 1968HI04 G.Himmele - Z.Physik 211, 68 (1968).
Das Kernquadrupolelement des Os¹⁸⁹.
- 1968IO01 A.Iordachescu, G.Pascovici, D.Plostinaru - Rev.Roumaine Phys. 13, 911 (1968).
Nuclear Isomers with Half-Lives in the 20 μs-15 ms Range.
- 1968KU17 D.Kucheida, F.Wagner, G.Kaindl et al. - Z.Physik 216, 346(1968).
Mossbauer Study of the Electromagnetic Properties of the 69.6-keV Level in Os 189.
- 1968PE09 B.Persson, H.Blumberg, M.Bent - Phys.Rev. 174, 1509 (1968).
Nuclear Properties and Magnetic Hyperfine Interaction of Os¹⁸⁹.
- 1968SC03 A.Schwenk, G.Zimmermann - Phys.Letters 26A, 258 (1968); Erratum Priv.Comm. (June 1968).
The Ratio of the Larmor Frequency of ¹⁸⁹Os Relative to ¹H.
- 1969AN17 W.Andrejscheff, F.Dubbers, K.-D.Schilling et al. - Nucl.Phys. A137, 693 (1969).

REFERENCES FOR A=189(CONTINUED)

- 1969GR10 *Lifetime Measurements in ^{187}Re and ^{189}Os .*
M.C.Gregory, B.L.Robinson, S.Jha - Phys.Rev. 180, 1158 (1969).
- 1969HA03 *Studies of Os^{189} : Gamma Rays, Lifetimes, and Mossbauer Effect.*
P.G.Hansen, P.Hornshøj, H.L.Nielsen et al. - Phys.Lett. 28B, 415 (1969); Erratum Phys.Lett. 28B, 663 (1969).
- 1969MUZP *Decay Characteristics of Short-Lived Radio-Nuclides Studied by On-Line Isotope Separator Techniques.*
T.M.Muminov, N.B.Badalov, A.F.Freilikhman et al. - Program and Theses, Proc.19th Ann.Conf.Nucl.Spectroscopy and Struct.Of At.Nuclei, Erevan, p.142 (1969).
- 1969PL06 *β - and γ -Spectra from the Decay of ^{188}Re and ^{189}Re .*
Z.Plajner, M.Vejs, V.Hnatowicz et al. - Czech.J.Phys. 19B, 1622 (1969).
- 1969WA02 *Gamma Radiation from the Decays of ^{189}Pt and ^{191}Pt .*
F.Wagner, G.Kaindl, H.Bohn et al. - Phys.Letters 28B, 548(1969).
- 1970BA10 *Lifetime and Magnetic Moment of the 36.2 keV Level of ^{189}Os .*
S.A.Bakiev, V.O.Kordyukovich, L.N.Kryukova et al. - Izv.Akad.Nauk SSSR, Ser.Fiz. 34, 59 (1970); Bull.Acad.Sci.USSR, Phys.Ser. 34, 58 (1971).
- 1970BA56 *Radioactive Decay of Neutron-Deficient Isotopes of Pt, Ir, and Os.*
A.Backlin, V.Berg, S.G.Malmskog - Nucl.Phys. A156, 647 (1970).
- 1970BO11 *Negative Parity States in Odd-Mass Ir and Au Nuclei.*
H.Bohn, G.Kaindl, D.Kucheida et al. - Phys.Lett. 32B, 346 (1970).
- 1970BO29 *Change of the Nuclear Charge Radius of ^{189}Os from Mossbauer Isomer Shifts.*
L.M.Bollinger, G.E.Thomas - Phys.Rev. C2, 1951 (1970).
- 1970ERZX *Average-Resonance Method of Neutron-Capture γ -Ray Spectroscopy: States of ^{106}Pd , ^{156}Gd , ^{158}Gd , ^{166}Ho , and ^{168}Er .*
B.R.Erdal, M.Finger, R.Foucher et al. - Proc.Int.Conf.Prop.Nuclei Far from Region of Beta-Stability, Leysin, Switzerland, Vol.2, p.1045 (1970); Cern 70-30 (1970).
- 1970FI16 *Isomerism in Odd and Odd-Odd Nuclei with Mass Number $185 \leq A \leq 191$.*
M.Finger, R.Foucher, J.P.Husson et al. - CERN-70-29 (1970).
- 1970JO02 *Main Decay Characteristics of Mercury Isotopes and their Daughter Products ($182 < A < 192$).*
A.Johansson, B.Svahn, B.Nyman et al. - Z.Phys. 230, 291 (1970).
- 1970MA37 *Decay Studies of Au Isotopes in the Mass Number Region 186-189.*
S.G.Malmskog, V.Berg, A.Backlin - Nucl.Phys. A153, 316 (1970).
- 1970PL06 *Transition Probabilities in ^{189}Os .*
Z.Plajner, M.Vejs, V.Hnatowicz et al. - Czech.J.Phys. 20B, 1227 (1970).
- 1970TA14 *^{189}Ir Excited States Populated in the Decay of ^{189}Pt .*
N.I.Tarantin, A.P.Kabachenko, A.V.Demyanov - Yad.Fiz. 12, 455 (1970); Sov.J.Nucl.Phys. 12, 248 (1971).
- 1971BE23 *Identification and Study of the Radioactive Properties of Bismuth Isotopes with an Electromagnetic Mass Separator in a Heavy-Ion Beam.*
R.B.Begzhanov, D.G.Gaffarov, K.T.Salikhbaev - Izv.Akad.Nauk SSSR, Ser.Fiz. 35, 135 (1971); Bull.Acad.Sci.USSR, Phys.Ser. 35, 123 (1972).
- 1971BE71 *Magnetic Moments of Some Excited States in ^{151}Sm , ^{153}Eu , ^{155}Eu , ^{155}Gd and ^{161}Dy .*
R.B.Begzhanov, D.G.Gaffarov, A.I.Muminov et al. - Izv.Akad.Nauk SSSR, Ser.Fiz. 35, 2295 (1971); Bull.Acad.Sci.USSR, Phys.Ser. 35, 2083 (1972).
- 1971PL08 *Magnetic Properties of ^{153}Eu , ^{155}Eu and ^{189}Os .*
Z.Plajner, M.Vejs, I.Prochazka et al. - Izv.Akad.Nauk SSSR, Ser.Fiz. 35, 1569 (1971); Bull.Acad.Sci.USSR, Phys.Ser. 35, 1431 (1972).
- 1972BA21 *$^{189}\text{Pt} \rightarrow ^{189}\text{Ir}$ Decay.*
A.Backlin, G.Hedin, V.Berg et al. - Nucl.Phys. A181, 76 (1972).
- 1972GA27 *E2 and M1 Transition Probabilities between Low-Energy States in ^{189}Ir .*
H.Gauvin, Y.Le Beyec, M.Lefort et al. - Phys.Rev.Lett. 29, 958 (1972).
- 1972HE05 *α Decay of Neutron-Deficient Isotopes of Bismuth and Lead Produced in (Ar, xn) and (Kr, xn) Reactions.*
G.Hedin, A.Backlin - Nucl.Phys. A184, 214 (1972).
- 1972VA12 *Levels in ^{189}Ir Studied in the Decay of ^{189}Pt .*
T.B.Vandlik, Y.Vandlik, N.G.Zaitseva et al. - Pisma Zh.Eksp.Teor.Fiz. 15, 386 (1972); JETP Lett.(USSR) 15, 271 (1972).
- 1972WA24 *The New Isotope Tl^{189} .*
F.E.Wagner, H.Spieler, D.Kucheida et al. - Z.Phys. 254, 112 (1972).
- 1973GA08 *Mossbauer Studies and Nuclear Quadrupole Moments of ^{186}Os , ^{188}Os , ^{189}Os , ^{190}Os .*
H.Gauvin, R.L.Hahn, Y.Le Beyec et al. - Nucl.Phys. A208, 360 (1973).
- 1973HO27 *Reactions of ^{40}Ar with ^{159}Tb , ^{142}Nd and ^{144}Sm ; New α -Activities from ^{189}Bi , ^{173}Pt and ^{177}Au .*
K.J.Hofstetter - Z.Phys. 261, 143 (1973).
- 1973JA16 *Levels in ^{189}Os Populated in the Decay of ^{189}Re .*
J.Jastrzebski, P.Kilcher, P.Paris - J.Phys.(Paris) 34, 755 (1973).
- 1973KLZZ *Desintegration du ^{189}Hg et du ^{189}Au .*
P.Kleinheinz - Priv.Comm. (December 1973).

REFERENCES FOR A=189(CONTINUED)

- 1973OT01 K.Otozai, R.Arakawa, M.Morita - Progr.Theor.Phys. 50, 1771 (1973).
Experimental Evidence for Nuclear Excitation by Electron Transition in ^{189}Os .
- 1973ROYQ I.A.Romanii, A.P.Klyucharev, Y.N.Rakivnenko et al. - Program and Theses, Proc.23rd Ann.Conf.Nucl.Spectrosc.Struct.At.Nuclei, Tbilisi, p.113 (1973); See Also 74Ro05.
Millisecond Isomers in Iridium Isotopes.
- 1974HA10 J.H.Hamilton, E.H.Spejewski, R.L.Mlekodaj et al. - Izv.Akad.Nauk SSSR, Ser.Fiz. 38, 2036 (1974);
Bull.Acad.Sci.USSR, Phys.Ser. 38, No.10, 22 (1974).
Initial UNISOR Research: New Isotopes ^{186}Tl , ^{188}Tl , ^{116}I ; Decays of $^{189,190}\text{Tl}$, ^{117}Xe , and ^{117}I ; and Off-Line Atomic and Nuclear Studies.
- 1974LE02 Y.Le Beyec, M.Lefort, J.Livet et al. - Phys.Rev. C9, 1091 (1974).
New Neutron-Deficient Pb and Bi Nuclides Produced in Cross Bombardments with Heavy Ions.
- 1974LE35 M.B.Lewis - Nucl.Data Sheets 12, 397 (1974).
Nuclear Data Sheets for A = 189.
- 1974WA05 F.E.Wagner, D.Kuchaida, U.Zahn et al. - Z.Phys. 266, 223 (1974).
Mossbauer Isomer Shifts and Quadrupole Splittings in Osmium Compounds.
- 1975AN08 S.Andre, J.Boutet, J.Rivier et al. - Nucl.Phys. A243, 229 (1975).
Excited States of the Transitional ^{189}Ir and ^{187}Ir Nuclei Populated by The $(\alpha, 2n)$ Reaction.
- 1975BA35 B.P.Bayhurst, J.S.Gilmore, R.J.Prestwood et al. - Phys.Rev. C12, 451 (1975).
Cross Sections for (n, xn) Reactions between 7.5 and 28 MeV.
- 1975BE17 V.Berg, R.Foucher, A.Hoglund - Nucl.Phys. A244, 462 (1975).
Quasi-Prolate and Quasi-Oblate Bands in Soft ^{189}Au .
- 1975BO29 H.E.Bosch, J.Davidson, V.Silbergleit et al. - Z.Phys. A273, 373 (1975).
Studies on the Nuclear Structure of ^{115}In .
- 1975DE20 M.A.Deleplanque, C.Gerschel, N.Perrin et al. - Nucl.Phys. A249, 366 (1975).
Coexistence des Formes Allongee et Aplatie dans ^{189}Au .
- 1975KE06 P.Kemnitz, L.Funke, H.Sodan et al. - Nucl.Phys. A245, 221 (1975).
High-Spin States in $^{187,189}\text{Ir}$: Coexistence of Strong-Coupling, Rotation-Alignment and Weak-Coupling.
- 1975MO29 P.Morgen, J.H.Onsgaard, B.S.Nielsen et al. - Nucl.Phys. A252, 477 (1975).
The Level Structure of ^{189}Os .
- 1975PI02 M.Piiparinen, J.C.Cunnane, P.J.Daly et al. - Phys.Rev.Lett. 34, 1110 (1975).
High-Spin Level Systematics in $^{186-194}\text{Pt}$ and Rotation-Alignment Coupling.
- 1975RU06 H.Rubinsztajn, M.Gustafsson - Phys.Lett. 58B, 283 (1975).
Nuclear Spin Measurements on Neutron-Deficient Isotopes of the Refractory Elements.
- 1975ST08 W.R.Stott, J.C.Waddington, D.G.Burke et al. - Can.J.Phys. 53, 922 (1975).
Mixed Positive Parity States in ^{165}Er .
- 1976BE50 D.Benson, Jr., P.Kleinheinz et al. - Phys.Rev. C14, 2095 (1976).
Nuclear Spectroscopy of ^{189}Os .
- 1976BO09 J.Bonn, G.Huber, H.-J.Kluge et al. - Z.Phys. A276, 203 (1976).
Spins, Moments and Charge Radii in the Isotopic Series $^{181}\text{Hg} - ^{191}\text{Hg}$.
- 1976DI14 J.S.Dionisio, C.Vieu, W.De Wiclawik et al. - J.Phys.(London) G2, L183 (1976).
On the $9/2^-$ Level Excitation Energy of Odd Tl, Au and Ir Isotopes.
- 1976EK01 C.Ekstrom, I.Lindgren, S.Engelman et al. - Phys.Lett. 60B, 146 (1976).
Nuclear Spins of $^{186,187,188,189\text{m}}\text{Au}$.
- 1976GOZE G.M.Gowdy - Thesis, Georgia Inst.of Technology (1976); TID-27710.
Decay Scheme Studies of Neutron-Deficient Odd-Mass Thallium Isotopes and the Systematics of Odd-Mass Mercury Levels.
- 1976HA25 J.H.Hamilton, K.R.Baker, C.R.Bingham et al. - Izv.Akad.Nauk SSSR, Ser.Fiz. 40, 2 (1976); Bull.Acad.Sci.USSR, Phys.Ser. 40, No.1, 1 (1976).
New Isotope ^{193}Pb and the Structure of ^{193}Tl ; Shape Coexistence in ^{188}Hg and in ^{189}Au ; and a New Ion Source: Recent UNISOR Research.
- 1976HI08 C.R.Hirning, D.G.Burke - Can.J.Phys. 54, 1360 (1976).
A Study of ^{187}Re , ^{189}Re , and ^{191}Re Using the (t, α) Reaction.
- 1976KEZO B.D.Kern, J.L.Weil, J.H.Hamilton et al. - Proc.Int.Conf.At.Masses,Fundamental Constants, 5th, Paris (1975), J.H.Sanders, A.H.Wapstra, Eds., Plenum Press, New York, p.81 (1976).
Mass Differences of Proton-Rich Atoms Near A = 116 and A = 190.
- 1976PI03 M.Piiparinen, S.K.Saha, P.J.Daly et al. - Phys.Rev. C13, 2208 (1976).
 $\nu_{13/2}$ and $\nu_{9/2}$ Isomers in Odd-A Pt Nuclei.
- 1976WO10 J.L.Wood, R.W.Fink, E.F.Zganjar et al. - Phys.Rev. C14, 682 (1976).
Symmetry between Particle and Hole Level Systems in ^{189}Au .
- 1977DE32 S.Della Negra, B.Lagarde, Y.Le Beyec - J.Phys.(Paris), Lett. 38, L-393 (1977).
Very Neutron-Deficient Polonium Isotopes Produced Through ^{20}Ne Induced Reactions.
- 1977GO09 A.L.Goodman - Nucl.Phys. A287, 1 (1977).
The $h_{9/2}$ 'Intruder' State in Odd Mass Au and Tl Isotopes.
- 1977HI06 C.R.Hirning, D.G.Burke, E.R.Flynn et al. - Nucl.Phys. A287, 24 (1977).

REFERENCES FOR A=189(CONTINUED)

- 1978DAZC *Proton Hole States in $^{187,189,191}\text{Re}$ Investigated by the (t,α) Reaction.*
P.J.Daly, C.L.Dors, H.Helppi et al. - Mich.State Univ.Cyclotron Lab.Ann.Rept., p.50 (1978).
- 1978LO07 *Extensive $vi_{13/2}$ Families in ^{187}Pt and ^{189}Pt .*
G.Lovhoiden, O.Straume, D.G.Burke - Nucl.Phys. A302, 51 (1978).
- 1978OT01 *Levels in ^{189}Ir and ^{191}Ir Studied with the (p,t) Reaction.*
K.Otozai, R.Arakawa, T.Saito - Nucl.Phys. A297, 97 (1978).
- 1978RU04 *Nuclear Excitation by Electron Transition in ^{189}Os .*
H.Rubinsztein, M.Gustavsson - Phys.Scr. 18, 209 (1978).
- 1978ST09 *Atomic-Beam Magnetic Resonance Studies of the Refractory Elements: Nuclear spin and hyperfine structure measurements.*
G.L.Struble, R.G.Lanier, L.G.Mann et al. - Phys.Rev. C17, 1564 (1978).
- 1978YA06 *Levels in ^{189}Ir and ^{191}Ir Observed in the (p,t) Reaction.*
T.Yamazaki, H.Nakayama, T.Numao et al. - J.Phys.Soc.Jpn. 44, 1421 (1978).
- 1979DA06 *On the Triaxial Deformation in Transitional Odd-A Nuclei.*
P.Dabkiewicz, F.Buchinger, H.Fischer et al. - Phys.Lett. 82B, 199 (1979).
- 1979GO15 *Nuclear Shape Isomerism in ^{185}Hg Detected by Laser Spectroscopy.*
Y.Gono, R.M.Lieder, M.Muller-Veggian et al. - Nucl.Phys. A327, 269 (1979).
- 1979SA18 *In-Beam γ -Ray Study of $^{189,191,193}\text{Au}$.*
M.Sakaguchi, T.Tamura, Z.-i.Matsumoto - J.Phys.Soc.Jpn. 46, 1067 (1979).
- 1980BE27 *Decay of ^{189}Re .*
I.Berkes, R.Haroutunian, G.Marest et al. - J.Phys.(London) G6, 775 (1980).
- 1980KA19 *Nuclear Orientation of $^{188-189}\text{Ir}$ and $^{189-191}\text{Pt}$.*
J.Kalifa, G.Berrier-Ronsin, M.Vergnes et al. - Phys.Rev. C22, 997 (1980).
- 1980MU07 *$^{189,191}\text{Pt}$ via the (p,d) Reaction.*
D.W.Murray, A.L.Allsop, N.J.Stone - Hyperfine Interactions 7, 481 (1980).
- 1980WOZN *Electric Quadrupole Orientation of Iridium Isotopes in Rhenium.*
J.Wood - Priv.Comm. (1980).
- 1981BO08 *C.Bourgeois, A.Zerrouki, M.G.Desthuilliers-Porquet et al. - Z.Phys. A299, 85 (1981).*
- 1981FI09 *High-Spin States in ^{189}Hg .*
R.B.Firestone - Nucl.Data Sheets 34, 537 (1981).
- 1981LE23 *Nuclear Data Sheets for A = 189.*
M.E.Leino, S.Yashita, A.Ghiorso - Phys.Rev. C24, 2370 (1981).
- 1983FA11 *Alpha Decay of Neutron Deficient Polonium and Bismuth Isotopes.*
H.R.Faust, H.Klewe-Nebenius, H.Rebel et al. - Nucl.Instrum.Methods 213, 277 (1983).
- 1983GU12 *Determination of the Multipolarity of Prompt Electromagnetic Transitions from Angular Distributions of Conversion Electrons Part II: Spectrometer and Measurements.*
M.Guttormsen, K.P.Blume, Y.K.Agarwal et al. - Z.Phys. A312, 155 (1983).
- 1983JH01 *Rotation Aligned Bands and Configuration Dependent Interaction in ^{189}Hg .*
S.Jha, W.A.Seale, R.V.Ribas et al. - Phys.Rev. C28, 921 (1983).
- 1984SCZQ *Coulomb Excitation of ^{189}Os .*
J.Schneider - GSI-84-3 (1984).
- 1985AB03 *Untersuchungen Extrem Neutronenarmer Isotope in der Protonenschale Z = 82.*
M.C.Abreu, V.Berg, K.Fransson et al. - Nucl.Phys. A437, 324 (1985).
- 1985BO46 *Half-Life Measurements in Doubly-Odd $^{186,188,190}\text{Au}$ Nuclei and the $^{188}\text{Hg} \rightarrow \text{Au}$ Decay.*
J.A.Bounds, C.R.Bingham, P.Juncar et al. - Phys.Rev.Lett. 55, 2269 (1985).
- 1985CO06 *Role of Deformation in the Intrusion of the $h_{9/2}$ Levels below the Z = 82 Proton Shell.*
E.Coenen, K.Deneffe, M.Huyse et al. - Phys.Rev.Lett. 54, 1783 (1985).
- 1985ED03 *α Decay of Neutron-Deficient Odd Bi Nuclei: Shell-model intruder states in Tl and Bi isotopes.*
R.Eder, E.Hagn, E.Zech - Hyperfine Interactions 22, 47 (1985).
- 1985ED05 *Electric Quadrupole Moments of Radioactive Pt Isotopes.*
R.Eder, H.Hagn, E.Zech - Phys.Lett. 158B, 371 (1985).
- 1985HA41 *Oblate Ground-State Shapes of $11\ h\ ^{189}\text{Pt}$ and $2.8\ d\ ^{191}\text{Pt}$.*
E.Hagn - Hyperfine Interactions 22, 19 (1985).
- 1985KL09 *Nuclear Orientation and Quadrupole Interaction.*
H.-J.Kluge - Hyperfine Interactions 24, 69 (1985).
- 1985OH05 *Optical Measurements of Ground-State Properties of Short-Lived Nuclei in Resonance Cells.*
S.Ohya, K.Nishimura, N.Okabe et al. - Hyperfine Interactions 22, 585 (1985).
- 1985VA07 *Nuclear Magnetic Resonance on Oriented $^{189,191}\text{Pt}$ in Iron.*
E.Van Walle, J.Wouters, D.Vandeplassche et al. - Hyperfine Interactions 22, 507 (1985).
- 1986BOZY *On-Line Nuclear Orientation of Au Isotopes at KOOL.*
J.A.Bounds - Diss.Abst.Int. 46B, 3896 (1986).
- 1986UL02 *Nuclear Structure of Light Thallium Isotopes as Deduced from Laser Spectroscopy on a Fast Atom Beam.*
G.Ulm, S.K.Bhattacharjee, P.Dabkiewicz et al. - Z.Phys. A325, 247 (1986).

REFERENCES FOR A=189(CONTINUED)

- 1986VA35 *Isotope Shift of ^{182}Hg and an Update of Nuclear Moments and Charge Radii in the Isotope Range $^{181}\text{Hg} - ^{206}\text{Hg}$.*
E.van Walle, D.Vandeplassche, J.Wouters et al. - Phys.Rev. B34, 2014 (1986).
- 1987BI08 *Internal Field Distribution on Au in the Au-Fe System in the Limit of Very Small Concentration.*
C.R.Bingham, J.A.Bounds, H.K.Carter et al. - Nucl.Instrum.Methods Phys.Res. B26, 426 (1987).
- 1987BO44 *Application of Collinear Laser Spectroscopy on Fast Atom Beams to Measure Nuclear Properties.*
J.A.Bounds, C.R.Bingham, H.K.Carter et al. - Phys.Rev. C36, 2560 (1987).
- 1987BOZT *Nuclear Structure of Light Thallium Isotopes as Deduced from Laser Spectroscopy on a Fast Atom Beam.*
C.Bourgeois, P.Kilcher, M.G.Porquet et al. - Univ.Paris, Inst.Phys.Nucl., 1986 Ann.Rept., p.E26 (1987).
- 1987WA06 *Transitions de Faible Energie dans $^{189,191}\text{Hg}$.*
K.Wallmeroth, G.Bollen, A.Dohn et al. - Phys.Rev.Lett. 58, 1516 (1987).
- 1988AR12 *Sudden Change in the Nuclear Charge Distribution of very Light Gold Isotopes.*
G.E.Arenas Peris, P.Federman - Phys.Rev. C38, 493 (1988).
- 1988GOZN *Weak-Coupling Description of Intruder States.*
L.Goettig, K.B.Beard, M.W.Drigert et al. - Proc.of the Conf. on High-Spin Nuclear Structure and Novel Nuclear Shapes, April 13-15, 1988, Argonne National Laboratory, Argonne, Illinois; ANL-PHY-88-2, p.280 (1988).
- 1988KO22 *Band Structure Studies in $^{187,189,191}\text{Tl}$.*
M.O.Kortelahti, E.F.Zganjar, H.K.Carter et al. - J.Phys.(London) G14, 1361 (1988).
- 1988KR16 *Nuclear Systematics Far from the Line of Beta Stability: The low-lying excited states of $^{185,187,189}\text{Au}$.*
A.J.Kreiner, J.Davidson, M.Davidson et al. - Phys.Rev. C38, 2674 (1988).
- 1988RO20 *Shape Coexistence in ^{189}Tl .*
B.Roussiere, F.Le Blanc, G.Savard et al. - Hyperfine Interactions 43, 473 (1988).
- 1989BE34 *Nuclear Moments and Charge Radius Changes in Platinum Isotopes.*
R.Bengtsson, W.Nazarewicz - Z.Phys. A334, 269 (1989).
- 1989DU01 *Shape Coexistence in the Neutron Deficient Pb Isotopes and the Configuration-Constrained Shell Correction Approach.*
H.T.Duong, J.Pinard, S.Liberman et al. - Phys.Lett. 217B, 401 (1989).
- 1989RA16 *Shape Transition in Neutron Deficient Pt Isotopes.*
S.Raman, C.W.Nestor, Jr. et al. - At.Data Nucl.Data Tables 42, 1 (1989).
- 1989WA11 *Predictions of $B(E2; 0_1^+ \rightarrow 2_1^+)$ Values for Even-Even Nuclei.*
K.Wallmeroth, G.Bollen, A.Dohn et al. - Nucl.Phys. A493, 224 (1989).
- 1990ANZR *Nuclear Shape Transition in Light Gold Isotopes.*
A.N.Andreev, D.D.Bogdanov, A.V.Eremin et al. - Program and Thesis, Proc.40th Ann.Conf.Nucl.Spectrosc.Struct.At.Nuclei, Leningrad, p.124 (1990).
- 1990FI02 *Measurement of Absolute Values of α -Branching for Neutron-Deficient Isotopes of $^{193,195}\text{Bi}$.*
R.B.Firestone - Nucl.Data Sheets 59, 869 (1990).
- 1990JA13 *Nuclear Data Sheets for A = 189.*
R.V.F.Janssens, M.P.Carpenter, M.W.Drigert et al. - Nucl.Phys. A520, 75c (1990).
- 1991CH36 *Superdeformation in the Mercury Nuclei.*
R.R.Chasman - Phys.Lett. 266B, 243 (1991).
- 1991DR04 *Superdeformed and Hyperdeformed Banana Shaped Nuclides Near A = 190.*
M.W.Drigert, M.P.Carpenter, R.V.F.Janssens et al. - Nucl.Phys. A530, 452 (1991).
- 1991PEZY *Superdeformed Bands in $^{189,190}\text{Hg}$.*
S.T.Perkins, D.E.Cullen, M.H.Chen et al. - UCRL-50400 vol.30 (1991).
- 1991PO15 *Tables and Graphs of Atomic Subshell and Relaxation Data Derived from the LLNL Evaluated Atomic Data Library (EADL), Z = 1 - 100.*
M.-G.Porquet, A.J.Kreiner, F.Hannachi et al. - Phys.Rev. C44, 2445 (1991).
- 1991SA12 *High-Spin Structure of ^{189}Tl : Role of $h_{9/2}$ Protons in the Minimum of Light Hg Isotopes.*
W.Satula, S.Cwiok, W.Nazarewicz et al. - Nucl.Phys. A529, 289 (1991).
- 1992BE18 *Structure of Superdeformed States in Au-Ra Nuclei.*
I.G.Bearden, R.V.F.Janssens, M.P.Carpenter et al. - Z.Phys. A341, 491 (1992).
- 1992BE25 *Characterization of the Superdeformed Band in ^{189}Hg .*
J.A.Becker, E.A.Henry, A.Kuhnert et al. - Phys.Rev. C46, 889 (1992).
- 1992BO23 *Level Spin for Superdeformed Nuclei Near A = 194.*
C.Bourgeois, A.Korichi, N.Perrin et al. - Z.Phys. A343, 243 (1992).
- 1992BR17 *High Spin States of ^{189}Au .*
A.M.Bruce, W.Gelletly, G.G.Colvin et al. - Nucl.Phys. A542, 1 (1992).
- 1992HI07 *Neutron Capture Studies of ^{189}Os .*
Th.Hilberath, St.Becker, G.Bollen et al. - Z.Phys. A342, 1 (1992).
- 1992KA48 *Ground-State Properties of Neutron-Deficient Platinum Isotopes.*
B.Kastelein, H.Postma, J.Andriessen - Hyperfine Interactions 75, 315 (1992).
- 1992KA49 *Nuclear Electric Quadrupole Interaction of Implanted Ions in Graphite.*
B.Kastelein, J.K.W.M.Vemer, H.J.van der Marel et al. - Nucl.Instrum.Methods Phys.Res. A316, 158 (1992).
- Electric Quadrupole Orientation of $^{188,189}\text{Ir}$ in Graphite.*

REFERENCES FOR A=189(CONTINUED)

- 1992SCZU H.A.Schuessler, E.C.Benck, F.Buchinger et al. - Contrib. 6th Intern.Conf.on Nuclei Far from Stability + 9th Intern.Conf.on Atomic Masses and Fundamental Constant, Bernkastel-Kues, Germany, PB7 (1992).
Deformation of $^{187,189}\text{Tl}$ from Laser Spectroscopy and Its Interpretation in the Strutinsky and Particle Plus Rotor Models.
- 1992VE05 Ts.Venkova, G.V.Marti, R.M.Lieder et al. - Z.Phys. A344, 231 (1992).
Shape Changes in ^{189}Au at High Spins.
- 1993AN19 A.N.Andreyev, D.D.Bogdanov, V.I.Chepigin et al. - Nucl.Instrum.Methods Phys.Res. A330, 125 (1993).
4 π -Ionization Chamber – a Detector for a Kinematic Separator of Heavy Ion Reaction Products.
- 1993HAZU E.Hagn - Proc.6th Intern.Conf.on Nuclei Far from Stability + 9th Intern.Conf.on Atomic Masses and Fundamental Constants, Bernkastel-Kues, Germany, 19-24 July, 1992, R.Neugart, A.Wohr, Eds., p.173 (1993).
Measurements of Nuclear Moments with NMR-ON.
- 1993PE17 N.Perrin, A.Korichi, C.Bourgeois et al. - Z.Phys. A347, 81 (1993).
Relative Population of Oblate and Prolate Structures in ^{189}Au .
- 1993WA04 J.Wauters, P.Dendooven, M.Huyse et al. - Phys.Rev. C47, 1447 (1993).
 α -Decay Properties of Neutron-Deficient Polonium and Radon Nuclei.
- 1994BE27 I.G.Bearden, R.V.F.Janssens, M.P.Carpenter et al. - Nucl.Phys. A576, 441 (1994).
Detailed Band Structures in ^{189}Hg and ^{190}Hg .
- 1994ZH40 C.Zhou, T.Liu - Chin.J.Nucl.Phys. 16, No 1, 85 (1994).
Level Spin Assignment of Superdeformed Bands for $A \approx 190$ Region.
- 1995BA75 J.C.Batchelder, K.S.Toth, D.M.Moltz et al. - Phys.Rev. C52, 1807 (1995).
Excitation Energy of the $\pi s_{1/2}$ Intruder State in ^{189}Bi .
- 1995LA15 L.Lakosi, N.C.Tam, I.Pavlicsek - Phys.Rev. C52, 1510 (1995).
Photoexcitation of $^{189\text{m}}\text{Os}$ and $^{193\text{m}}\text{Ir}$. I. Excitation of $^{189\text{m}}\text{Os}$ by Low-Energy X Rays.
- 1995LA16 L.Lakosi, N.C.Tam, I.Pavlicsek et al. - Phys.Rev. C52, 1516 (1995).
Photoexcitation of $^{189\text{m}}\text{Os}$ and $^{193\text{m}}\text{Ir}$. II. Excitation by ^{137}Cs and ^{60}Co γ Rays.
- 1995LA25 L.Lakosi, N.X.Khanh, N.C.Tam et al. - Appl.Radiat.Isot. 46, 433 (1995).
Isomer Excitation by High Activity ^{137}Cs and ^{60}Co Sources and Low Energy X-Rays.
- 1995LA26 L.Lakosi, N.X.Khanh, N.C.Tam et al. - Appl.Radiat.Isot. 46, 435 (1995).
Photoexcitation of Isomers by Bremsstrahlung of 4 MeV Electrons.
- 1995LE15 M.Leino, J.Aysto, T.Enqvist et al. - Acta Phys.Pol. B26, 309 (1995).
Research on Heavy Elements Using the JYFL Gas-Filled Recoil Separator RITU.
- 1995MO14 K.Morita, Y.H.Pu, J.Feng et al. - Z.Phys. A352, 7 (1995).
New α -Decaying Neutron Deficient Isotopes ^{197}Rn and ^{200}Fr .
- 1995RE18 W.Reviol, L.L.Riedinger, J.M.Lewis et al. - Phys.Scr. T56, 167 (1995).
Competing Shapes in Light Tl Nuclei.
- 1995SP01 K.Spohr, W.Meczynski, J.B.Fitzgerald et al. - Acta Phys.Pol. B26, 297 (1995).
Spectroscopy with Large γ -Arrays in Coincidence with a RFD.
- 1996RIZZ L.L.Riedinger, W.Reviol, J.M.Lewis et al. - Proc.Workshop Gammasphere Physics, Berkeley, California, 1-2 December 1995, World Scientific, Singapore, p.98 (1996).
The Multiplicity of Shapes in Tl Nuclei.
- 1996SE15 G.Seewald, E.Hagn, B.Hinfurtner et al. - Phys.Rev.Lett. 77, 5016 (1996).
Measurements of Spectroscopic Quadrupole Moments of Neutron Deficient Ir Isotopes and Shape Coexistence in ^{186}Ir .
- 1996WO04 J.L.Wood, M.O.Kortelahti, E.F.Zganjar et al. - Nucl.Phys. A600, 283 (1996).
Decay of Mass-Separated $^{189\text{m}}\text{Hg}$ (8.7 min) and $^{189\text{g}}\text{Hg}$ (7.7 min) to ^{189}Au .
- 1997AN09 A.N.Andreyev, N.Bijnens, T.Enqvist et al. - Z.Phys. A358, 63 (1997).
Alpha-Decay Characteristics of Neutron-Deficient ^{190}Po , ^{189}Bi and ^{186}Pb Isotopes.
- 1997BR18 A.M.Bruce, C.Thwaites, W.Gelletly et al. - Phys.Rev. C56, 1438 (1997).
Tests of Pseudospin Symmetry Via Coulomb Excitation Measurements on ^{187}Os and ^{189}Os .
- 1997MI27 S.Mirzadeh, F.F.Knapp, Jr. et al. - Radiochim.Acta 77, 99 (1997).
Burn-Up Cross-Section of ^{188}W .
- 1997MO25 P.Moller, J.R.Nix, K.-L.Kratz et al. - At.Data Nucl.Data Tables 66, 131 (1997).
Nuclear Properties for Astrophysical and Radioactive-Ion-Beam Applications.
- 1997PE13 F.M.Penkov - Yad.Fiz. 60, No 6, 1003 (1997); Phys.Atomic Nuclei 60, 897 (1997).
Nuclear Transitions from Molecular Resonances.
- 1997PE26 N.Perrin, C.Bourgeois, A.Korichi et al. - Z.Phys. A359, 373 (1997).
 g Factor Measurements of High Spin Isomeric States in $^{187,189,191}\text{Au}$.
- 1997RA14 T.Radon, Th.Kerscher, B.Schlitt et al. - Phys.Rev.Lett. 78, 4701 (1997).
Schottky Mass Measurements of Cooled Proton-Rich Nuclei at the GSI Experimental Storage Ring.
- 1997WA05 J.Wauters, J.C.Batchelder, C.R.Bingham et al. - Phys.Rev. C55, 1192 (1997).
Fine Structure in the α Decay of ^{189}Bi .
- 1997YA03 W.F.Yang, Z.Z.Zhao, Z.W.Li et al. - Z.Phys. A357, 353 (1997).
The Decay of ^{189}W .
- 1998AK04 Y.A.Akovi - Nucl.Data Sheets 84, 1 (1998).

REFERENCES FOR A=189(CONTINUED)

- 1998HI08 *Review of Alpha-Decay Data from Doubly-Even Nuclei.*
B.Hinfurter, H.Ratai, G.Seewald et al. - Phys.Rev. C57, 2165 (1998).
- 1998KR23 *Measurements of Quadrupole-Interaction-Resolved NMR on Oriented ^{185}Pt , ^{189}Pt , and ^{191}Pt in hcp-Co.*
J.Krause, I.Berkes, J.Camps et al. - Phys.Rev. C58, 3181 (1998).
- 1998LI54 *α Particle Angular Distributions of $^{189,191,193}\text{Bi}$.*
S.X.Liu, J.Y.Zeng - Phys.Rev. C58, 3266 (1998).
- 1998RE04 *Variation of Moments of Inertia with Angular Momentum and Systematics of Bandhead Moments of Inertia of Superdeformed Bands.*
W.Reviol, W.F.Mueller, L.L.Riedinger et al. - Nucl.Phys. A630, 434c (1998).
- 1998RE20 *Superdeformed Shapes and Configurations in Thallium Nuclei.*
W.Reviol, D.E.Ellis, L.L.Riedinger et al. - Phys.Rev. C58, R2644 (1998).
- 1999AN52 *Superdeformed Bands in ^{189}Tl .*
A.N.Andreyev, D.Ackermann, P.Cagarda et al. - Eur.Phys.J. A 6, 381 (1999).
- 1999BE63 *Alpha Decay of the New Isotopes $^{188,189}\text{Po}$.*
J.Benlliure, K.-H.Schmidt, D.Cortina-Gil et al. - Nucl.Phys. A660, 87 (1999); Erratum Nucl.Phys. A674, 578 (2000).
- 1999SC46 *Production of Neutron-Rich Isotopes by Cold Fragmentation in the Reaction $^{197}\text{Au} + \text{Be}$ at 950 A MeV.*
C.Scheidenberger, F.Attallah, K.Beckert et al. - Acta Phys.Hung.N.S. 10, 177 (1999).
- 2000AH03 *Mass Measurements of Relativistic Exotic Nuclei.*
I.Ahmad, R.W.Dunford, H.Esbensen et al. - Phys.Rev. C61, 051304 (2000).
- 2000MO05 *Nuclear Excitation by Electronic Transition in ^{189}Os .*
P.Mohr, C.Hutter, K.Vogt et al. - Eur.Phys.J. A 7, 45 (2000).
- 2000POZY *Half-Lives of Platinum Isotopes from Photoactivation.*
Zs.Podolyak, P.H.Regan, M.Pfutzner et al. - Proc.2nd Intern.Conf Fission and Properties of Neutron-Rich Nuclei, St Andrews, Scotland, June 28-July 3, 1999, J.H.Hamilton, W.R.Phillips, H.K.Carter, Eds., World Scientific, Singapore, p.156 (2000).
- 2000RA23 *High Spin Fragmentation Spectroscopy.*
T.Radon, H.Geissel, G.Munzenberg et al. - Nucl.Phys. A677, 75 (2000).
- 2000RE10 *Schottky Mass Measurements of Stored and Cooled Neutron-Deficient Projectile Fragments in the Element Range of $57 \leq Z \leq 84$.*
W.Reviol - J.Res.Natl.Inst.Stand.Technol. 105, 153 (2000).
- 2000SA58 *Spectroscopy in the Second Minimum: Isotopic limits, lifetimes, and magnetic properties of superdeformed Tl nuclei.*
J.Sauvage, N.Boos, L.Cabaret et al. - Hyperfine Interactions 129, 303 (2000).
- 2000SAZZ *COMPLIS experiments: Collaboration for spectroscopy Measurements using a Pulsed Laser Ion Source.*
J.Sauvage, N.Boos, L.Cabaret et al. - IPNO DR 00-04 (2000).
- 2000SC46 *COMPLIS Experiments: Collaboration for spectroscopy Measurements using a Pulsed Laser Ion source.*
P.Schuermans, I.Berkes, P.Herzog et al. - Hyperfine Interactions 129, 163 (2000).
- 2000VE10 *Alpha-anisotropy studies of near spherical nuclei at ISOLDE.*
D.Verney, F.Le Blanc, L.Cabaret et al. - Hyperfine Interactions 127, 79 (2000).
- 2000ZI04 *Nuclear moments of neutron-deficient iridium isotopes from laser spectroscopy.*
A.Zilges, P.Mohr - Prog.Part.Nucl.Phys. 44, 39 (2000).
- 2001AN11 *Reactions with Real Photons in the Vicinity of the Neutron Threshold.*
A.N.Andreyev, D.Ackermann, P.Cagarda et al. - Eur.Phys.J. A 10, 129 (2001).
- 2001HU21 *New Microsecond Isomers in $^{189,190}\text{Bi}$.*
M.Huyse, A.Andreyev, K.Van de Vel et al. - Hyperfine Interactions 132, 141 (2001).
- 2001MAZN *Anomalies in the α -Decay Energies and Half-Lives of Neutron-Deficient Po Isotopes.*
G.Marti, D.Hojman - Priv.Comm. (2001).
- 2001SC41 *S.Schwarz, F.Ames, G.Audi et al. - Nucl.Phys. A693, 533 (2001).*
Accurate Masses of Neutron-Deficient Nuclides Close to $Z = 82$.
- 2002HU14 *A.Hurstel, M.Rejmund, E.Bouchez et al. - Eur.Phys.J. A 15, 329 (2002).*
Isomeric states in proton-unbound $^{187,189}\text{Bi}$ isotopes.
- 2002KR01 *S.Kroger, G.Basar, A.Baier et al. - Phys.Scr. 65, 56 (2002).*
Hyperfine Structure and Isotope Shift of Osmium I.
- 2002MI40 *S.Mirzadeh, F.Y.Lambrecht, R.M.Lambrecht - Appl.Radiat.Isot. 57, 637 (2002).*
Decay of Tungsten-189.
- 2002VA13 *K.Van de Vel, A.N.Andreyev, M.Huyse et al. - Phys.Rev. C65, 064301 (2002).*
Identification of Low-Lying Proton-Based Intruder States in $^{189-193}\text{Pb}$.
- 2003KE08 *H.Kettunen, T.Enqvist, T.Grahn et al. - Eur.Phys.J. A 17, 537 (2003).*
Alpha-decay studies of the new isotopes ^{191}At and ^{193}At .
- 2003MO09 *P.Moller, B.Pfeiffer, K.-L.Kratz - Phys.Rev. C 67, 055802 (2003).*
New calculations of gross β -decay properties for astrophysical applications: Speeding-up the classical r process.
- 2003WU02 *S.-C.Wu, H.Niu - Nucl.Data Sheets 100, 1 (2003).*
Nuclear Data Sheets for $A = 189$.
- 2004AN14 *I.Angeli - At.Data Nucl.Data Tables 87, 185 (2004).*

REFERENCES FOR A=189(CONTINUED)

- 2004HU15 A consistent set of nuclear rms charge radii: properties of the radius surface $R(N,Z)$.
A.Hurstel, Y.Le Coz, E.Bouchez et al. - Eur.Phys.J. A 21, 365 (2004).
Prolate deformation in the $^{187,189}\text{Bi}$ isotopes.
- 2005AN17 A.N.Andreyev, D.Ackermann, S.Antalic et al. - Phys.Rev. C 72, 014612 (2005).
Cross section systematics for the lightest Bi and Po nuclei produced in complete fusion reactions with heavy ions.
- 2005BA51 A.M.Baxter, A.P.Byrne, G.D.Dracoulis et al. - Phys.Rev. C 71, 054302 (2005).
Spherical and deformed structures in ^{189}Pb .
- 2005DE01 H.De Witte, A.N.Andreyev, S.Dean et al. - Eur.Phys.J. A 23, 243 (2005).
Alpha-decay of neutron-deficient ^{200}Fr and heavier neighbours.
- 2005KE10 H.Kettunen, T.Enqvist, K.Eskola et al. - Eur.Phys.J. A 25, Supplement 1, 181 (2005).
Decay studies of neutron-deficient odd-mass At and Bi isotopes.
- 2005UU02 J.Uusitalo, M.Leino, T.Enqvist et al. - Phys.Rev. C 71, 024306 (2005).
 α decay studies of very neutron-deficient francium and radium isotopes.
- 2005UU03 J.Uusitalo, S.Eeckhaudt, T.Enqvist et al. - Eur.Phys.J. A 25, Supplement 1, 179 (2005).
Alpha-decay studies using the JYFL gas-filled recoil separator RITU.
- 2005VA04 K.Van de Vel, A.N.Andreyev, D.Ackermann et al. - Eur.Phys.J. A 24, 57 (2005).
Prolate structures in ^{189}Po and ^{185}Pb .
- 2006AC01 E.Achterberg, O.A.Capurro, G.V.Marti et al. - Nucl.Data Sheets 107, 1 (2006).
Nuclear Data Sheets for A = 193.
- 2006AN36 A.N.Andreyev, S.Antalic, M.Huyse et al. - Phys.Rev.C 74, 064303 (2006).
 α decay of the new isotopes $^{193,194}\text{Rn}$.
- 2006MUZX S.F.Mughabghab - Atlas of Neutron Resonances, 5ed., Resonance Parameters and Thermal Cross Sections, Z = 1-100,
Elsevier, Amsterdam (2006).
- 2006SE18 M.Seliverstov, A.Andreyev, N.Barre et al. - Hyperfine Interactions 171, 225 (2006).
Study of the neutron deficient $^{182-190}\text{Pb}$ isotopes by simultaneous atomic- and nuclear-spectroscopy.
- 2006VE10 D.Verney, L.Cabaret, J.E.Crawford et al. - Eur.Phys.J. A 30, 489 (2006).
Deformation change in light iridium nuclei from laser spectroscopy.
- 2007CH41 S.K.Chamoli, R.Kumar, I.M.Govil et al. - Phys.Rev. C 75, 054323 (2007).
Experimental study of shape coexistence in ^{189}Tl .
- 2007DE09 H.De Witte, A.N.Andreyev, N.Barre et al. - Phys.Rev.Lett. 98, 112502 (2007).
Nuclear Charge Radii of Neutron-Deficient Lead Isotopes Beyond N = 104 Midshell Investigated by In-Source Laser Spectroscopy.
- 2007DOZW C.Dossat, Ch.Theisen, A.Burger et al. - Proc.Inter.Conf.Proton Emitting Nuclei and Related Topics (PROCON 2007),
Lisbon, Portugal, 17-23 June 2007, L.S.Ferreira Ed. p.196 (2007); AIP Conf.Proc. 961 (2007).
Spectroscopy of the very neutron-deficient ^{189}Bi .
- 2008KI07 T.Kibedi, T.W.Burrows, M.B.Trzhaskovskaya et al. - Nucl.Instrum.Methods Phys.Res. A589, 202 (2008).
Evaluation of theoretical conversion coefficients using BrIcc.
- 2008STZY S.J.Steer - University of Surrey (2008).
Isomer Decay Spectroscopy of $N \leq 126$ Neutron-Rich Nuclei.
- 2009AL12 H.H.Alharbi, H.A.Alhendi, F.S.Alhakami - Phys.Rev. C 79, 054324 (2009).
Description of superdeformed nuclei in the A ~ 190 region by generalized deformed $\text{su}_q(2)$.
- 2009AL30 N.Alkhomashi, P.H.Regan, Zs.Podolyak et al. - Phys.Rev. C 80, 064308 (2009).
 β^+ -delayed spectroscopy of neutron-rich tantalum nuclei: Shape evolution in neutron-rich tungsten isotopes.
- 2009CH62 L.M.Chen, R.S.Guo - Chin.J.Phys.(Taiwan) 47, 788 (2009).
The Projected Shell Model Description of the Yrast Bands in Superdeformed Thallium Nuclei.
- 2009DR03 G.D.Dracoulis, G.J.Lane, T.Kibedi et al. - Phys.Rev. C 79, 031302 (2009).
Characterization of the 32 μs isomer in ^{189}Pb as a shears-mode bandhead.
- 2009HU12 W.Hua, X.H.Zhou, Y.H.Zhang et al. - Phys.Rev. C 80, 034303 (2009).
Properties of the rotational bands in the transitional nucleus ^{189}Pt .
- 2009HU17 W.Hua, X.-H.Zhou, Y.-H.Zhang et al. - Chin.Phys.C 33, 743 (2009).
Study of the $\nu_{13/2}^{-1}$ band in ^{189}Pt .
- 2009SA09 J.Sauvage, J.Genevey, B.Roussiere et al. - Eur.Phys.J. A 39, 33 (2009).
Nuclear structure of ^{189}Tl states studied via β^+/EC decay and laser spectroscopy of $^{189\text{m}+g}\text{Pb}$.
- 2009SE13 M.D.Seliverstov, A.N.Andreyev, N.Barre et al. - Eur.Phys.J. A 41, 315 (2009).
Charge radii and magnetic moments of odd- A $^{183-189}\text{Pb}$ isotopes.
- 2009YU11 S.-G.Yuan, Y.-B.Xu, H.-J.Ding et al. - Chin.Phys.C 33, Supplement 1, 191 (2009).
Gamma decay of the lowly excited states of ^{189}Re .
- 2010CO02 N.Colonna, and The n.TOF Collaboration - Appl.Radiat.Isot. 68, 643 (2010).
Neutron cross-sections for next generation reactors: New data from n.TOF.
- 2010FU04 K.Fujii, for the n.TOF Collaboration - Phys.Rev. C 82, 015804 (2010).
Neutron physics of the Re/Os clock. III. Resonance analyses and stellar (n,γ) cross sections of $^{186,187,188}\text{Os}$.
- 2010MO15 M.Mosconi, for the The n.TOF Collaboration - Phys.Rev. C 82, 015802 (2010).

REFERENCES FOR A=189(CONTINUED)

- 2010MO16 *Neutron physics of the Re/Os clock. I. Measurement of the (n,γ) cross sections of $^{186,187,188}\text{Os}$ at the CERN n_TOF facility.*
M.Mosconi, M.Heil, F.Kappeler et al. - Phys.Rev. C 82, 015803 (2010).
- 2011PR03 *Neutron physics of the Re/Os clock. II. The (n,n') cross section of ^{187}Os at 30 keV neutron energy.*
B.Pritychenko, E.Betak, M.A.Kellett et al. - Nucl.Instrum.Methods Phys.Res. A640, 213 (2011).
The Nuclear Science References (NSR) database and Web Retrieval System.
- 2011ST21 S.J.Steer, Zs.Podolyak, S.Pietri et al. - Phys.Rev. C 84, 044313 (2011).
Isomeric states observed in heavy neutron-rich nuclei populated in the fragmentation of a ^{208}Pb beam.
- 2012AL05 N.Al-Dahan, P.H.Regan, Zs.Podolyak et al. - Phys.Rev. C 85, 034301 (2012); Pub.Note Phys.Rev. C 85, 039904 (2012).
Multiple B^- decaying states in ^{194}Re : Shape evolution in neutron-rich osmium isotopes.
- 2012BA32 A.E.Barzakh, L.Kh.Batist, D.V.Fedorov et al. - Phys.Rev. C 86, 014311 (2012).
Hyperfine structure anomaly and magnetic moments of neutron deficient Tl isomers with $I=9/2$.
- 2012GR19 J.L.Gross, M.Thoennessen - At.Data Nucl.Data Tables 98, 983 (2012).
Discovery of gallium, germanium, lutetium, and hafnium isotopes.
- 2012MAZP P.J.R.Mason, Zs.Podolyak, N.Marginean et al. - Proc.Intern.Conf.on Nuclear Structure and Dynamics,12, Opatija, Croatia, 9-13 July, 2012, T.Niksic, M.Milin, D.Vretenar, S.Szilner, Eds., p.93 (2012); AIP Conf.Proc.1491 (2012).
 ^7Li -induced reactions for fast-timing with $\text{LaBr}_3\text{:Ce}$ detectors.
- 2012RO36 R.Robinson, M.Thoennessen - At.Data Nucl.Data Tables 98, 911 (2012).
Discovery of tantalum, rhenium, osmium, and iridium isotopes.
- 2013AN02 I.Angeli, K.P.Marinova - At.Data Nucl.Data Tables 99, 69 (2013).
Table of experimental nuclear ground state charge radii: An update.
- 2013HE25 C.-Y.He, X.G.Wu, J.-L.Wang et al. - Chin.Phys.Lett. 30, 112101 (2013).
Lifetime Measurement of the Low Lying Yrast States in ^{189}Pt .
- 2013SA43 J.Sauvage, B.Roussiere, J.Genevey et al. - Eur.Phys.J. A 49, 109 (2013).
Decay of ^{185}Tl , $^{185\text{m}+\text{g}}\text{Hg}$, $^{189\text{m}+\text{g}}\text{Pb}$ and energy location of the $13/2^+$ isomeric states in ^{185}Hg , ^{189}Pb , ^{193}Po and ^{197}Rn .
- 2013SH30 D.Shubina, R.B.Cakirli, Yu.A.Litvinov et al. - Phys.Rev. C 88, 024310 (2013).
Schottky mass measurements of heavy neutron-rich nuclides in the element range $70 \leq Z \leq 79$ at the GSI Experimental Storage Ring.
- 2014KU02 T.Kurtukian-Nieto, J.Benlliure, K.-H.Schmidt et al. - Phys.Rev. C 89, 024616 (2014).
Production cross sections of heavy neutron-rich nuclei approaching the nucleosynthesis r-process path around $A=195$.
- 2015HO14 D.Hodge, D.M.Cullen, M.J.Taylor et al. - Phys.Rev. C 92, 054312 (2015).
Identification of a dipole band above the $I^\pi = 31/2^-$ isomeric state in ^{189}Pb .
- 2016MA12 T.Marketin, L.Huther, G.Martinez-Pinedo - Phys.Rev. C 93, 025805 (2016).
Large-scale evaluation of β -decay rates of r-process nuclei with the inclusion of first-forbidden transitions.
- 2016RE02 M.W.Reed, G.J.Lane, G.D.Dracoulis et al. - Phys.Lett. B 752, 311 (2016).
Impact of triaxiality on the rotational structure of neutron-rich rhenium isotopes.
- 2016ST14 N.J.Stone - At.Data Nucl.Data Tables 111-112, 1 (2016).
Table of nuclear electric quadrupole moments.
- 2017AU03 G.Audi, F.G.Kondev, M.Wang et al. - Chin.Phys.C 41, 030001 (2017).
The NUBASE2016 evaluation of nuclear properties.
- 2017WA10 M.Wang, G.Audi, F.G.Kondev et al. - Chin.Phys.C 41, 030003 (2017).
The AME2016 atomic mass evaluation (II). Tables, graphs and references.