^{187}Re(^{16}O,5nγ) 2014Pa53,1996Zh23

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Huang Xiaolong and Kang Mengxiao	NDS 133, 221 (2016)	1-Dec-2015

2014Pa53: Includes ^{185}Re(^{16}O,3nγ). E(^{16}O)=112.5 MeV. 18.5 mg/cm^2-thick, natural Re target. Prompt γ-ray spectroscopy study using the INGA array comprising of 15 Compton-suppressed HPGe detectors at Pelletron accelerator facility of IUAC, New Delhi. Measured Eγ, Iγ, $\gamma\gamma\gamma$ coin., $\gamma\gamma(\theta)$(DCO) and linear polarization. Deduced: level scheme, J, π, multipolarity, magnetic dipole bands, B(M1)/B(E2) ratios, configurations. Comparison with tilted-axis cranking (TAC) model calculations.

1996Zh23: ^{187}Re(^{16}O,5nγ), E=85-105 MeV; measured Eγ, Iγ, $\gamma\gamma$(t), $\gamma(\theta)$ with 6 BGO(AC)HPGe detectors and planar Ge detector. See also 1996Zh04, 1996Zh27, 1995Zh08, 1994Da17.

^{198}Bi Levels

E(level)[†]	J^{π}[‡]	$T_{1/2}$[#]	Comments
0.0	(2$^+$,3$^+$)[#]	10.3 min *3*	Level not populated in the present study. configuration: $\pi(h^{+1}_{9/2})\otimes\nu(f^{-1}_{5/2})$ (2014Pa53).
0.0+x	7$^+$	11.6 min *3*	Additional information 1. This level decays by $\varepsilon+\beta^+$ decay and no γ transition from this level is known. Thus the excitation energy of this state remains unknown. J^{π}: 248.5γ E3 from 10$^-$. configuration: $\pi(h^{+1}_{9/2})\otimes\nu(f^{-1}_{5/2})$ (2014Pa53).
248.5+x *5*	10$^-$[#]	7.7 s *5*	configuration: $\pi(h^{+1}_{9/2})\otimes\nu(i^{-1}_{13/2})$ (2014Pa53).
874.4+x *5*	11$^-$		
1224.0+x *6*	12$^-$		
1239.0+x *6*	11$^-$		
1547.0+x *6*	12$^-$		
1662.0+x *6*	13$^-$		
1707.3+x *6*	13$^-$		
1768.6+x *6*	14$^-$		
1822.5+x *6*	14$^-$		
1877.8+x *6*	15$^+$	8.0 ns *36*	configuration: $\pi(h^{+1}_{9/2})\otimes\nu(i^{-2}_{13/2}p^{-1}_{3/2})$ (2014Pa53). $T_{1/2}$: From γ(t) in 1996Zh23.
2223.3+x *6*	16$^-$		configuration: $\pi(h^{+1}_{9/2})\otimes\nu(i^{-1}_{13/2}f^{-2}_{5/2})$ (2014Pa53).
2289.3+x?[a] *12*	(16$^+$)		
2595.7+x[&] *7*	17$^-$		
2724.1+x[a] *7*	17$^+$		
2837.9+x[&] *7*	(18$^-$)		
2853.8+x *7*	17$^+$		
3132.1+x[&] *7*	(19$^-$)		
3203.7+x *8*	18$^+$		
3232.9+x *7*	18$^-$		
3300.8+x[a] *7*	18$^+$		
3429.0+x[&] *7*	(20$^-$)		
3452.0+x *8*			
3635.5+x[@] *8*	19$^+$		
3746.7+x[&] *8*	(21$^-$)		
3763.3+x[a] *7*	19$^+$		
3966.1+x[@] *8*	20$^+$		
4065.1+x[a] *8*	(20$^+$)		
4126.5+x[&] *8*	(22$^-$)		
4157.7+x *7*			
4192.3+x[@] *10*	(21$^+$)		
4339.4+x[&] *8*	(23$^-$)		

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^{187}Re(^{16}O,5nγ) 2014Pa53,1996Zh23 (continued)

^{198}Bi Levels (continued)

E(level)[†]	Jπ[‡]	E(level)[†]	Jπ[‡]	E(level)[†]	Jπ[‡]	E(level)[†]	Jπ[‡]
4384.9+x[a] *9*	(21+)	4646.1+x[a] *10*	(22+)	4856.4+x[&] *9*	(25−)	5971.0+x[@] *12*	(26+)
4482.6+x[@] *10*	(22+)	4661.7+x *12*		5272.0+x[@] *11*	(24+)	6486.1+x[@] *13*	(27+)
4627.2+x[&] *9*	(24−)	4845.5+x[@] *11*	(23+)	5767.5+x[@] *12*	(25+)		

[†] From a least-squares fit to Eγ.
[‡] From the deduced transition multipolarities and the proposed level scheme in 2014Pa53, unless otherwise stated.
[#] From Adopted Levels.
[@] Band(A): ΔJ=1 band 1, based on 19+. Proposed configuration=$\pi(h^{+1}_{9/2})\otimes\nu(i^{-2}_{13/2}\,(p_{3/2}f_{5/2})^{-3})$ for lower members of the band and $\pi(h^{+1}_{9/2})\otimes\nu(i^{-4}_{13/2}(p_{3/2}f_{5/2})^{-3})$ after the back-bending (2014Pa53); interpreted as a magnetic-dipole rotational (δ) band.
[&] Band(B): ΔJ=1 band 2, based on 17−. Proposed configuration=$\pi(h^{+1}_{9/2})\otimes\nu(i^{-3}_{13/2})$ for lower members of the band and $\pi(h^{+1}_{9/2})\otimes\nu(i^{-3}_{13/2}\,p^{-2}_{3/2})$ after the back-bending (2014Pa53); interpreted as a magnetic-dipole rotational (δ) band.
Evaluator's note: proposed configuration after the back-bend seems questionable since a pair of $p_{3/2}$ neutrons is unlikely to produce such an upbend with a gain in alignment; a back-bend is generally caused by an intruder (high-spin) orbital.
[a] Band(C): ΔJ=1 band 3, based on 16+. Proposed tentative configuration=$\pi(h^{+2}_{9/2}\,i^{+1}_{13/2}\,s^{-2}_{1/2})\otimes\nu(i^{-1}_{13/2})$.

γ(^{198}Bi)

A 222.7γ placed from a 3075 level in 1996Zh23 is not confirmed by 2014Pa53. Note that orderings of the γ rays in bands 1, 2 and 3 in 2014Pa53 are quite different from those in 2000Zw02.
DCO ratios are for 90° and 148° geometry. Expected values are 1.81 for a stretched quadrupole transition when gated on a stretched dipole, and 0.55 for a stretched dipole when gated on stretched quadrupole transition (2014Pa53).
Values of POL are expected to be positive for electric and negative for magnetic transitions.

Eγ[&]	Iγ[&a]	Ei(level)	Jπi	Ef	Jπf	Mult.	α[b]	Comments
(55.0[c†] *5*)		1822.5+x	14−	1768.6+x	14−			
(55.0[c†] *5*)		1877.8+x	15+	1822.5+x	14−	[E1][@]	0.472 *14*	
(66)		2289.3+x?	(16+)	2223.3+x	16−	[E1][@]	0.289	
106.6 *2*	9.6 *12*	1768.6+x	14−	1662.0+x	13−	M1+E2	6.8 *17*	Mult.: DCO=0.91 *24* (from 625.8-keV, ΔJ=1, M1(+E2) gate) (2014Pa53). Other: Eγ=106.6 *5*, Iγ=10 *4* (1996Zh23).
110.8 *4*	8.6 *11*	1877.8+x	15+	1768.6+x	14−	E1	0.345 *6*	Mult.: DCO=0.98 *26* (from 345.5-keV, ΔJ=1, E1 gate) (2014Pa53). Other: Eγ=109.4 *5*, Iγ=6 *3* (1996Zh23).
115.2 *3*	5.1 *7*	1822.5+x	14−	1707.3+x	13−	M1+E2	5.3 *16*	Mult.: DCO=1.69 *46* (from 975.9-keV, ΔJ=2, E2 gate) (2014Pa53). Other: Eγ=116 (1996Zh23).
115.8 *2*	10.0 *12*	1662.0+x	13−	1547.0+x	12−	M1+E2	5.2 *16*	Mult.: DCO=1.05 *25* (from 625.8-keV, ΔJ=1, M1(+E2) gate) (2014Pa53). Other: Eγ=115.8 *5*, Iγ=10 *4* (1996Zh23).
203.5 *3*	1.0 *2*	5971.0+x	(26+)	5767.5+x	(25+)	(M1)[#]	1.358	
212.9 *2*	1.1 *2*	4339.4+x	(23−)	4126.5+x	(22−)	(M1)[#]	1.197	
226.2 *6*	3.0 *4*	4192.3+x	(21+)	3966.1+x	20+	(M1)[#]	1.011 *16*	
229.2 *1*	0.6 *1*	4856.4+x	(25−)	4627.2+x	(24−)	[M1][@]	0.975	
242.2 *2*	4.3 *5*	2837.9+x	(18−)	2595.7+x	17−	(M1)[#]	0.836	Other: Eγ=242.7 *5*, Iγ=12 *3* (1996Zh23). This γ placed from a 2465 level in 1996Zh23 is not confirmed by 2014Pa53.

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^{187}Re(^{16}O,5nγ) 2014Pa53,1996Zh23 (continued)

γ(^{198}Bi) (continued)

E_γ[&]	I_γ[&a]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	α[b]	Comments
248.3[‡] *3*	0.8 *1*	3452.0+x		3203.7+x	18⁺			
248.5 *5*		248.5+x	10⁻	0.0+x	7⁺	E3	1.54 *3*	E_γ,Mult.: From Adopted Gammas.
261.2 *4*	1.1 *2*	4646.1+x	(22⁺)	4384.9+x	(21⁺)	(M1)[#]	0.679	
287.8 *3*	0.8 *1*	4627.2+x	(24⁻)	4339.4+x	(23⁻)	(M1)[#]	0.520	
290.3 *2*	1.6 *2*	4482.6+x	(22⁺)	4192.3+x	(21⁺)	(M1)[#]	0.508	
294.1 *3*	2.8 *3*	3132.1+x	(19⁻)	2837.9+x	(18⁻)	(M1)[#]	0.490	
296.6 *3*	2.4 *3*	3429.0+x	(20⁻)	3132.1+x	(19⁻)	(M1)[#]	0.479	
301.8 *3*	4.2 *6*	4065.1+x	(20⁺)	3763.3+x	19⁺	(M1)[#]	0.456	
317.5 *3*	2.1 *3*	3746.7+x	(21⁻)	3429.0+x	(20⁻)	(M1)[#]	0.397	
319.8 *4*	3.2 *5*	4384.9+x	(21⁺)	4065.1+x	(20⁺)	(M1)[#]	0.390	
330.6 *2*	8.2 *10*	3966.1+x	20⁺	3635.5+x	19⁺	M1	0.356	Mult.: DCO=1.01 *20* (from 379.1-keV, ΔJ=1, E1 gate); POL=−0.25 *10* (2014Pa53). A_2=−0.33 *7*, A_4=+0.04 *3* (1996Zh23). Other: Eγ=330.1 *5*, Iγ=15 *3* (1996Zh23).
345.5 *1*	100 *3*	2223.3+x	16⁻	1877.8+x	15⁺	E1	0.0221	Mult.: DCO=1.81 *27* (from 975.9-keV, ΔJ=2, E2 gate); POL=+0.18 *5* (2014Pa53). A_2=−0.29 *5*, A_4=+0.02 *4* (1996ZH23). Other: Eγ=345.3 *5* (1996Zh23).
349.9 *4*	5.0 *4*	3203.7+x	18⁺	2853.8+x	17⁺	M1+E2	0.19 *12*	Mult.: DCO=0.94 *26* (from 345.5-keV, ΔJ=1, E1 gate) (2014Pa53). Other: Eγ=350.1 *5*, Iγ=10 *3* (1996Zh23).
362.9 *3*	1.6 *2*	4845.5+x	(23⁺)	4482.6+x	(22⁺)	(M1)[#]	0.277	
372.4 *2*	7.2 *6*	2595.7+x	17⁻	2223.3+x	16⁻	M1	0.258	Mult.: DCO=0.96 *17* (from 345.5-keV, ΔJ=1, E1 gate); POL=−0.26 *15* (2014Pa53).
379.1 *1*	39.0 *20*	3232.9+x	18⁻	2853.8+x	17⁺	E1	0.0179	Mult.: DCO=1.80 *30* (from 975.9-keV, ΔJ=2, E2 gate); POL=+0.16 *7* (2014Pa53). A_2=−0.28 *9*, A_4=+0.04 *6* (1996Zh23). Other: Eγ=378.9 *5*, Iγ=31 *4* (1996Zh23).
379.8[‡] *1*	1.8 *2*	4126.5+x	(22⁻)	3746.7+x	(21⁻)	[M1][@]	0.245	
402.6 *4*	18.3 *12*	3635.5+x	19⁺	3232.9+x	18⁻	E1	0.01572	Mult.: DCO=0.91 *10* (from 379.1-keV, ΔJ=1, E1 gate); POL=+0.16 *7* (2014Pa53). A_2=−0.17 *8*, A_4=+0.06 *3* (1996Zh23). Other: Eγ=402.3 *5*, Iγ=19 *6* (1996Zh23).
426.5 *3*	1.3 *2*	5272.0+x	(24⁺)	4845.5+x	(23⁺)	(M1)[#]	0.179	
434[d]	6 *1*	2724.1+x	17⁺	2289.3+x?	(16⁺)	[M1][@]	0.1709	
453.7 *3*	11.4 *7*	2223.3+x	16⁻	1768.6+x	14⁻	E2	0.0389	Mult.: DCO=0.61 *12* (from 625.8-keV, ΔJ=1, M1(+E2) gate); POL=+0.23 *8* (2014Pa53). Other: Eγ=454.7 *5*, Iγ=8.8 *21* (1996Zh23).
462.5[‡] *2*	8.9 *7*	3763.3+x	19⁺	3300.8+x	18⁺	M1	0.1442	I_γ: uncertainty of 0.07 in table I of 2014Pa53 seems too low in comparison to other Δ(Iγ) in the table; increased to 0.7 by evaluator. Mult.: DCO=0.98 *19* (from 345.5-keV, ΔJ=1, E1 gate) (2014Pa53).
468.2 *1*	19.8 *10*	1707.3+x	13⁻	1239.0+x	11⁻	E2	0.0360	Mult.: DCO=0.53 *10* (from 345.5-keV, ΔJ=1, E1 gate); POL=+0.21 *6* (2014Pa53) A_2=+0.20 *5*, A_4=+0.06 *4* (1996Zh23). Other: Eγ=468.0 *5*, Iγ=20 *4* (1996Zh23).
483.4 *1*	13.0 *12*	1707.3+x	13⁻	1224.0+x	12⁻	M1+E2	0.08 *5*	Mult.: DCO=1.01 *25* (from 345.5-keV, ΔJ=1, E1 gate); POL=−0.26 *10* (2014Pa53) A_2=−0.17 *9*, A_4=−0.05 *7* (1996Zh23). Other: Eγ=482.4 *5*, Iγ=7.3 *24* (1996Zh23).
495.5 *4*	1.2 *2*	5767.5+x	(25⁺)	5272.0+x	(24⁺)	(M1)[#]	0.1201	

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^{187}Re(^{16}O,5nγ) 2014Pa53,1996Zh23 (continued)

γ(^{198}Bi) (continued)

Eγ[&]	Iγ[&a]	Ei(level)	J^π_i	Ef	J^π_f	Mult.	α[b]	Comments
500.8 *1*	30.4 *15*	2724.1+x	17+	2223.3+x	16−	E1	0.00988	Mult.: DCO=0.97 *11* (from 345.5-keV, ΔJ=1, E1 gate); POL=+0.20 *11* (2014Pa53). Other: Eγ=500.3 *5*, Iγ=20 *6* (1996Zh23).
504[‡d]	1.0 *1*	4661.7+x		4157.7+x				
515.1 *5*	0.8 *2*	6486.1+x	(27+)	5971.0+x	(26+)	(M1)[#]	0.1083	
576.7 *1*	23.7 *15*	3300.8+x	18+	2724.1+x	17+	M1	0.0804	Mult.: DCO=1.04 *26* (from 345.5-keV, ΔJ=1, E1 gate); POL=−0.25 *10* (2014Pa53). Other: Eγ=576.0 *5*, Iγ=13 *3* (1996Zh23).
591.3 *3*	0.5 *1*	3429.0+x	(20−)	2837.9+x	(18−)	[E2][@]	0.0208	Other: Eγ=590.4 *5*, Iγ=4.1 *19* (1996Zh23). This γ placed from a 3821 level in 1996Zh23 is not confirmed by 2014Pa53.
615.2 *5*	0.6 *1*	3746.7+x	(21−)	3132.1+x	(19−)	[E2][@]	0.0190	
625.8 *1*	83 *3*	874.4+x	11−	248.5+x	10−	M1(+E2)	0.042 *24*	Mult.: DCO=1.07 *16* (from 345.5-keV, ΔJ=1, E1 gate); POL=−0.14 *6* (2014Pa53). A_2=−0.23 *3*, A_4=+0.01 *3* (1996Zh23). Other: Eγ=624.8 *5*, Iγ=72 *5* (1996Zh23).
630.5 *1*	61.1 *25*	2853.8+x	17+	2223.3+x	16−	E1	0.00620	Mult.: DCO=0.99 *10* (from 345.5-keV, ΔJ=1, E1 gate); POL=+0.21 *7* (2014Pa53) A_2=−0.31 *8*, A_4=+0.03 *2* (1996Zh23). Other: Eγ=630.5 *5*, Iγ=48 *5* (1996Zh23).
672.8 *1*	66.0 *24*	1547.0+x	12−	874.4+x	11−	M1+E2	0.035 *19*	Mult.: DCO=0.84 *12* (from 345.5-keV, ΔJ=1, E1 gate); POL=−0.24 *6* (2014Pa53) A_2=−0.22 *4*, A_4=−0.10 *4* (1996Zh23). Other: Eγ=671.7 *5*, Iγ=59 *5* (1996Zh23).
787.5 *1*	16.2 *11*	1662.0+x	13−	874.4+x	11−	E2	0.01127	Mult.: DCO=0.60 *10* (from 345.5-keV, ΔJ=1, E1 gate); POL=+0.19 *8* (2014Pa53) A_2=+0.16 *2*, A_4=+0.07 *3* (1996Zh23). Other: Eγ=787.5 *5*, Iγ=13 *3* (1996Zh23).
924.8[‡] *2*	4.3 *6*	4157.7+x		3232.9+x	18−			
975.9 *2*	16.0 *12*	1224.0+x	12−	248.5+x	10−	E2	0.00734	Mult.: DCO=0.54 *11* (from 345.5-keV, ΔJ=1, E1 gate); POL=+0.13 *7* (2014Pa53). Other: Eγ=975.3 *5* (1996Zh23).
976.4 *3*	7.1 *6*	2853.8+x	17+	1877.8+x	15+	E2	0.00733	Mult.: DCO=0.65 *18* (from 625.8-keV, ΔJ=1, M1(+E2) gate) (2014Pa53). Other: Eγ=975.3 *5* (1996Zh23).
990.1 *2*	24.6 *10*	1239.0+x	11−	248.5+x	10−	M1+E2	0.013 *7*	Mult.: DCO=1.61 *29* (from 345.5-keV, ΔJ=1, E1 gate); POL=−0.12 *8* (2014Pa53) A_2=−0.24 *9*, A_4=−0.08 *1* (1996Zh23). Other: Eγ=989.9 *5*, Iγ=21 *3* (1996Zh23).
1298.7 *2*	17.0 *8*	1547.0+x	12−	248.5+x	10−	E2	0.00427	Mult.: DCO=0.62 *14* (from 345.5-keV, ΔJ=1, E1 gate); POL=+0.12 *8* (2014Pa53). Other: Eγ=1297 (1996Zh23).

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^{187}Re(^{16}O,5nγ) 2014Pa53,1996Zh23 (continued)

γ(^{198}Bi) (continued)

† From Adopted Gammas, based on a doubly-placed 55.0γ proposed in 1996Zh23. This doublet could not be confirmed by 2014Pa53 since the energy threshold was somewhat higher than 55 keV in their experiment. Evaluator's note: proposed 55.0-keV transition from 1822.5+x, 14^- to 1768.6+x, 14^-, requiring mult=M1 or M1+E2 seems questionable since no conclusive evidence is provided in 1996Zh23.

‡ Observed only and placed by 2014Pa53.

\# 2014Pa53 quote multipolarity from 2000Zw02, where the assignments are based on measurements of DCO ratios and γ transition intensity balances.

@ Assumed assignment from ΔJ^π value.

& From 2014Pa53, except as noted.

[a] Relative intensity normalized to Iγ(345.5 γ)=100 *3*.

[b] Additional information 2.

[c] Multiply placed.

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

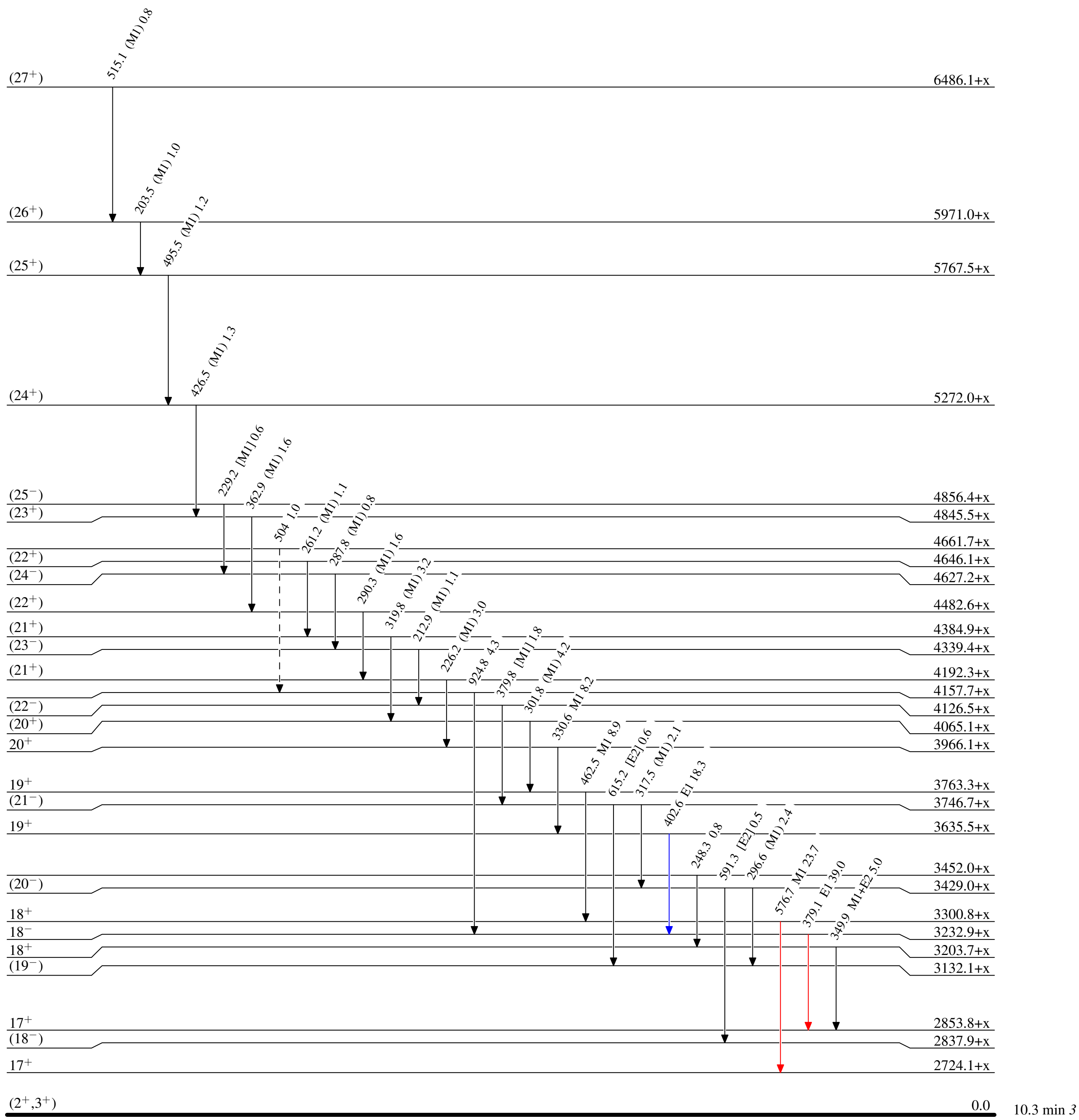
$^{187}Re(^{16}O,5n\gamma)$ 2014Pa53,1996Zh23

Level 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)

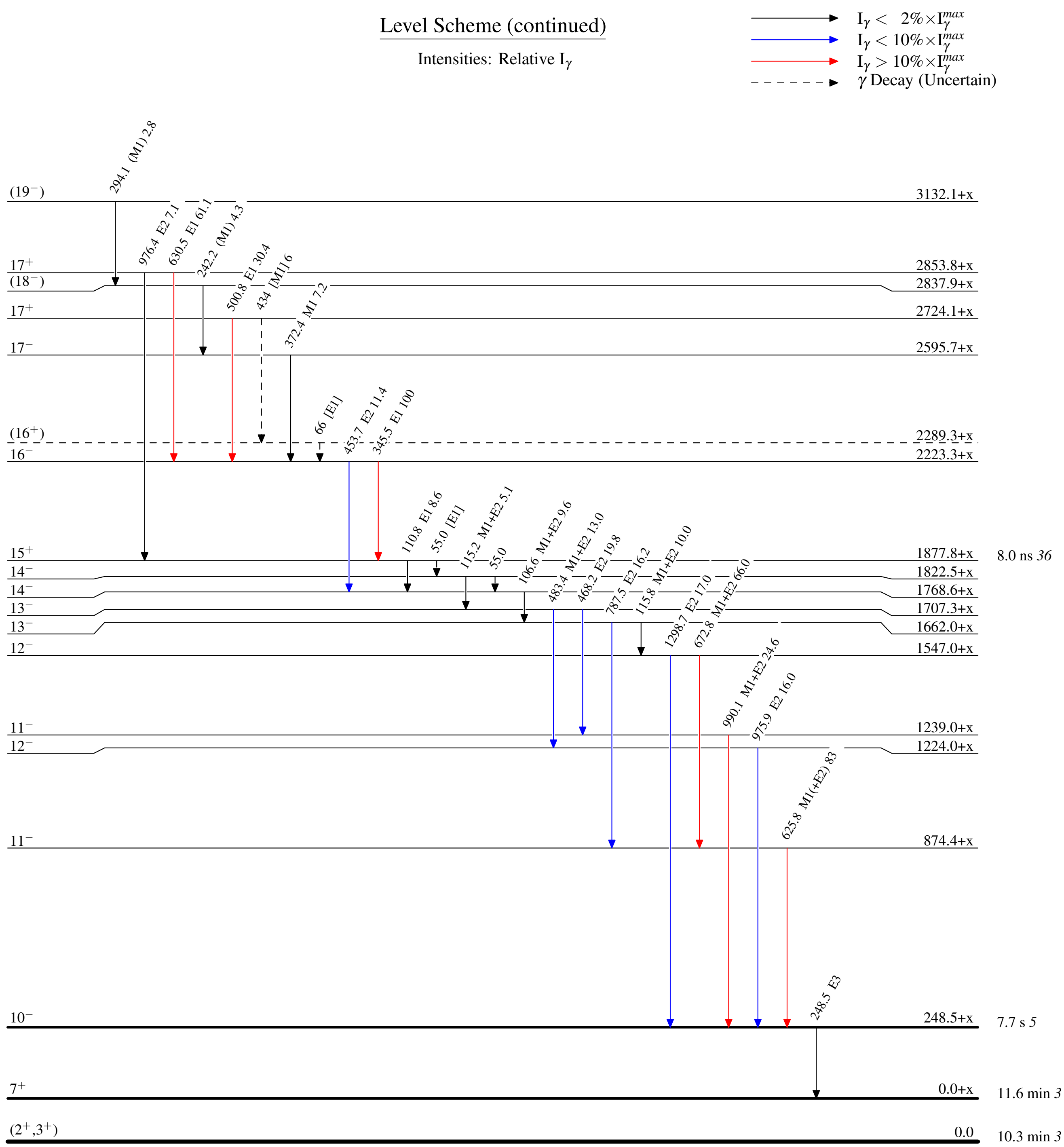


$^{198}_{83}Bi_{115}$

$^{187}Re(^{16}O,5n\gamma)$ 2014Pa53,1996Zh23

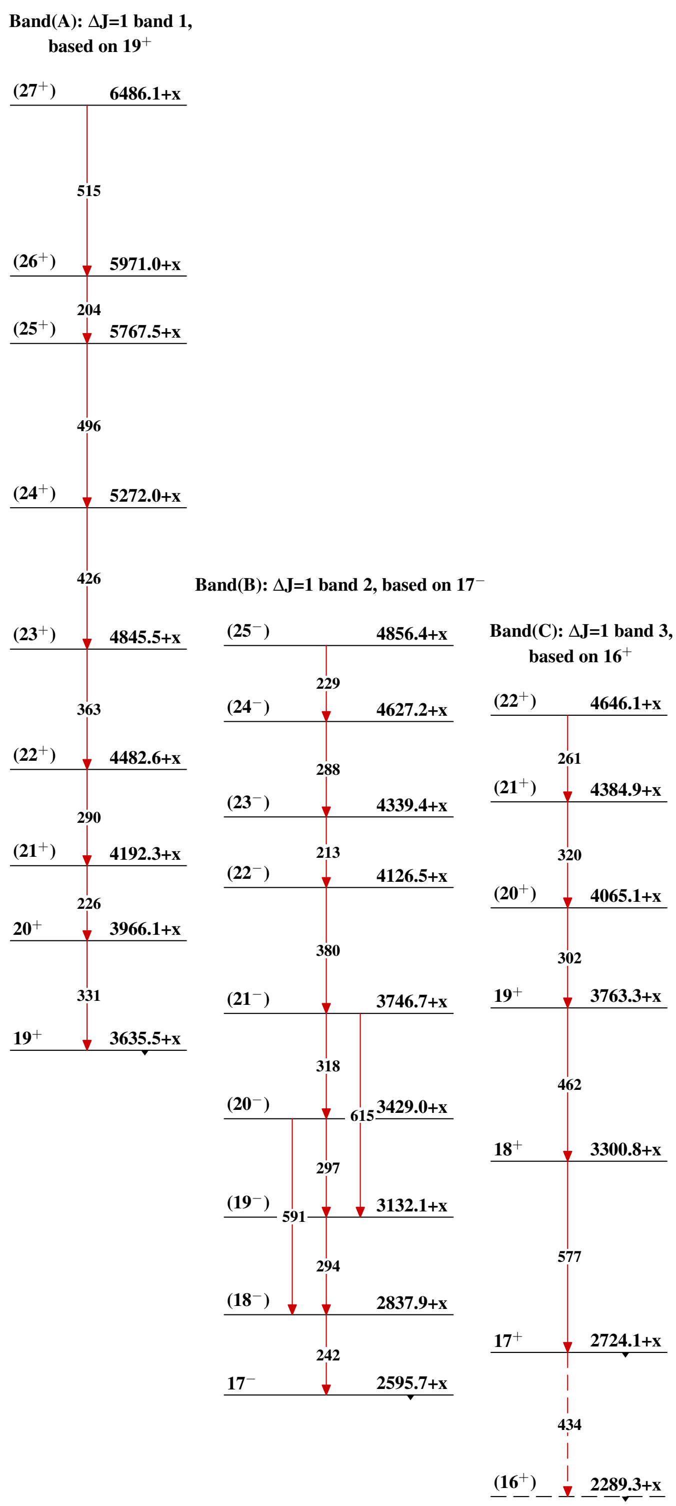
Level Scheme (continued)

Intensities: Relative I_γ



$^{198}_{83}Bi_{115}$

^{187}Re(^{16}O,5nγ) 2014Pa53,1996Zh23



$^{198}_{83}Bi_{115}$