^{249}Cf(^{18}O,^{19}Oγ) 2022Or04,2010Ta10

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	C. D. Nesaraja	NDS 204,374 (2025)	30-Jun-2024

Includes: Cf(^{18}O,xnγ) and ^{249}Cf(^{208}Pb,^{209}Pbγ).

XUNDL work for 2022Or04 compiled by B. Singh (McMaster), April 27, 2023 has been incorporated along with the work of 2010Ta10 by the evaluator.

2022Or04 : Single neutron transfer reaction was performed with E(^{18}O)=140.4 MeV beam from the Japan Atomic Energy Agency-Tokai tandem accelerator. The target consisted of 104 μg/cm^2 thick radioactive ^{249}Cf electrodeposited on a ≈270 μg/cm^2 thick nickel foil. Measured Eγ, Iγ, (^{19}O)γ-coin, $\gamma\gamma$-coin, lifetimes of isomers by $\gamma\gamma$(t) using Si array of ten ΔE-E telescopes for ^{19}O, four Ge detectors and four LaBr$_3$(Ce) detectors for γ radiation. Deduced high-spin levels, J^π, isomers, B(E1), and Nilsson configurations.

2012HoZW: High-spin states were populated via the 1n transfer reaction ^{249}Cf(^{208}Pb,^{209}Pbγ) at Argonne National Laboratory. The γ rays emitted were detected with 101 Compton-suppressed, HPGe detectors of the Gammasphere spectrometer. The level scheme with g.s. band up to 28$^+$ and octupole band up to 25$^-$ was proposed. In an email communication with P. Chowdhury on 27 August, 2024, the evaluator was advised not to use the data in the thesis. The data needs to be corrected and will be published by the authors. Hence, the evaluator has not included the work of 2012HoZW in this dataset.

2010Ta10: Neutron transfer reaction was performed with E(^{18}O)=153 MeV beam from the Japan Atomic Energy Agency-Tokai tandem accelerator facility. The target consisted of 63% ^{249}Cf, 13% ^{250}Cf, and 24% ^{251}Cf. Outgoing nuclei were detected using four sets of Si ΔE-E detectors. γ rays were measured using six Ge detectors in coincidence with the outgoing nuclei. Measured Eγ, Iγ. Deduced levels, J, π.

^{248}Cf Levels

E(level)[†]	J^π	$T_{1/2}$	Comments
0.0[#]	0$^+$		
41.53[#] *6*	2$^+$		
137.8[#] *1*	4$^+$		
287.5[#] *2*	6$^+$		
488.1[#] *2*	8$^+$		
592.1[@] *1*	2$^-$	4.64 ns *14*	K^π=2$^-$ isomer (2022Or04). $T_{1/2}$: from measured mean lifetime τ=6.7 ns *2* (2022Or04) by (^{19}O)$\gamma\gamma$(t).
630[‡@] *1*	3$^-$		
677[‡@] *1*	4$^-$		
735[‡@] *1*	5$^-$		
737.3[#] *5*	10$^+$		
806[‡@] *1*	6$^-$		
885[‡@] *1*	7$^-$		
0.90×10^3? *30*		>139 ns	K≥5 isomer (2022Or04). Possible K^π=5$^-$, π3/2[521]⊗π7/2[633] state or K^π=8$^-$, ν9/2[734]⊗ν1/2[620] state (2022Or04), based on theoretical calculations. This level could possibly be associated with a known 8$^-$ level at 1261 keV from (d,t) work by 2008Ka27. $T_{1/2}$: from mean lifetime τ >200 ns as estimated by 2022Or04 based on the large K that makes the decay too long to be detected.
0.95×10^3? *30*		11.64 ns *35*	E(level): from Fig. 8 in 2022Or04. Authors list (930) in Table I. J^π: If K^π=5$^-$ for the 0.90-MeV state, then E1 for the 47.8γ suggests 4$^+$,5$^+$,6$^+$ for the 0.95-MeV state. $T_{1/2}$: from measured mean lifetime τ=16.8 ns *5* (2022Or04) by (^{19}O)$\gamma\gamma$(t).
979[‡@] *2*	8$^-$		
1021.7? *3*			Level taken from (d,t) work of 2008Ka27; tentatively assigned in the present work based

Continued on next page (footnotes at end of table)

^{249}Cf(^{18}O,^{19}Oγ) 2022Or04,2010Ta10 (continued)

^{248}Cf Levels (continued)

E(level)†	Jπ	Comments
		on strong 429.6γ in delayed coin with the 550.6γ.
1319 *1*		
1.40×10^3 *30*		E(level): from Fig. 8 in 2022Or04, listed as 1391 in authors′ Table I.
1477	2$^-$	E(level): level shown in Fig. 8 of 2022Or04.
1507 *1*	3$^-$	
1556 *2*	4$^-$	
1571.5? *5*		
1634.1? *6*		
2495 *2*		

† From Eγ data, assuming 1 keV uncertainty when not given.
‡ From Adopted Levels.
# Band(A): $K^\pi=0^+$, g.s. band.
@ Band(B): $K^\pi=2^-$, octupole vibrational band.

γ(^{248}Cf)

In the Table below, the intensities of x rays are relative to 100 for the 550.6-keV γ rays. The Kα and Kβ x rays were unresolved in the $LaBr_3$ spectrum (2022Or04).

x ray data from 2022Or04

Cf x ray	E(x ray) (keV)	I(x ray)	Coincident γ rays
Kα_1	109.6 *1*	18 *1*	551.48, 637, 806
Kα_2	115.0 *1*	23 *1*	551.48, 637, 806
Kβ_1	129.2 *2*	9.4 *4*	551
Kβ_2	133.7 *4*	2.8 *5*	551

E$_\gamma$†	I$_\gamma$†	E$_i$(level)	J$_i^\pi$	E$_f$	J$_f^\pi$	Mult.	α@	Comments
(41.53‡ *6*)		41.53	2$^+$	0.0	0$^+$			
47.8 *1*	34 *1*	0.95×10$^{3?}$		0.90×10$^{3?}$		E1	1.000 *15*	α(L)=0.744 *11*; α(M)=0.1896 *29* α(N)=0.0517 *8*; α(O)=0.01253 *19*; α(P)=0.001857 *28*; α(Q)=4.80×10^{-5} *7* 47.8γ in delayed coin with 175γ, (323γ), (384γ), 461.1γ, and 1175γ; and in prompt coin with 588γ. Mult.: from analysis of γ-ray coincidences showing large intensity consistent with the conversion coefficent data in ^{248}Cf β- decay. BE1=1.12E−6 30 (2022Or04). B(E1) in e^{2}b units. B(E1)(W.u.)=4.4E−5 *12* (2022Or04). Note that 2022Or04 assigned transition branching ratio of 66% *18* for the 47.8-keV transition, not 100%, on which basis B(E2), B(E2)(W.u.) and E1 hindrance factor were deduced. E1 hindrance factor=2.3×10^4 *6* (2022Or04), consistent with ΔK=0, 1 or 2.
^{x}69#								69γ in delayed coin with 550.6γ.

Continued on next page (footnotes at end of table)

^{249}Cf(^{18}O,^{19}Oγ) 2022Or04,2010Ta10 (continued)

γ(^{248}Cf) (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.	α @	Comments
x96 #								96γ in prompt coin with 461.1γ, and as a contaminant in delayed coin with 550.6γ.
(96.28 ‡ *6*)		137.8	4^+	41.53	2^+			
x109 #								109γ in prompt coin with 200.6γ.
x131.4 *3*	1.8 *5*							
149.7 *1*	5.0 *7*	287.5	6^+	137.8	4^+	(E2)	3.69 *5*	α(K)=0.1479 *21*; α(L)=2.55 *4*; α(M)=0.726 *10* α(N)=0.2043 *29*; α(O)=0.0507 *7*; α(P)=0.00821 *12*; α(Q)=4.46×10^{-5} *6* 149.7γ in prompt coin with 200.6γ and 1355γ. Mult.: ΔJ=2 from Iγ(in-plane)/Iγ(out-of-plane)=1.10 *12* (2010Ta10).
x164 #								164γ in delayed coin with 550.6γ.
x173 #								173γ in prompt coin with 200.6γ.
x175 #								175γ in delayed coin with 47.8γ.
200.6 *1*	2.7 *7*	488.1	8^+	287.5	6^+	(E2)	1.129 *16*	α(K)=0.1403 *20*; α(L)=0.714 *10*; α(M)=0.2018 *29* α(N)=0.0567 *8*; α(O)=0.01410 *20*; α(P)=0.002318 *33*; α(Q)=1.792×10^{-5} *25* 200.6γ in prompt coin with 109γ, 150γ, 173γ, and 1465γ. Mult.: ΔJ=2 from Iγ(in-plane)/Iγ(out-of-plane)=1.05 *18* (2010Ta10).
x217.7 *1*	5.9 *8*							217.7γ in prompt coin with 524γ, 660γ, 738γ, and 891.1γ.
x224 #								224γ in delayed coin with 550.6γ.
249.3 *5*	1.14 *25*	737.3	10^+	488.1	8^+	[E2]	0.507 *8*	α(K)=0.1081 *15*; α(L)=0.289 *5*; α(M)=0.0811 *13* α(N)=0.0228 *4*; α(O)=0.00568 *9*; α(P)=0.000945 *15*; α(Q)=9.74×10^{-6} *15* Eγ: Obtained from γ-γ coincidence data from 2010Ta10. Iγ: Weighted average of 1.28 *25* and 0.95 *29*. 1.28 *25* was derived from the ratio of I(149.7γ): 5.0 *7* (2010Ta10) and 9.4 *5* (2022Or04) with I(249.3γ)=2.4 *3* (2010Ta10). Whereas 0.95 *29* was derived from the ratio of I(200.6γ): 6.8 *6* (2010Ta10) and 2.7 *7* (2022Or04) with I(249.3γ)=2.4 *3* (2010Ta10).
x271 #								271γ in delayed coin with 550.6γ.
x319.2 *4*	5.7 *7*							319.2γ in prompt coin with 1014γ.
x323 #								323γ in delayed coin with 47.8γ and 550.6γ.
x333 #								333γ, a contaminant, in delayed coin with 550.6γ.
x384 #								Uncertain γ, in delayed coin with 47.8γ.
x388 #								388γ, a contaminant, in delayed coin with 550.6γ.
x428 #								428γ in prompt coin with 429.6γ.
429.6 & *3*	7.3 *7*	1021.7?		592.1	2^-			429.6γ in prompt coin with 428γ, 550.6γ, 833γ, 924γ, and 1039γ.

Continued on next page (footnotes at end of table)

^{249}Cf(^{18}O,^{19}Oγ) 2022Or04,2010Ta10 (continued)

γ(^{248}Cf) (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.	α @	Comments
461.1 *1*	31 *1*	1.40×10^3		0.95×10$^{3?}$				461.1γ in prompt coin with 47.8γ, 96γ, 564γ, 582γ, and 672γ.
x488#								488γ in prompt coin with 550.6γ.
x494#								494γ in delayed coin with 550.6γ.
x524#								524γ in prompt coin with 217.7γ.
550.7‡ *1*	100 *1*	592.1	2$^-$	41.53	2$^+$	E1	0.01365 *19*	B(E1)↓=5.55×10^{-9} *17* (2022Or04) B(E1)(W.u.)=2.18×10^{-7} *7* (2022Or04) α(K)=0.01087 *15*; α(L)=0.002094 *29*; α(M)=0.000508 *7* α(N)=0.0001398 *20*; α(O)=3.59×10^{-5} *5*; α(P)=6.70×10^{-6} *9*; α(Q)=3.47×10^{-7} *5* 550.6γ in delayed coin with 69γ, 96γ, 164γ, 224γ, 271γ, 323γ, 333γ, 388γ, 429.6γ, 494γ, 599γ, 640γ, 727γ, 731γ, 911γ, 915γ, 926γ, 979.4γ, 1042.0γ, 1176γ, 1226γ, and 1283γ; and in prompt coin with 488γ, 1190γ, and 1257γ. B(E1) in e^{2}b units. E1 hindrance factor=4.59×10^6 *14*, consistent with ΔK=2, but ΔK=1 and 3 are not excluded. Mult.: from ce measurement in ^{248}Bk β^- decay.
x564#								564γ in prompt coin with 461.1γ.
x582#								582γ in prompt coin with 461.1γ.
x588#								588γ in prompt coin with 47.8γ.
x599#								599γ in delayed coin with 550.6γ.
x637#								637γ in prompt coin with 109.6-keV and 115.0-keV K$_\alpha$ x rays.
x640#								640γ in delayed coin with 550.6γ.
x660#								660γ in prompt coin with 217.7γ.
x672#								672γ in prompt coin with 461.1γ.
727&	2 *1*	1319		592.1	2$^-$			727γ in prompt coin with 550.6γ.
x731#								731γ in delayed coin with 550.6γ.
x738#								738γ seen in prompt coin with 217.7γ.
x783.7 *4*	3.5 *7*							
x806#								806γ in prompt coin with 109.6-keV and 115.0-keV K$_\alpha$ x-rays.
x833#								833γ in prompt coin with 429.6γ.
x891.1 *4*	6.5 *9*							891γ in prompt coin with 217.7γ, 550.6γ, and 1370γ.
x911#								911γ in delayed weak coin with 550.6γ.
915&	5 *2*	1507	3$^-$	592.1	2$^-$			915γ in prompt coin with 550.6γ.
x924#								924γ in prompt coin with 429.6γ.
926&	2 *1*	1556	4$^-$	630	3$^-$			926γ in prompt coin with 550.6γ.
979.4& *5*	11.5 *9*	1571.5?		592.1	2$^-$			979.4γ in prompt coin with 550.6γ.
x1014#								1014γ in prompt coin with 319.2γ.
x1019#								1019γ in delayed weak coin with 551γ.
x1039#								1039γ in prompt coin with 429.6γ.

Continued on next page (footnotes at end of table)

^{249}Cf(^{18}O,^{19}Oγ) 2022Or04,2010Ta10 (continued)

γ(^{248}Cf) (continued)

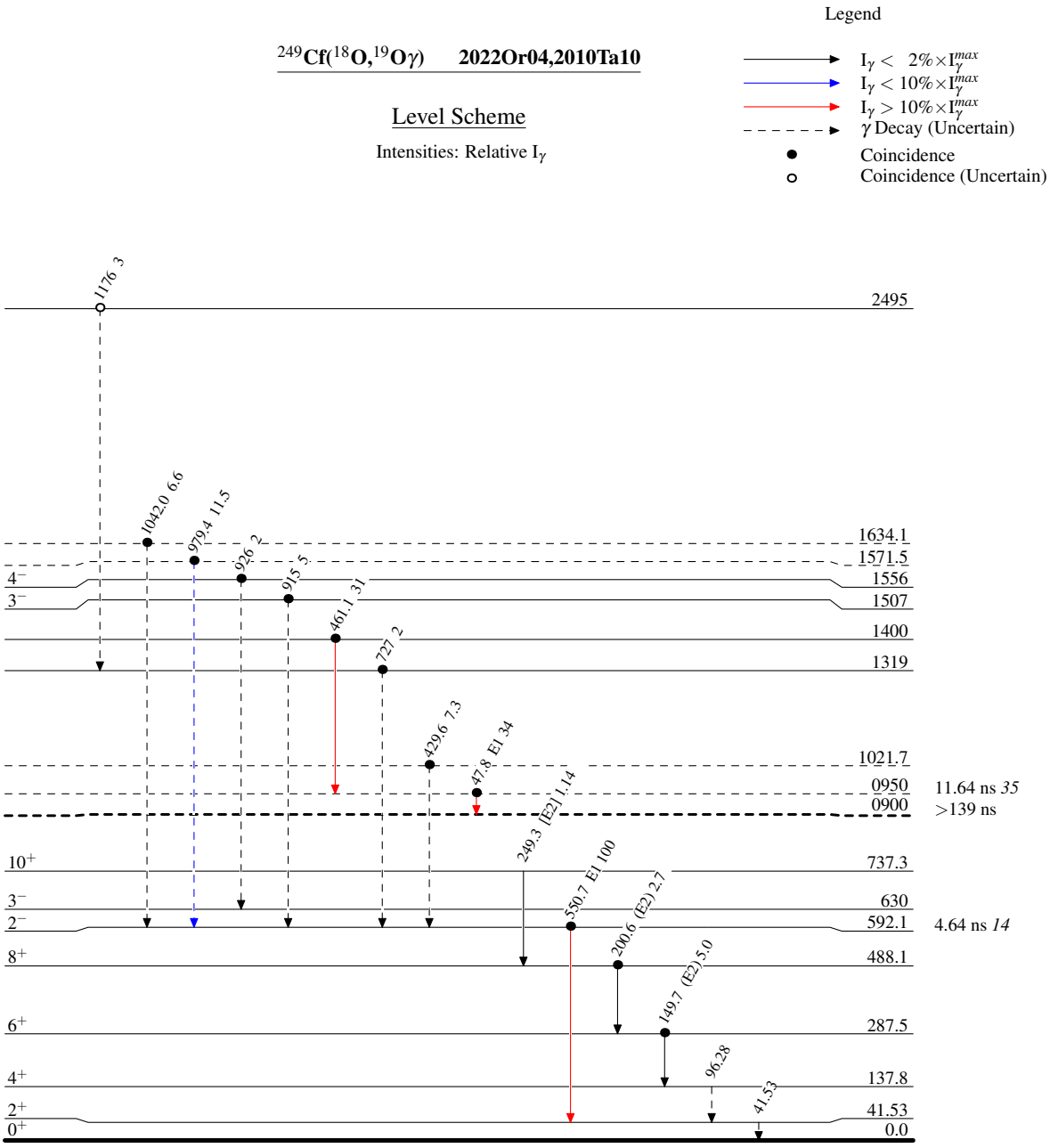
E_γ[†]	I_γ[†]	E_i(level)	E_f	J^π_f	Comments
1042.0[&] *6*	6.6 *9*	1634.1?	592.1	2^-	1042.0γ in prompt coin with 550.6γ.
[x]1131.6 *8*	5 *1*				
[x]1170.9 *6*	6 *1*				
[x]1175[#]					Uncertain γ, in delayed coin with 47.8γ.
1176[&]	3 *1*	2495	1319		1176γ in delayed weak coin with 550.6γ.
[x]1190[#]					1190γ in prompt coin with 550.6γ.
[x]1226[#]					Uncertain assignment to ^{248}Cf. 1226γ in delayed coin with 550.6γ.
[x]1257[#]					1257γ in prompt coin with 550.6γ.
[x]1283[#]					Uncertain assignment to ^{248}Cf. 1283γ in delayed weak coin with 550.6γ.
[x]1355[#]					1355γ in prompt coin with 149.7γ.
[x]1370[#]					1370γ in prompt coin with 891.1γ.
[x]1465[#]					1465γ in prompt coin with 200.6γ.

[†] From 2022Or04 except as noted.
[‡] From the Adopted Gammas.
[#] γ from $\gamma\gamma$-coin data listed in column 4 of Table I of 2022Or04.
[@] Additional information 1.
[&] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

^{249}Cf(^{18}O,^{19}Oγ) **2022Or04,2010Ta10**

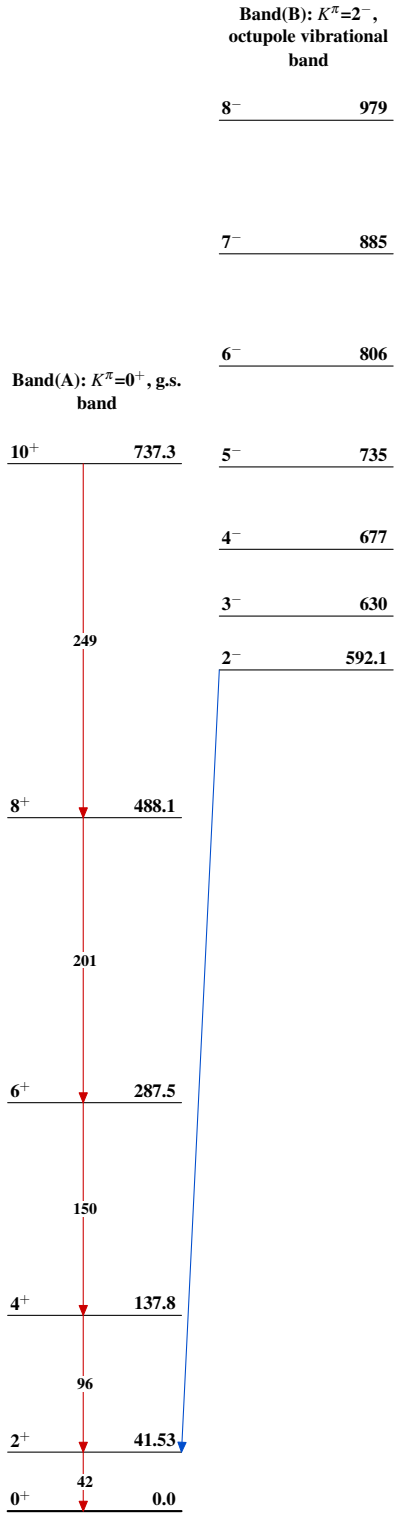
Level Scheme

Intensities: Relative I_γ



$^{248}_{98}Cf_{150}$

$^{249}Cf(^{18}O,^{19}O\gamma)$ 2022Or04,2010Ta10



$^{248}_{98}Cf_{150}$