^{169}Tm(^{40}Ar,4nγ) 2012Ja01

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	F. G. Kondev	NDS 166, 1 (2020)	20-Apr-2020

2012Ja01: E=180 MeV beam delivered by the K-130 cyclotron at JYFL. RITU recoil separator and GREAT spectrometer in conjunction with the alpha-decay tagging technique. JUROGAM array of 43 Compton-suppressed Ge detectors. Measured Eγ, Iγ, $\gamma\gamma$, $\alpha\gamma$ coin, (recoils)γ coin, $\gamma(\theta)$, γ(t) and ce.

Other: 2008Ha39, but the level scheme was not confirmed by 2012Ja01, where it was suggested that the intense γ rays assigned to ^{205}Fr by 2008Ha39 actually belong to ^{206}Fr.

^{205}Fr Levels

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$	Comments
0.0[#]	9/2$^-$	3.90 s *7*	J$^\pi$,$T_{1/2}$: From Adopted Levels. configuration: $\pi(h^{+1}_{9/2})$.
209.0 *10*	7/2$^-$		configuration: $\pi(f^{+1}_{7/2})$.
444.0 *12*	5/2$^-$		configuration: $\pi(h^{+1}_{9/2})\otimes 2^+$.
516.80[#] *20*	13/2$^-$		configuration: $\pi(h^{+1}_{9/2})\otimes 2^+$.
544.0[@] *10*	13/2$^+$	80 ns *20*	$T_{1/2}$: From 2012Ja01 (estimate), based on the feeding intensity of the isomer measured by the JUROGAM array (target position), the number of events detected in the GREAT clover detector (focal plane), and the time-of-flight of the recoiling nuclei between the target position and focal plane. Due to low statistics, the lifetime could not be measured directly. configuration: $\pi(i^{+1}_{13/2})$.
609 *6*	1/2$^+$	1.15 ms *4*	$T_{1/2}$: From implant-ce(t) in 2012Ja01. configuration: $\pi(s^{+1}_{1/2})$.
763 *6*	(5/2$^+$)		
840.0? *14*	(11/2$^-$)		
1020.6[@] *10*	15/2$^+$		
1097.30[#] *23*	17/2$^-$		configuration: $\pi(h^{+1}_{9/2})\otimes 4^+$.
1169.8 *11*			
1176? *6*	(9/2$^+$)		
1197.2[@] *10*	17/2$^+$		
1588.5 *10*	17/2$^+$		configuration: $\pi(h^{+1}_{9/2})\otimes\nu(f^{-1}_{5/2},i^{-1}_{13/2})_{5^-}$ or $\pi(h^{+1}_{9/2})\otimes\nu(p^{-1}_{3/2},i^{-1}_{13/2})_{5^-}$.
1592.8 *3*			
1643.9[@] *10*	19/2$^+$		
1761.90[#] *25*	21/2$^-$		configuration: $\pi(h^{+1}_{9/2})\otimes 6^+$.
1827.8[@] *11*	21/2$^+$		
1873.5 *11*	(19/2$^+$)		
1894.1 *11*	(21/2$^+$)		
2037.2 *3*	23/2$^-$		configuration: $\pi(h^{+2}_{9/2}f^{+1}_{7/2})$.
2039.7 *3*			
2080.5 *3*			
2139.5? *11*	(21/2$^+$)		
2185.4[@] *11*	23/2$^+$		configuration: $\pi(h^{+1}_{9/2})\otimes\nu(f^{-1}_{5/2},i^{-1}_{13/2})_{7^-}$ or $\pi(h^{+1}_{9/2})\otimes\nu(p^{-1}_{3/2},i^{-1}_{13/2})_{7^-}$.
2189.8 *11*	(21/2$^+$)		
2348.3 *11*	27/2$^+$		configuration: $\pi(h^{+1}_{9/2})\otimes\nu(f^{-1}_{5/2},i^{-1}_{13/2})_{9^-}$.
2441.6 *11*	(23/2$^+$)		
2481.1[#] *4*	(25/2$^-$)		configuration: $\pi(h^{+5}_{9/2})$ or $\pi(h^{+3}_{9/2})\otimes 2^+$.
2643.0 *4*	(27/2$^-$)		configuration: $\pi(h^{+4}_{9/2},f^{+1}_{7/2})$ or $\pi(h^{+2}_{9/2},f^{+1}_{7/2})\otimes 2^+$.
2644.3 *11*	(29/2$^+$)		configuration: $\pi(h^{+1}_{9/2})\otimes\nu(f^{-1}_{7/2},i^{-1}_{13/2})$.
2831.1? *11*	(25/2$^+$)		
2922.8 *11*	(27/2$^+$)		

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^{169}Tm(^{40}Ar,4nγ) 2012Ja01 (continued)

^{205}Fr Levels (continued)

E(level)[†]	J$^{\pi}$[‡]
2996.5 *11*	(31/2$^+$)
3081.6 *11*	(33/2$^+$)

[†] From least-squares fit to Eγ.
[‡] From 2012Ja01.
[#] Seq.(A): Based on the $\pi(h^{+1}_{9/2})$ state.
[@] Seq.(B): Based on the $\pi(i^{+1}_{13/2})$ state.

$\gamma(^{205}Fr)$

E$_\gamma$[†]	I$_\gamma$[†]	E$_i$(level)	J$_i^\pi$	E$_f$	J$_f^\pi$	Mult.[‡]	Comments
[x]140.2 *1*	3.8 *6*						
154.3[@] *5*		763	(5/2$^+$)	609	1/2$^+$		
162.9 *1*	9.5 *5*	2348.3	27/2$^+$	2185.4	23/2$^+$	(E2)	Mult.: A$_2$=+0.23 *9*.
(165 *5*)		609	1/2$^+$	444.0	5/2$^-$	[M2]	E$_\gamma$: From the observed summed (K+L+M)ce peak at 169 keV and GEANT4 simulations of the J^π=(1/2$^+$) isomer decay (2012Ja01).
[x]166.8 *2*	3.5 *5*						
[x]170.9 *2*	1.9 *4*						
175.8 *1*	4.2 *4*	1197.2	17/2$^+$	1020.6	15/2$^+$		
183.6 *2*	4.8 *6*	1827.8	21/2$^+$	1643.9	19/2$^+$		
[x]191.2 *3*	3.7 *6*						
[x]194.5 *2*	6.3 *6*						
209 *1*	19 *1*	209.0	7/2$^-$	0.0	9/2$^-$		
235 *1*		444.0	5/2$^-$	209.0	7/2$^-$		
275.3 *1*	5.4 *5*	2037.2	23/2$^-$	1761.90	21/2$^-$	D	Mult.: A$_2$=−0.51 *13*.
285.0 *1*	8.7 *5*	1873.5	(19/2$^+$)	1588.5	17/2$^+$		
296.0 *2*	3.7 *5*	2644.3	(29/2$^+$)	2348.3	27/2$^+$		
305.6 *1*	11 *1*	1894.1	(21/2$^+$)	1588.5	17/2$^+$		
[x]324.9 *2*	3.5 *5*						
[x]343.6 *2*	2.4 *4*						
358.2 *6*	17 *1*	2185.4	23/2$^+$	1827.8	21/2$^+$	(M1)	Mult.: A$_2$=−0.29 *11*.
390.6 *1*	6.4 *5*	1588.5	17/2$^+$	1197.2	17/2$^+$		
[x]411.4 *2*	3.4 *5*						
413.1[@] *5*		1176?	(9/2$^+$)	763	(5/2$^+$)		
[x]417.0 *2*	3.3 *5*						
437.3 *1*	5.1 *5*	3081.6	(33/2$^+$)	2644.3	(29/2$^+$)	(Q)	Mult.: A$_2$=+0.43 *17*.
444 *2*		444.0	5/2$^-$	0.0	9/2$^-$		
446.6 *1*	24 *1*	1643.9	19/2$^+$	1197.2	17/2$^+$		
[x]472.4 *2*	4.1 *6*						
476.6 *2*	72 *2*	1020.6	15/2$^+$	544.0	13/2$^+$	(M1)	Mult.: A$_2$=−0.17 *4*.
481.2 *2*	5.6 *6*	2922.8	(27/2$^+$)	2441.6	(23/2$^+$)		
516.8 *2*	100 *2*	516.80	13/2$^-$	0.0	9/2$^-$	(E2)	Mult.: A$_2$=+0.25 *1*.
[x]532.4 *2*	6.0 *8*						
541.4 *2*	6.8 *10*	2185.4	23/2$^+$	1643.9	19/2$^+$	(E2)	Mult.: A$_2$=+0.6 *3*.
544 *1*		544.0	13/2$^+$	0.0	9/2$^-$	(M2)	Mult.: α(K)exp=0.25 *10* (2012Ja01).
547.5 *1*	13 *2*	2441.6	(23/2$^+$)	1894.1	(21/2$^+$)	D	Mult.: A$_2$=−0.48 *4*.
550.6[@] *3*	5.4 *9*	2139.5?	(21/2$^+$)	1588.5	17/2$^+$		
568.5 *1*	45 *2*	1588.5	17/2$^+$	1020.6	15/2$^+$	D	Mult.: A$_2$=−0.28 *16*.
580.5 *1*	56 *2*	1097.30	17/2$^-$	516.80	13/2$^-$	(E2)	Mult.: A$_2$=0.28 *4*.
601.3 *1*	21 *2*	2189.8	(21/2$^+$)	1588.5	17/2$^+$		

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^{169}Tm(^{40}Ar,4nγ) 2012Ja01 (continued)

$\gamma(^{205}Fr)$ (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.‡	Comments
605.8 *3*	5.6 *11*	2643.0	$(27/2^-)$	2037.2	$23/2^-$		
623.5 *2*	8.8 *9*	1643.9	$19/2^+$	1020.6	$15/2^+$		
630.9# *2*	48 *2*	1827.8	$21/2^+$	1197.2	$17/2^+$	(E2)	Mult.: A_2=+0.24 *3*.
631# *1*		840.0?	$(11/2^-)$	209.0	$7/2^-$		
640.9@ *2*	5.8 *9*	2831.1?	$(25/2^+)$	2189.8	$(21/2^+)$		
648.2 *2*	7.3 *9*	2996.5	$(31/2^+)$	2348.3	$27/2^+$		
653# *1*		1169.8		516.80	$13/2^-$		
653.2# *1*	63 *2*	1197.2	$17/2^+$	544.0	$13/2^+$	(E2)	Mult.: A_2=+0.21 *5*.
664.6 *1*	24 *1*	1761.90	$21/2^-$	1097.30	$17/2^-$	(E2)	Mult.: A_2=+0.29 *7*.
x675.7 *5*	3.5 *10*						
x688.4 *5*	3.5 *8*						
x697.2 *4*	5.2 *11*						
x701.4 *3*	4.9 *11*						
x707.6 *3*	5.5 *10*						
x714.2 *4*	3.8 *8*						
719.2 *2*	6.5 *8*	2481.1	$(25/2^-)$	1761.90	$21/2^-$		
x774.6 *2*	3.7 *6*						
x840.8 *3*	7 *4*						
x848.3 *6*	7.0 *15*						
x857.6 *8*	4.0 *15*						
x890.3 *3*	3.7 *7*						
x919.1 *2*	5.5 *7*						
942.4 *2*	5.5 *7*	2039.7		1097.30	$17/2^-$		
983.2 *2*	7.1 *7*	2080.5		1097.30	$17/2^-$	Q	Mult.: A_2=+0.25 *1*.
x997.7 *3*	4.5 *7*						
x1020.0 *4*	3.0 *7*						
1076.0 *2*	6.5 *8*	1592.8		516.80	$13/2^-$		

† From 2012Ja01.
‡ From the α(K)exp and angular distribution data (A_4=0) (2012Ja01).
# Doublet.
@ Placement of transition in the level scheme is uncertain.
x γ ray not placed in level scheme.

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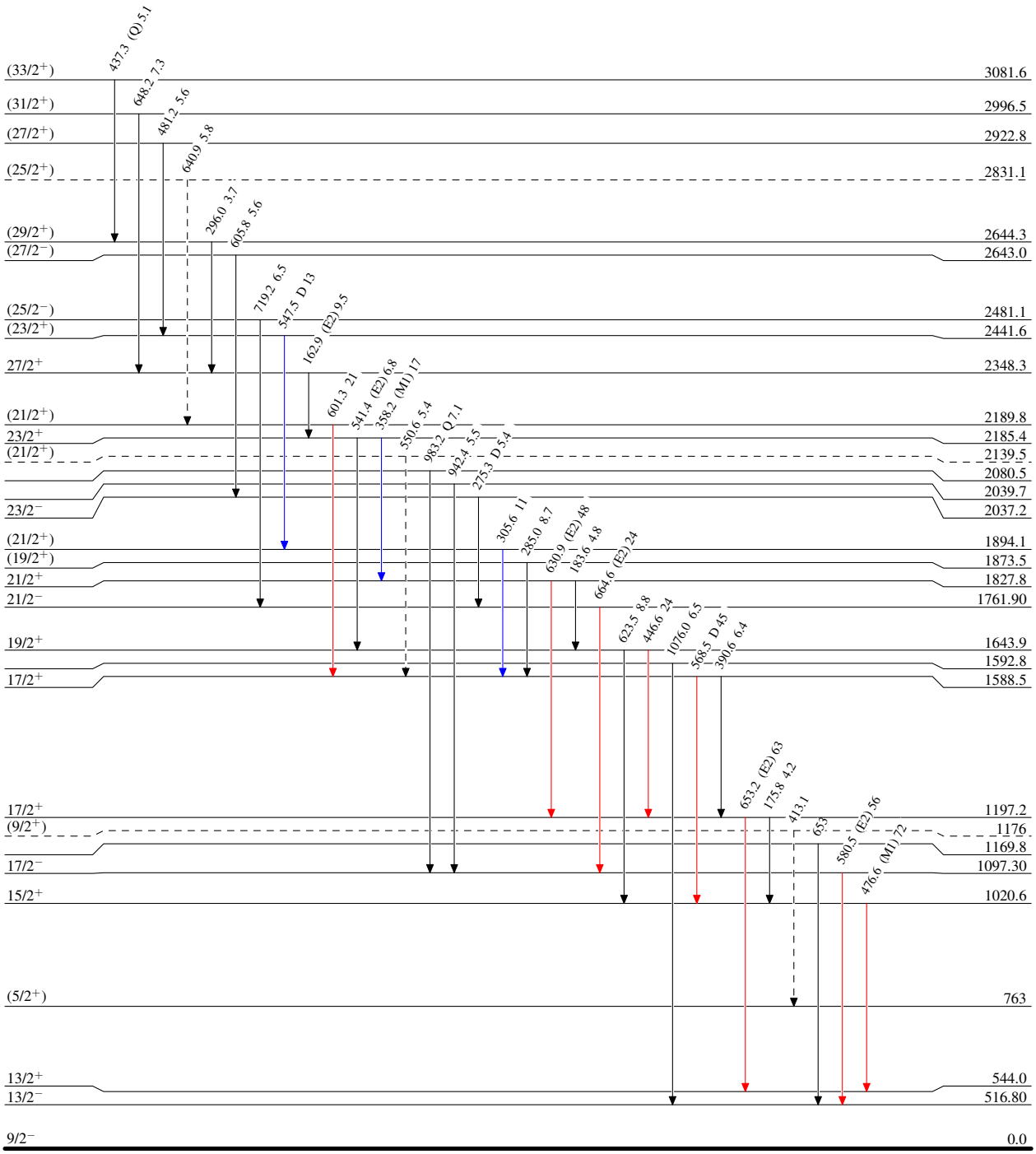
Level Scheme

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)



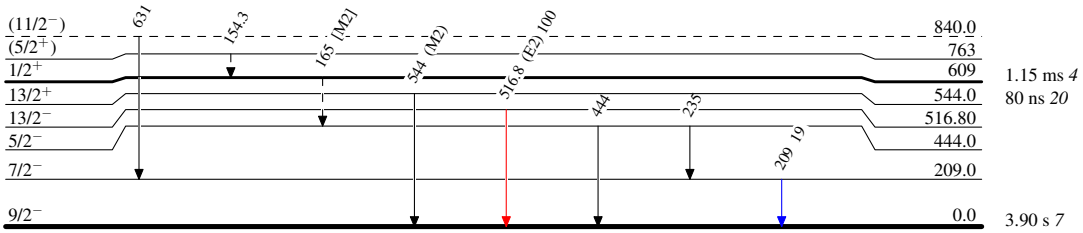
$^{205}_{87}Fr_{118}$

^{169}Tm(^{40}Ar,4nγ) 2012Ja01

Level Scheme (continued)

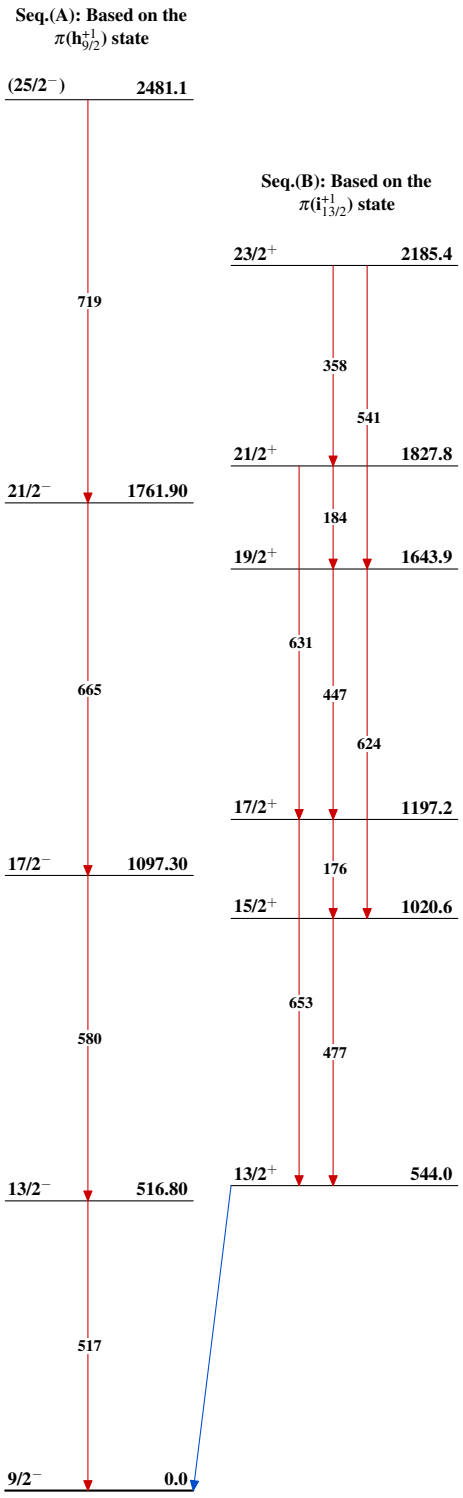
Intensities: Relative I_γ

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



$^{205}_{87}Fr_{118}$

^{169}Tm(^{40}Ar,4nγ) 2012Ja01



$^{205}_{87}Fr_{118}$