

^{252}Cf SF decay [2013HwZZ,2012Hw05,2017Ur03](#)

Type	Author	History	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen, Balraj Singh		NDS 164, 1 (2020)	15-Feb-2020

Parent: ^{252}Cf : $E=0$; $J^\pi=0^+$; $T_{1/2}=2.645$ y 8; %SF decay=3.092 8

^{252}Cf - $T_{1/2}$: From ^{252}Cf Adopted Levels in the ENSDF database.

^{252}Cf -%SF decay: %SF=3.092 8 for ^{252}Cf decay from ^{252}Cf Adopted Levels in the ENSDF database.

[2013HwZZ](#), [2012Hw05](#): measured γ -ray spectra, $\gamma\gamma$ -coin using Gammasphere array with 101 Compton-suppressed Ge detectors.

Deduced levels, J, π , one-phonon octupole vibrational (1-POV) and two-phonon octupole vibrational (2-POV) bands.

[2013HwZZ](#): priv. comm. from J.K. Hwang, June 17, 2013.

[2017Ur03](#): measured $\gamma\gamma(\theta)$ for six cascades involving five levels using Gammasphere array at Argonne National Laboratory.

Information about E_γ and I_γ data is not available.

Additional information 1.

[1995Ha20](#) (also [1995HaZT](#), [1995HaZZ](#)): earlier paper from the same group as [2012Hw05](#), but probably a separate experiment.

[2001AhZY](#): Measured g factor of first 2^+ state using integral PAC method.

[1970ChZH](#), [1970ChYJ](#): measured (fission fragment)(γ ,x ray) coin.

Other: [1990DuZW](#).

All data are from [2013HwZZ](#) unless otherwise stated.

 ^{98}Zr Levels

In the level scheme, [2013HwZZ](#) include 6539.8, 16^+ ; 6604.3, (16^+); and 7596.8, 18^+ levels together with respective gamma rays of 949.6, 63.0 and 1057.0, but these gamma rays are not obtained in ^{252}Cf SF decay study. Thus these three levels are omitted here.

E(level) [†]	J^π [†]	$T_{1/2}$	Comments
0.0	0^+		
852.9 3	0^+		
1222.5	2^+	<0.20 ns	$T_{1/2}$: from 2001AhZY . g-factor>+0.19 9 (preliminary result from 2001AhZY).
1436.1 @ 3	0^+		
1590.5 @ 3	2^+		
1743.8 3	2^+		
1805.5 & 3	3^-		
1842.8 @ 3	4^+		
2047.0 3	4^+		
2276.8 3	4^+		
2489.6 @ 3	6^+		
2799.6 & 3	(5^-)		
3064.3 3	(5^-)		
3117.0 3	6^+		
3216.4 @ 3	8^+		
3336.4 3			
3576.4 a 3	(6^+) [#]		
3591.4 & 3	(7^-)		
3811.8 3	8^+		
3894.1 3			
3985.6 @ 3	10^+		
4165.18 ‡ 6	1^-		
4198.8 a 3	(8^+) [#]		
4290.3 3	6^+		J^π : from $\gamma\gamma(\theta)$ and $\gamma(\text{pol})$ (2017Ur03).
4544.3 3			

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^{252}Cf SF decay [2013HwZZ](#),[2012Hw05](#),[2017Ur03](#) (continued) ^{98}Zr Levels (continued)

<u>E(level)[†]</u>	<u>J^π[†]</u>
4755.6@ 3	12 ⁺
4916.2 ^a 3	(10 ⁺) [#]
5589.4@ 3	14 ⁺
5720.8 ^a 3	(12 ⁺) [#]
6541.3 ^a 3	(14 ⁺) [#]

[†] From [2013HwZZ](#).[‡] Population of this level implied from $\gamma\gamma(\theta)$ study by [2017Ur03](#) in ^{252}Cf SF decay.[#] Note that [2006Si36](#) assign spin higher by one unit and negative parity.@ Seq.(B): γ cascade based on 0⁺, 1436.& Seq.(C): γ cascade based on 3⁻.^a Band(A): Two-phonon octupole band. In [2006Si36](#), and also in the Adopted Levels, this band is assigned negative parity with spin one unit higher than in [2013HwZZ](#). $\gamma(^{98}\text{Zr})$

<u>E_γ[†]</u>	<u>I_γ[†]</u>	<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.</u>	<u>Comments</u>
204.2	2	2047.0	4 ⁺	1842.8	4 ⁺		
213.6	<7	1436.1	0 ⁺	1222.5	2 ⁺		
215.0	3	1805.5	3 ⁻	1590.5	2 ⁺		
241.5	3	2047.0	4 ⁺	1805.5	3 ⁻		
252.7	3	1842.8	4 ⁺	1590.5	2 ⁺		
254.0	0.2	4544.3		4290.3	6 ⁺		
369.6	2.7	1222.5	2 ⁺	852.9	0 ⁺		
456.5	2	2047.0	4 ⁺	1590.5	2 ⁺		
512.1	1.4	3576.4	(6 ⁺)	3064.3	(5 ⁻)		
521.3	1.7	1743.8	2 ⁺	1222.5	2 ⁺		
583.0	22	1805.5	3 ⁻	1222.5	2 ⁺	(E1)	Mult.: from $\gamma\gamma(\theta)$ (2017Ur03). $\delta(Q/D)=0.00$ 2 from (583.2 γ)(1222.9 γ)(θ): $A_2=-0.069$ 2, $A_4=-0.015$ 18 for J(1806)=3. $\delta=-0.16$ 1 for J(1806)=1, and no solution for δ for J(1806)=2 (2017Ur03).
620.3	63	1842.8	4 ⁺	1222.5	2 ⁺		(620.5 γ)(1222.9 γ)(θ): $A_2=+0.095$ 7, $A_4=-0.006$ 11, consistent with 4 $\rightarrow$ 2 $\rightarrow$ 0 sequence (2017Ur03).
622.4	1.7	4198.8	(8 ⁺)	3576.4	(6 ⁺)		
646.8	38	2489.6	6 ⁺	1842.8	4 ⁺		
677.7	2.5	3894.1		3216.4	8 ⁺		
686.3	1.4	2276.8	4 ⁺	1590.5	2 ⁺		
694.8	0.5	3811.8	8 ⁺	3117.0	6 ⁺		
698.6	0.4	4290.3	6 ⁺	3591.4	(7 ⁻)		
717.4	0.6	4916.2	(10 ⁺)	4198.8	(8 ⁺)		
725.7	13	3216.4	8 ⁺	2489.6	6 ⁺		(725.3 γ)(1222.9 γ)(θ): $A_2=+0.089$ 13, $A_4=0.00$ 2 (2017Ur03) consistent with 8 $\rightarrow$ 6 $\rightarrow$ 4 sequence (2017Ur03).
752.6	8	2799.6	(5 ⁻)	2047.0	4 ⁺		
769.2	8	3985.6	10 ⁺	3216.4	8 ⁺		
770.0	5	4755.6	12 ⁺	3985.6	10 ⁺		
776.8	3	3576.4	(6 ⁺)	2799.6	(5 ⁻)		
791.8	2	3591.4	(7 ⁻)	2799.6	(5 ⁻)		
804.6	0.3	5720.8	(12 ⁺)	4916.2	(10 ⁺)		
820.5	0.3	6541.3	(14 ⁺)	5720.8	(12 ⁺)		
824.5	4	2047.0	4 ⁺	1222.5	2 ⁺		

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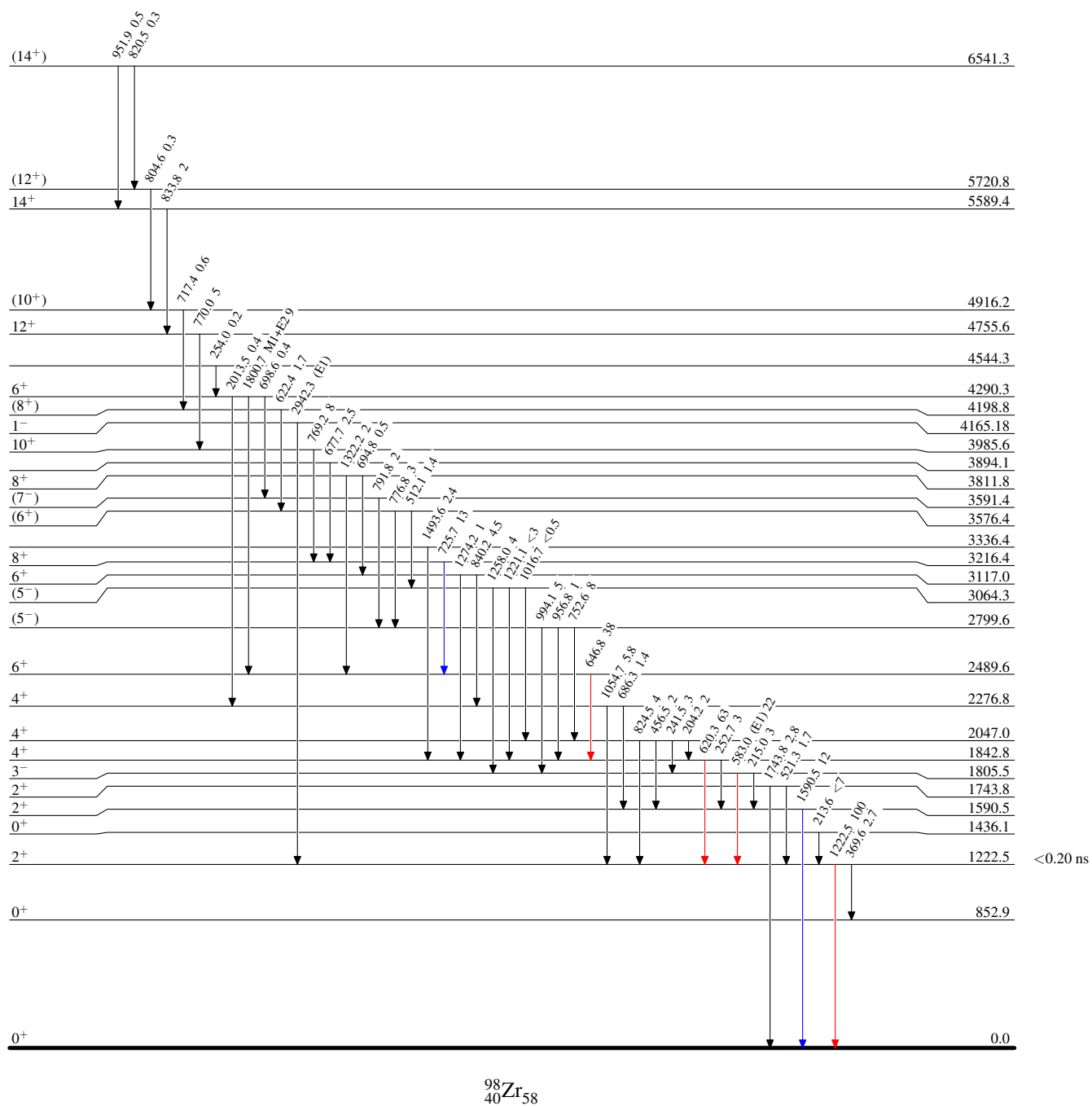
^{252}Cf SF decay [2013HwZZ,2012Hw05,2017Ur03](#) (continued) $\gamma(^{98}\text{Zr})$ (continued)

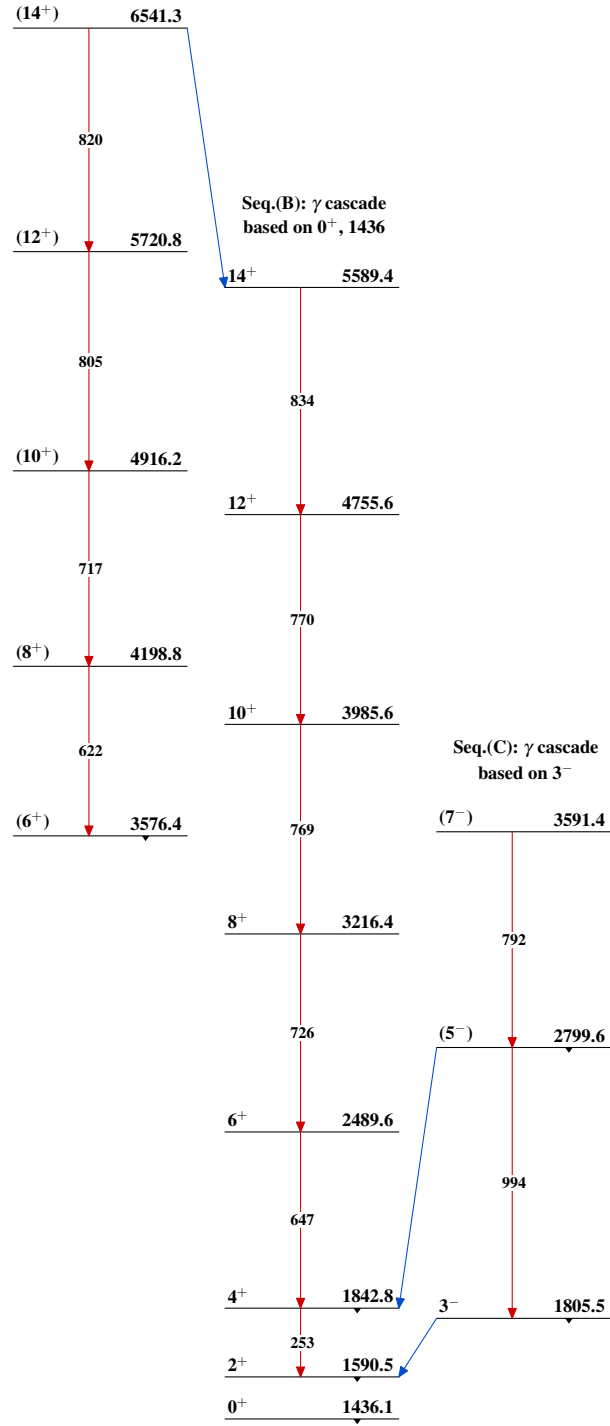
E_γ [†]	I_γ [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	δ	Comments
833.8	2	5589.4	14^+	4755.6	12^+			Additional information 2.
840.2	4.5	3117.0	6^+	2276.8	4^+			
951.9	0.5	6541.3	(14^+)	5589.4	14^+			
956.8	1	2799.6	(5^-)	1842.8	4^+			
994.1	5	2799.6	(5^-)	1805.5	3^-			
1016.7	<0.5	3064.3	(5^-)	2047.0	4^+			
1054.7	5.8	2276.8	4^+	1222.5	2^+			
1221.1	<3	3064.3	(5^-)	1842.8	4^+			
1222.5	100	1222.5	2^+	0.0	0^+			
1258.0	4	3064.3	(5^-)	1805.5	3^-			
1274.2	1	3117.0	6^+	1842.8	4^+			
1322.2	2	3811.8	8^+	2489.6	6^+			
1493.6	2.4	3336.4		1842.8	4^+			
1590.5	12	1590.5	2^+	0.0	0^+			
1743.8	2.8	1743.8	2^+	0.0	0^+			
1800.7	9	4290.3	6^+	2489.6	6^+	M1+E2	+0.17 8	Mult., δ : from $\gamma\gamma(\theta)$ and linear polarization data in 2017Ur03 . Preferred $\delta(\text{E2/M1})$ value in 2017Ur03 from three possible values for $J(4292)=6$: -0.77 12, $+0.17$ 8 or -0.80 14. Polarization data is from $^{235}\text{U}(\text{n},\text{F}\gamma)$ experiment. $\delta(\text{E2/M1})=-0.80$ 14 or $+0.17$ 8 (2017Ur03) from $(1801.6\gamma)(1222.9\gamma+620.5\gamma+647.1\gamma)(\theta)$: $A_2=+0.14$ 2, $A_4=-0.04$ 3 for $J(4292)=6$. $\delta(\text{Q/D})=+0.38$ 6 or $+2.3$ 3 for $J(4292)=7$.
2013.5	0.4	4290.3	6^+	2276.8	4^+			
2942.3 1		4165.18	1^-	1222.5	2^+	(E1)		Mult.: from $\gamma\gamma(\theta)$ (2017Ur03); $\delta(\text{Q/D})=0.00$ 3 from $(2942.3\gamma)(1222.9\gamma)(\theta)$: $A_2=-0.25$ 3, $A_4=+0.02$ 4 for $J(4165)=1$. No solution for δ for $J(4165)=0$ or 2.

[†] From [2013HwZZ](#). Note that 62.0-, 63.5-, 949.6-, 1057.0-keV γ rays shown in figure 14 of [2012Hw05](#) are not observed in SF decay of ^{252}Cf according to e-mail reply in [2013HwZZ](#), thus omitted here.

^{252}Cf SF decay 2013HwZZ,2012Hw05,2017Ur03**Level Scheme**Intensities: Relative I_γ **Legend**

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



^{252}Cf SF decay 2013HwZZ,2012Hw05,2017Ur03Band(A): Two-phonon
octupole band $^{98}_{40}\text{Zr}_{58}$