## $^{248}$Cm,$^{252}$Cf SF decay 2017Ur03

History

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

Parent: $^{248}$Cm: E=0; $J^\pi=0^+$; $T_{1/2}=3.48\times10^5$ y *6*; %SF decay=8.39 *16*

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

$^{248}$Cm(0)-%SF decay: %SF=8.39 *16* for $^{248}$Cm SF decay.

$^{252}$Cf(0)-%SF decay: %SF=3.092 *8* for $^{252}$Cf SF decay.

Includes study of prompt $\gamma$ rays from $^{252}$Cf SF decay.

2017Ur03: measured E$\gamma$, I$\gamma$, $\gamma\gamma$-coin, $\gamma\gamma(\theta)$, half-lives of isomers by $\gamma\gamma$(t) using Eurogam2 array at Institut Laue-Langevin (ILL), Grenoble for prompt $\gamma$ rays from $^{248}$Cm SF decay, and Gammasphere array at Argonne National Laboratory (ANL) for $\gamma$ rays from $^{252}$Cf SF decay. Combined decay scheme is presented by the authors from both the decays.

1998Hw08: $^{252}$Cf SF decay, measured E$\gamma$, $\gamma\gamma$-coin using Gammasphere array of 72 HPGe detectors.

Others: 1972Ho08, 1972ClZN.

All data are from 2017Ur03. The results from 1998Hw08 are in agreement in E$\gamma$ values and overall level scheme, but much less extensive than in 2017Ur03. Also the spin assignments are lower by two units in 1998Hw08 for levels above 450 keV.

### $^{98}$Y Levels

| E(level)[†] | $J^\pi$[‡] | $T_{1/2}$ | Comments |
|---|---|---|---|
| 0.0 | $0^-$ | | |
| 119.3 *2* | $1^-$ | | |
| 170.78 *14* | $2^-$ | 0.64[#] $\mu$s *2* | |
| 375.0 *2* | $4^-$ | 35.0 ns *5* | $T_{1/2}$: from $\gamma\gamma$(t) (2017Ur03). |
| 446.2 *2* | $3^+$ | | |
| 496.1[@] *2* | $4^-$ | 6.95[#] $\mu$s *6* | $J^\pi$: ($2^-$) in 1998Hw08. |
| 547.9 *3* | $1^+$ | | |
| 564.0 *2* | ($1^-$,2) | | |
| 564.0+x[&] | ($3^-$,$4^-$) | 180 ns *7* | Additional information 1.<br>$T_{1/2}$: from decay curve for prompt lines above the 564+x level gated at 444.7-keV line below the isomer in $^{252}$Cf SF data (2017Ur03). Other: 160 ns *40* from $^{248}$Cm SF data.<br>Interpreted by 2017Ur03 as deformed state with a band built on it as shown in authors' level-scheme Fig. 2. |
| 596.7[@] *2* | $5^-$ | | $J^\pi$: ($3^-$) in 1998Hw08. |
| 600.2 *3* | $1^+$ | | |
| 603.6 *2* | ($5^-$,$6^-$) | | |
| 615.2 *2* | (2,3) | | |
| 658.3 *2* | ($6^-$,$7^-$) | | |
| 665.1+x[&] *1* | | | |
| 666.3 *2* | ($1^-$,2) | | |
| 726.4[@] *2* | $6^-$ | | $J^\pi$: ($4^-$) in 1998Hw08. |
| 798.8+x[&] *2* | | | |
| 869.5 *3* | ($6^-$) | | |
| 884.4[@] *2* | $7^-$ | | $J^\pi$: ($5^-$) in 1998Hw08. |
| 964.3+x[&] *2* | | | |
| 972.2 *3* | ($8^+$) | 0.45[#] $\mu$s *15* | |
| 1053.1 *3* | ($6^-$,$7^-$) | | |
| 1070.7[@] *2* | $8^-$ | | $J^\pi$: ($6^-$) in 1998Hw08. |
| 1163.3+x[&] *2* | | | |
| 1181.4[a] *3* | $10^-$ | 0.72[#] $\mu$s *2* | $J^\pi$: ($8^-$) in 1998Hw08. |
| 1291.7[@] *2* | $9^-$ | | $J^\pi$: ($7^-$) in 1998Hw08. |

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## $^{248}$Cm,$^{252}$Cf SF decay 2017Ur03 (continued)

### $^{98}$Y Levels (continued)

| E(level)† | Jπ‡ | Comments |
|---|---|---|
| 1386.9+x& 2 | | |
| 1532.6@ 2 | 10⁻ | Jπ: (8⁻) in 1998Hw08. |
| 1631.6+x& 3 | | |
| 1679.2 4 | | |
| 1842.9@ 3 | 11⁻ | |
| 1896.9+x& 4 | | |
| 1945.0 5 | | |
| 2100.6@ 3 | 12⁻ | |
| 2178.1+x& 5 | | |
| 2366.0a 4 | | |
| 3165.0a 5 | | |

† From a least-squares fit to Eγ data.
‡ As given in 2017Ur03, based on previous assignment and γγ(θ) data and band assignments in the present work.
# From $^{235}$U(n,Fγ):delayed γ (2017Ur03).
@ Band(A): πg$_{9/2}$⊗νh$_{11/2}$, deformed.
& Band(B): πg$_{9/2}$⊗νh$_{11/2}$, deformed.
a Band(C): πg$_{9/2}$⊗νh$_{11/2}$, spherical. Intensity of this band is about 1/3 of that of the band based on 496.1 level. This band is confirmed in $^{252}$Cf SF data.

### γ($^{98}$Y)

γγ(θ) data and associated A$_2$, A$_4$ coefficients are from $^{252}$Cf SF decay study using Gammasphere array.

| Eγ | Iγ† | Ei(level) | Jiπ | Ef | Jfπ | Mult. | δ | Comments |
|---|---|---|---|---|---|---|---|---|
| x | | 564.0+x | (3⁻,4⁻) | 564.0 | (1⁻,2) | | | 2017Ur03 discuss a 26.3-keV γ line seen in the decay of $^{98}$Sr in connection with the decay of the 564.0+x level, but did not conclude anything due to spin mismatches. |
| 36.2 | | 600.2 | 1⁺ | 564.0 | (1⁻,2) | | | |
| 49.9 | | 496.1 | 4⁻ | 446.2 | 3⁺ | | | |
| 51.1 | | 666.3 | (1⁻,2) | 615.2 | (2,3) | | | |
| 51.5 | | 170.78 | 2⁻ | 119.3 | 1⁻ | | | |
| 54.7 1 | 53 12 | 658.3 | (6⁻,7⁻) | 603.6 | (5⁻,6⁻) | M1+E2 | 0.25 +5−6 | α(exp)=1.5 2 (2017Ur03)<br>α(exp): from γ-intensity balance.<br>Mult.: from α(total)exp.<br>δ: deduced by evaluators from α(total)exp. |
| 71.3 | | 446.2 | 3⁺ | 375.0 | 4⁻ | | | |
| 100.6 1 | 210 9 | 596.7 | 5⁻ | 496.1 | 4⁻ | | | Eγ=101.0 (1998Hw08). |
| 101.1 1 | 56 8 | 665.1+x | | 564.0+x | (3⁻,4⁻) | | | |
| 102.3 | | 666.3 | (1⁻,2) | 564.0 | (1⁻,2) | | | |
| 110.8 | | 1181.4 | 10⁻ | 1070.7 | 8⁻ | | | Eγ=111.1 (1998Hw08). |
| 119.3 | | 119.3 | 1⁻ | 0.0 | 0⁻ | | | Eγ=119.4 (1998Hw08).<br>δ(Q/D)=0.0 2 from (428.6γ)(119.4γ)(θ): A$_2$=−0.16 2, A$_4$=+0.07 3. |
| 121.1 | | 496.1 | 4⁻ | 375.0 | 4⁻ | M1+E2 | −0.8 2 | δ: from (121.1γ)(204.3γ)(θ): A$_2$=+0.22 2, A$_4$=+0.09 4. |

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## $^{248}$Cm,$^{252}$Cf SF decay 2017Ur03 (continued)

### $\gamma(^{98}Y)$ (continued)

| $E_\gamma$ | $I_\gamma$[†] | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Comments |
|---|---|---|---|---|---|---|
| | | | | | | Mult.: large mixing ratio suggests mult=M1+E2 in contrast to E1+M2. |
| | | | | | | Eγ=121.0 (1998Hw08). |
| 129.7 *1* | 190 *8* | 726.4 | $6^-$ | 596.7 | $5^-$ | Eγ=130.0 (1998Hw08). |
| 133.7 *1* | 58 *5* | 798.8+x | | 665.1+x | | |
| 158.0 *1* | 125 *8* | 884.4 | $7^-$ | 726.4 | $6^-$ | Eγ=158.3 (1998Hw08). |
| 165.5 *1* | 48 *5* | 964.3+x | | 798.8+x | | |
| 170.8 | | 170.78 | $2^-$ | 0.0 | $0^-$ | Eγ=170.9 (1998Hw08). |
| 186.2 *1* | 98 *6* | 1070.7 | $8^-$ | 884.4 | $7^-$ | Eγ=186.5 (1998Hw08). |
| 199.0 *1* | 25 *4* | 1163.3+x | | 964.3+x | | |
| 204.3 *1* | 114 *7* | 375.0 | $4^-$ | 170.78 | $2^-$ | Eγ=203.9 (1998Hw08). |
| 221.0 *1* | 55 *5* | 1291.7 | $9^-$ | 1070.7 | $8^-$ | Eγ=221.4 (1998Hw08). |
| 223.5 *2* | 22 *3* | 1386.9+x | | 1163.3+x | | |
| 228.6 *1* | 101 *6* | 603.6 | $(5^-,6^-)$ | 375.0 | $4^-$ | Eγ=229.0 (1998Hw08). δ(Q/D)=+0.31 *5* or +2.5 *3* for J(603)=5. δ(O/Q)=0.0 for J(603)=6 from (228.6γ)(204.3γ)(θ): $A_2$=+0.11 *2*, $A_4$=−0.01 *4*. |
| 230.4 *1* | 8 *2* | 726.4 | $6^-$ | 496.1 | $4^-$ | Eγ=231.0 (1998Hw08). |
| 240.2 | | 615.2 | (2,3) | 375.0 | $4^-$ | |
| 240.9 *1* | 47 *4* | 1532.6 | $10^-$ | 1291.7 | $9^-$ | Eγ=241.1 (1998Hw08). |
| 244.7 *2* | 12 *2* | 1631.6+x | | 1386.9+x | | |
| 257.7 *2* | 10 *2* | 2100.6 | $12^-$ | 1842.9 | $11^-$ | |
| 265.3 *2* | 8 *2* | 1896.9+x | | 1631.6+x | | |
| 265.9 *2* | 18 *4* | 869.5 | $(6^-)$ | 603.6 | $(5^-,6^-)$ | Eγ=266.0 (1998Hw08). |
| 275.2 | | 446.2 | $3^+$ | 170.78 | $2^-$ | |
| 281.2 *3* | 6 *2* | 2178.1+x | | 1896.9+x | | |
| 287.8 *1* | 25 *4* | 884.4 | $7^-$ | 596.7 | $5^-$ | Eγ=288.3 (1998Hw08). |
| 299[‡] | | 964.3+x | | 665.1+x | | |
| 310.3 *2* | 16 *3* | 1842.9 | $11^-$ | 1532.6 | $10^-$ | |
| 313.9 *1* | 60 *5* | 972.2 | $(8^+)$ | 658.3 | $(6^-,7^-)$ | Eγ=314.0 placed from a 917.8 level(1998Hw08). |
| 325.2 | | 496.1 | $4^-$ | 170.78 | $2^-$ | |
| 344.2 *1* | 24 *4* | 1070.7 | $8^-$ | 726.4 | $6^-$ | Eγ=344.8 (1998Hw08). |
| 364[‡] | | 1163.3+x | | 798.8+x | | |
| 393.3 | | 564.0 | $(1^-,2)$ | 170.78 | $2^-$ | |
| 407.3 *1* | 34 *3* | 1291.7 | $9^-$ | 884.4 | $7^-$ | Eγ=407.9 (1998Hw08). |
| 422.6 *2* | 5 *2* | 1386.9+x | | 964.3+x | | |
| 428.6 | | 547.9 | $1^+$ | 119.3 | $1^-$ | |
| 444.7 | | 564.0 | $(1^-,2)$ | 119.3 | $1^-$ | δ(Q/D)=−0.04 *6* for J(564)=1, +0.2 *2* for J(564)=2 from (36.2γ)(444.7γ)(θ): $A_2$=+0.09 *5*, $A_4$=−0.15 *9*. δ(Q/D)=+0.04 *2* for J(564)=1, +0.4 *2* for J(564)=2 from (444.7γ)(119.3γ)(θ): $A_2$=−0.19 *2*, $A_4$=−0.02 *3*. |
| 449.5 *2* | 12 *2* | 1053.1 | $(6^-,7^-)$ | 603.6 | $(5^-,6^-)$ | |
| 462.0 *1* | 25 *3* | 1532.6 | $10^-$ | 1070.7 | $8^-$ | Eγ=462.5 (1998Hw08). |
| 551.1 *2* | 18 *3* | 1842.9 | $11^-$ | 1291.7 | $9^-$ | |
| 564.0 | | 564.0 | $(1^-,2)$ | 0.0 | $0^-$ | |
| 568.0 *2* | 15 *3* | 2100.6 | $12^-$ | 1532.6 | $10^-$ | |
| 707.0 *3* | | 1679.2 | | 972.2 | $(8^+)$ | $I_\gamma$: 3 *1* relative to 100 for 313.9γ in $^{252}$Cf SF decay. |
| 763.6 *3* | | 1945.0 | | 1181.4 | $10^-$ | $I_\gamma$: 7 *2* relative to 100 for 110.8γ in $^{252}$Cf SF decay. |
| 799.0 *3* | | 3165.0 | | 2366.0 | | $I_\gamma$: 2 *1* relative to 100 for 110.8γ in $^{252}$Cf SF decay. |
| 1184.5 *2* | | 2366.0 | | 1181.4 | $10^-$ | $I_\gamma$: 5 *2* relative to 100 for 110.8γ in $^{252}$Cf SF decay. |

[†] From SF decay of $^{248}$Cm, obtained from γ spectrum with gates on prompt 167.4- and 211.9-keV γ rays from complementary fission fragment $^{147}$La.

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

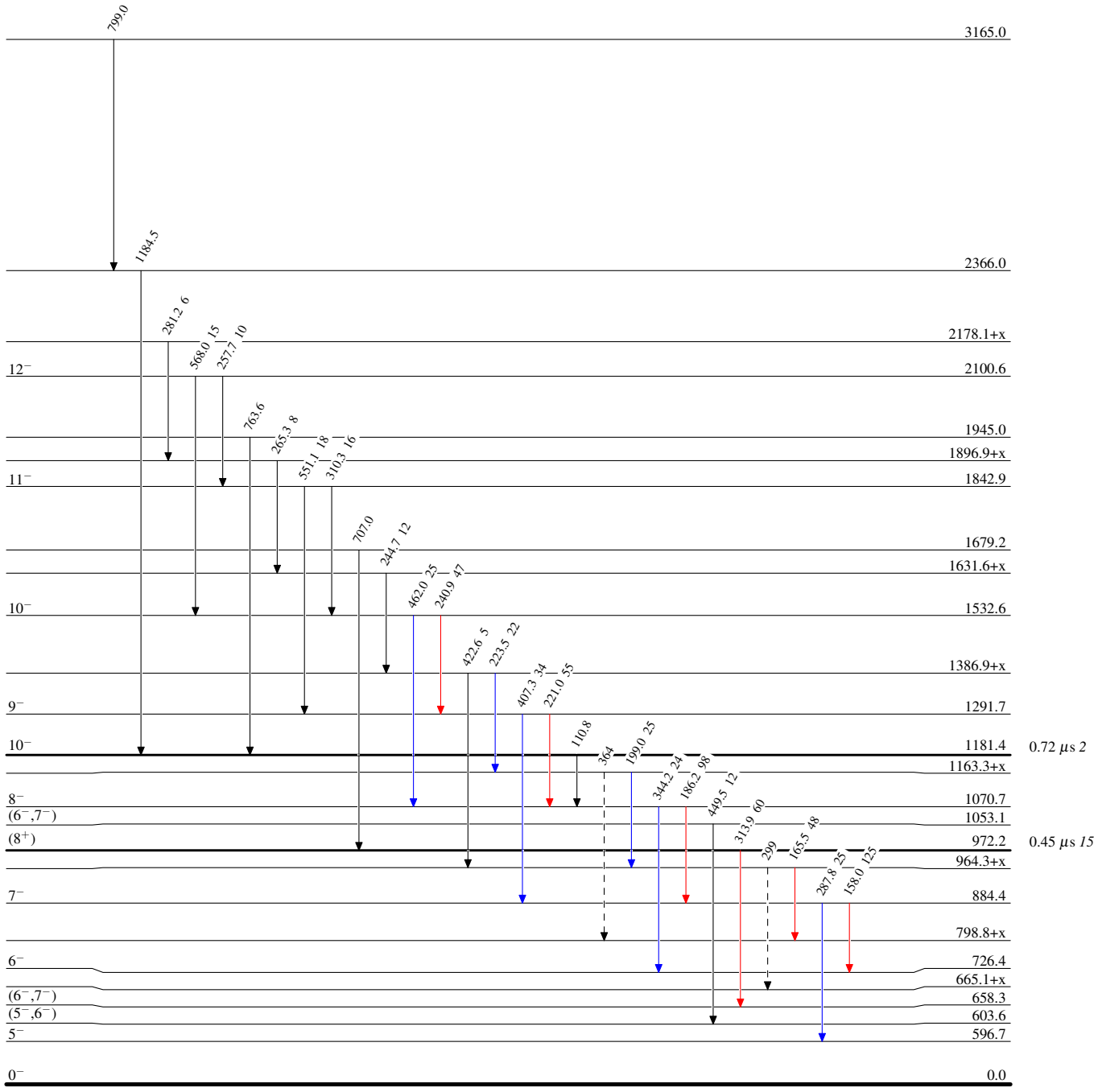
## $^{248}$Cm,$^{252}$Cf SF decay 2017Ur03

Level Scheme

Intensities: Relative $I_\gamma$

Legend

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

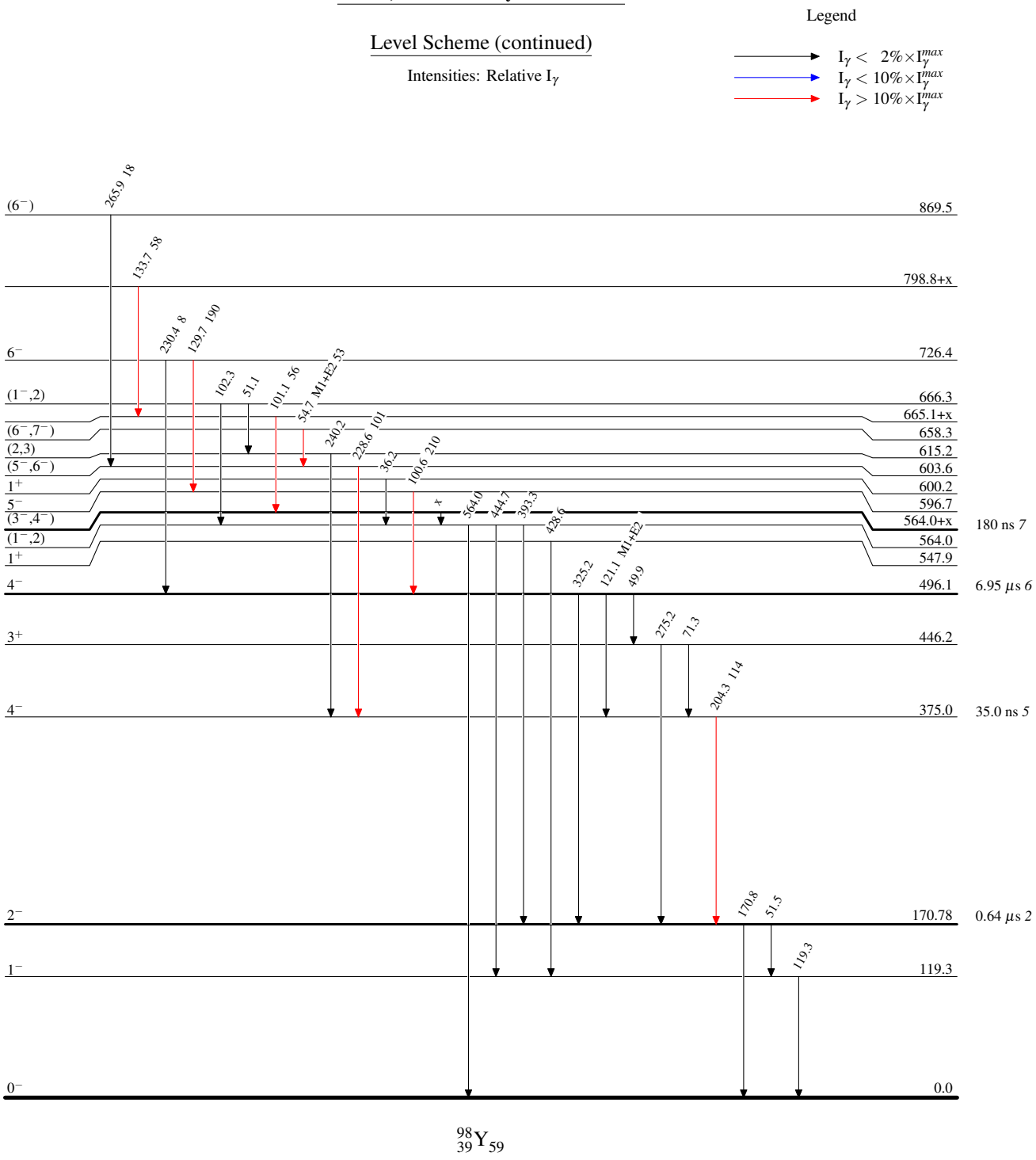



$^{98}_{39}Y_{59}$

## $^{248}$Cm,$^{252}$Cf SF decay 2017Ur03

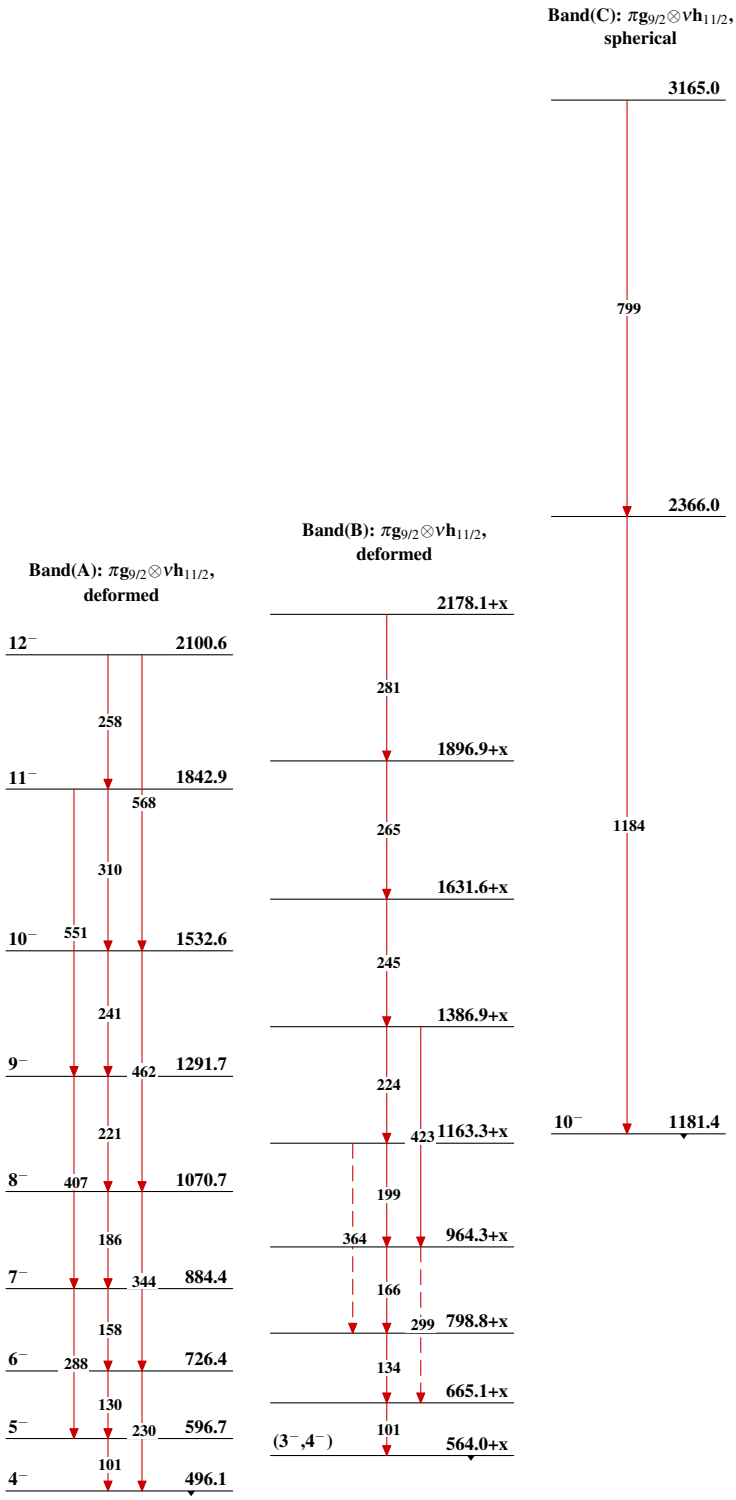
### Level Scheme (continued)

Intensities: Relative $I_\gamma$




$^{98}_{39}Y_{59}$

## $^{248}$Cm,$^{252}$Cf SF decay 2017Ur03




$^{98}_{39}Y_{59}$