

¹⁸⁴W(³⁰Si,4nγ) 2004Re04

| Type | Author | History | Citation | Literature Cutoff Date |
|-----------------|------------------------|---------|---------------------|------------------------|
| Full Evaluation | M. Shamsuzzoha Basunia | | NDS 121, 561 (2014) | 31-Mar-2014 |

Others: 2005Re02, 2005Re23.

2004Re04: Isotopically pure ¹⁸⁴W target (200 μg/cm²), E=148 MeV. Recoil reaction products were separated by the Small Angle Separator System at Yale for Evaporation Residues (SASSYER). Measured E_γ, I_γ, γ-γ coin with an array of 8 clover HPGe detectors. Delayed γ rays depopulating isomeric states within 6 μs following a recoil implantation were detected with 5 additional HPGe detectors. Deduced level scheme. Also in 2005Re23 (presented level scheme up to isomeric state).

2005Re02: Gamma rays from ²¹⁰Ra isomer were measured as a by product of isomeric decay study of ²⁰⁸Ra in ¹⁸²W(³⁰Si,4nγ) reaction, E=151 MeV.

All data are from 2004Re04, except otherwise noted.

²¹⁰Ra Levels

| E(level) [†] | J ^π [‡] | T _{1/2} | Comments |
|----------------------------|-----------------------------|------------------|--|
| 0.0 [#] | 0 ⁺ | | |
| 603.5 [#] 4 | 2 ⁺ | | |
| 1204.5 6 | 4 ⁺ | | |
| 1377.2 [#] 6 | 4 ⁺ | | |
| 1954.2 [#] 6 | 6 ⁺ | | E(level): Level from weak prompt coincidences of 577 and 750 γ rays. |
| 2049.9 [@] 8 | 8 ⁺ | 2.1 μs 1 | T _{1/2} : from γ-γ(t). From weighted least squares fit of summed intensity of 577, 601, 603, 750, and 774 keV γ-rays. |
| 2267.4 [@] 9 | (9 ⁺) | | |
| 2574.1 [@] 10 | (10 ⁺) | | |
| 3092.3 [@] 11 | (12 ⁺) | | |
| 3261.9 ^{&} 11 | (12 ⁺) | | |
| 3897.4 ^{&} 12 | (14 ⁺) | | |
| 4255.9 ^{&} 13 | (16 ⁺) | | |

[†] From least-squares fit to γ-ray energies.

[‡] Suggested in 2004Re04 from comparison with neighboring even-even Po, Rn, and Ra nuclides with n~126 and γ-ray character.

[#] Band(A): γ-sequence based on g.s..

[@] Band(B): Band based on 8⁺ isomer.

[&] Band(C): γ-sequence based on (12⁺).

γ(²¹⁰Ra)

| E _γ | I _γ [‡] | E _i (level) | J _i ^π | E _f | J _f ^π | Mult. [@] | α ^{&} | Comments |
|----------------|-----------------------------|------------------------|-----------------------------|----------------|-----------------------------|--------------------|--------------------|--|
| 95.7 5 | 9 [#] 1 | 2049.9 | 8 ⁺ | 1954.2 | 6 ⁺ | E2 | 11.7 4 | α(L)=8.60 25; α(M)=2.34 7 α(N)=0.618 18; α(O)=0.131 4; α(P)=0.0190 6; α(Q)=6.44×10 ⁻⁵ 15 E _γ , I _γ : Other: E _γ =95 1, I _γ =7 4 (scaled to 100 (577γ) by evaluator) (2005Re02). Mult.: Assigned in 2004Re04 from intensity balance at 1954 keV level. |
| 169.5 7 | 7 1 | 3261.9 | (12 ⁺) | 3092.3 | (12 ⁺) | M1 | 3.49 7 | α(K)=2.80 6; α(L)=0.519 10; α(M)=0.1241 23 α(N)=0.0327 6; α(O)=0.00747 14; α(P)=0.001301 24; α(Q)=0.0001020 19 |
| 217.5 5 | 55 2 | 2267.4 | (9 ⁺) | 2049.9 | 8 ⁺ | M1 | 1.73 3 | α(K)=1.391 22; α(L)=0.257 4; α(M)=0.0613 10 |

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$^{184}\text{W}(^{30}\text{Si},4n\gamma)$ **2004Re04 (continued)** $\gamma(^{210}\text{Ra})$ (continued)

| E_γ | I_γ^\ddagger | $E_i(\text{level})$ | J_i^π | E_f | J_f^π | Mult. @ | $\alpha\&$ | Comments |
|-----------------------------------|---------------------|---------------------|--------------------|---------------------------|-----------|---------|------------|---|
| $^{x}231.6^\ddagger$ 5 306.7 5 | <54 <116 | 2574.1 | (10 ⁺) | 2267.4 (9 ⁺) | | M1 | 0.667 | $\alpha(\text{N})=0.01617$ 25; $\alpha(\text{O})=0.00369$ 6; $\alpha(\text{P})=0.000643$ 10; $\alpha(\text{Q})=5.04\times 10^{-5}$ 8 I_γ : <54 2. |
| 358.5 5 | 24 2 | 4255.9 | (16 ⁺) | 3897.4 (14 ⁺) | | E2 | 0.0908 | $\alpha(\text{K})=0.537$ 8; $\alpha(\text{L})=0.0985$ 15; $\alpha(\text{M})=0.0235$ 4 $\alpha(\text{N})=0.00620$ 10; $\alpha(\text{O})=0.001415$ 21; $\alpha(\text{P})=0.000247$ 4; $\alpha(\text{Q})=1.93\times 10^{-5}$ 3 I_γ : <116 4. |
| $^{x}397.7^\ddagger$ 5 518.2 5 | 29 2 100 4 | 3092.3 | (12 ⁺) | 2574.1 (10 ⁺) | | E2 | 0.0356 | $\alpha(\text{K})=0.0491$ 7; $\alpha(\text{L})=0.0309$ 5; $\alpha(\text{M})=0.00812$ 13 $\alpha(\text{N})=0.00214$ 4; $\alpha(\text{O})=0.000466$ 7; $\alpha(\text{P})=7.19\times 10^{-5}$ 11; $\alpha(\text{Q})=1.89\times 10^{-6}$ 3 |
| 524.2 7 | | 2574.1 | (10 ⁺) | 2049.9 8 ⁺ | | E2 | 0.0346 | $\alpha(\text{K})=0.0235$ 4; $\alpha(\text{L})=0.00897$ 13; $\alpha(\text{M})=0.00230$ 4 $\alpha(\text{N})=0.000606$ 9; $\alpha(\text{O})=0.0001333$ 19; $\alpha(\text{P})=2.13\times 10^{-5}$ 3; $\alpha(\text{Q})=8.58\times 10^{-7}$ 13 |
| 577.1 5 | 100# 5 | 1954.2 | 6 ⁺ | 1377.2 4 ⁺ | | E2 | 0.0278 | $\alpha(\text{K})=0.0230$ 4; $\alpha(\text{L})=0.00865$ 13; $\alpha(\text{M})=0.00221$ 4 $\alpha(\text{N})=0.000584$ 9; $\alpha(\text{O})=0.0001286$ 19; $\alpha(\text{P})=2.06\times 10^{-5}$ 3; $\alpha(\text{Q})=8.38\times 10^{-7}$ 12 |
| 600.9 4 | 59# 7 | 1204.5 | 4 ⁺ | 603.5 2 ⁺ | | E2 | 0.0254 | $\alpha(\text{K})=0.0191$ 3; $\alpha(\text{L})=0.00648$ 10; $\alpha(\text{M})=0.001645$ 24 $\alpha(\text{N})=0.000434$ 7; $\alpha(\text{O})=9.58\times 10^{-5}$ 14; $\alpha(\text{P})=1.546\times 10^{-5}$ 22; $\alpha(\text{Q})=6.88\times 10^{-7}$ 10 E_γ, I_γ : Other: 577.1 5, $I_\gamma=100$ 12 (scaled to 100 (577 γ) by evaluator) (2005Re02). |
| 603.5 4 | 157# 9 | 603.5 | 2 ⁺ | 0.0 0 ⁺ | | E2 | 0.0252 | $\alpha(\text{K})=0.01772$ 25; $\alpha(\text{L})=0.00576$ 9; $\alpha(\text{M})=0.001458$ 21 $\alpha(\text{N})=0.000385$ 6; $\alpha(\text{O})=8.50\times 10^{-5}$ 12; $\alpha(\text{P})=1.376\times 10^{-5}$ 20; $\alpha(\text{Q})=6.34\times 10^{-7}$ 9 E_γ : Weighted average of 601.2 5 (2004Re04) and 600.5 6 (2005Re02). I_γ : Others: 55 7 (scaled to 100 (577 γ) by evaluator) (2005Re02), 32 6 (prompt) relative to 100 (518.2 γ) (2004Re04). |
| 635.5 5 | 59 2 | 3897.4 | (14 ⁺) | 3261.9 (12 ⁺) | | E2 | 0.0225 | $\alpha(\text{K})=0.01758$ 25; $\alpha(\text{L})=0.00568$ 8; $\alpha(\text{M})=0.001439$ 21 $\alpha(\text{N})=0.000380$ 6; $\alpha(\text{O})=8.39\times 10^{-5}$ 12; $\alpha(\text{P})=1.359\times 10^{-5}$ 20; $\alpha(\text{Q})=6.29\times 10^{-7}$ 9 E_γ : Weighted average of 603.5 6 (2004Re04) and 603.4 5 (2005Re02). I_γ : Others: 182 1 (scaled to 100 (577 γ) by evaluator) (2005Re02), 105 6 (prompt) relative to 100 (518.2 γ) (2004Re04). |
| 687.9 5 | 64 3 | 3261.9 | (12 ⁺) | 2574.1 (10 ⁺) | | E2 | 0.0190 | $\alpha(\text{K})=0.01595$ 23; $\alpha(\text{L})=0.00491$ 7; $\alpha(\text{M})=0.001237$ 18 $\alpha(\text{N})=0.000326$ 5; $\alpha(\text{O})=7.23\times 10^{-5}$ 11; $\alpha(\text{P})=1.176\times 10^{-5}$ 17; $\alpha(\text{Q})=5.67\times 10^{-7}$ 8 |
| $^{x}705^\ddagger$ 1 | 15 2 | | | | | | | $\alpha(\text{K})=0.01375$ 20; $\alpha(\text{L})=0.00394$ 6; $\alpha(\text{M})=0.000988$ 14 $\alpha(\text{N})=0.000260$ 4; $\alpha(\text{O})=5.78\times 10^{-5}$ 9; $\alpha(\text{P})=9.47\times 10^{-6}$ 14; $\alpha(\text{Q})=4.85\times 10^{-7}$ 7 |

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$^{184}\text{W}(^{30}\text{Si},4n\gamma)$ **2004Re04 (continued)** $\gamma(^{210}\text{Ra})$ (continued)

| E_γ | I_γ^\ddagger | $E_i(\text{level})$ | J_i^π | E_f | J_f^π | Mult. [@] | $\alpha^\&$ | Comments |
|-----------------------------------|---------------------|---------------------|----------------|--------|----------------|--------------------|-------------|---|
| 749.6 4 | 59 [#] 3 | 1954.2 | 6 ⁺ | 1204.5 | 4 ⁺ | E2 | 0.01591 | $\alpha(\text{K})=0.01173$ 17; $\alpha(\text{L})=0.00313$ 5; $\alpha(\text{M})=0.000781$ 11 $\alpha(\text{N})=0.000206$ 3; $\alpha(\text{O})=4.58\times 10^{-5}$ 7; $\alpha(\text{P})=7.56\times 10^{-6}$ 11; $\alpha(\text{Q})=4.10\times 10^{-7}$ 6 E_γ : Weighted average of 749.7 5 (2004Re04) and 749.4 5 (2005Re02). I_γ : Other:63 8 (scaled to 100 (577 γ) by evaluator) (2005Re02). |
| 773.8 4 | 102 [#] 5 | 1377.2 | 4 ⁺ | 603.5 | 2 ⁺ | E2 | 0.01491 | $\alpha(\text{K})=0.01107$ 16; $\alpha(\text{L})=0.00289$ 4; $\alpha(\text{M})=0.000717$ 10 $\alpha(\text{N})=0.000189$ 3; $\alpha(\text{O})=4.22\times 10^{-5}$ 6; $\alpha(\text{P})=6.97\times 10^{-6}$ 10; $\alpha(\text{Q})=3.85\times 10^{-7}$ 6 E_γ : Weighted average of 773.7 5 (2004Re04) and 773.9 5 (2005Re02). I_γ : Others: 99 12 (scaled to 100 (577 γ) by evaluator) (2005Re02), 39 2 (prompt) relative to 100 (518.2 γ) (2004Re04). |
| ^x 843.7 [†] 5 | 33 2 | | | | | | | |

[†] Transition may feed the isomeric state.

[‡] Values are relative to 100 for 518-keV transition, unless stated otherwise.

[#] From 2004Re04; delayed intensity relative to 100 for 577-keV transition.

[@] Suggested based on γ -ray intensities between two rings of the clover array. Quadrupole transitions favored in the backward ring (140°) and dipole transitions in the side rings (90°).

[&] [Additional information 1.](#)

^x γ ray not placed in level scheme.

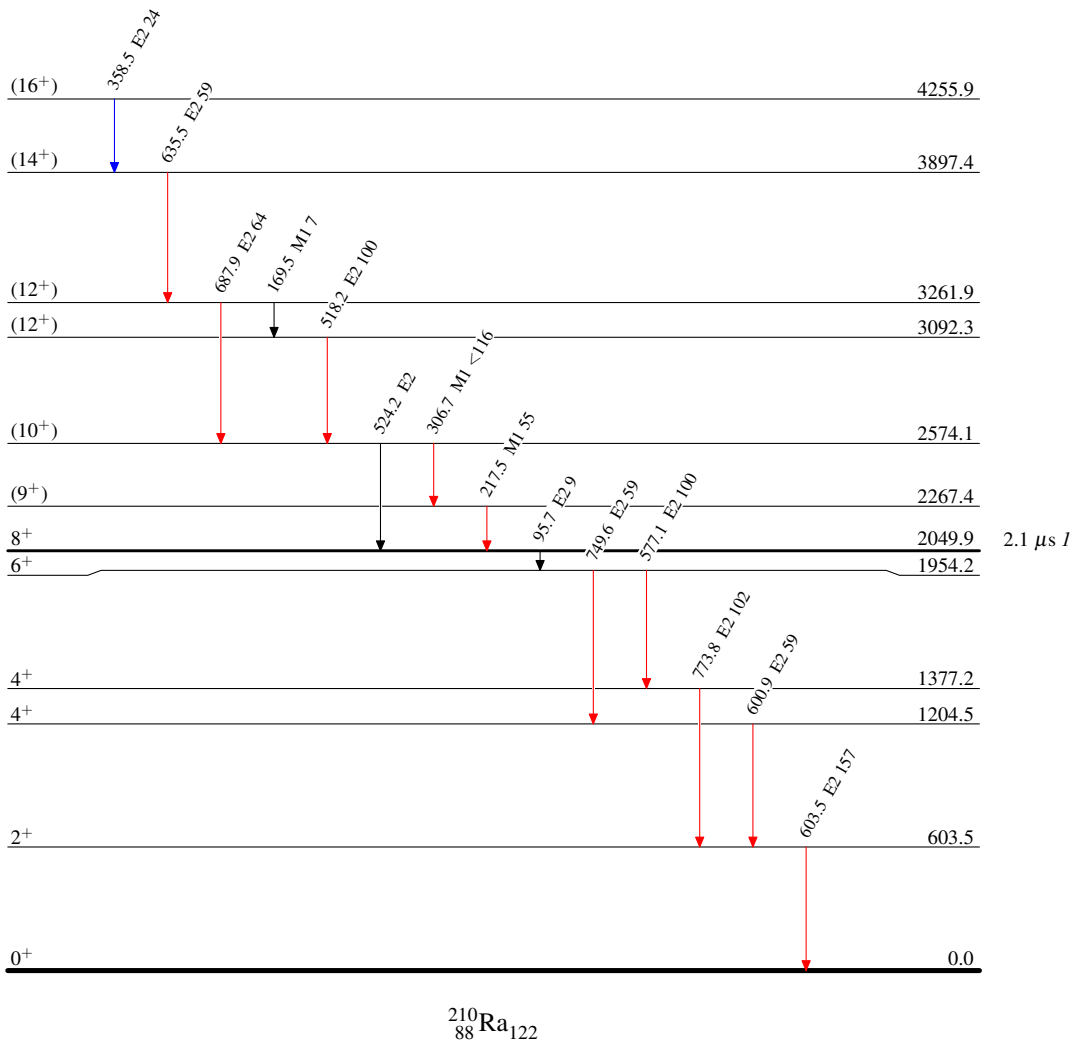
$^{184}\text{W}(^{30}\text{Si}, 4n\gamma)$ 2004Re04

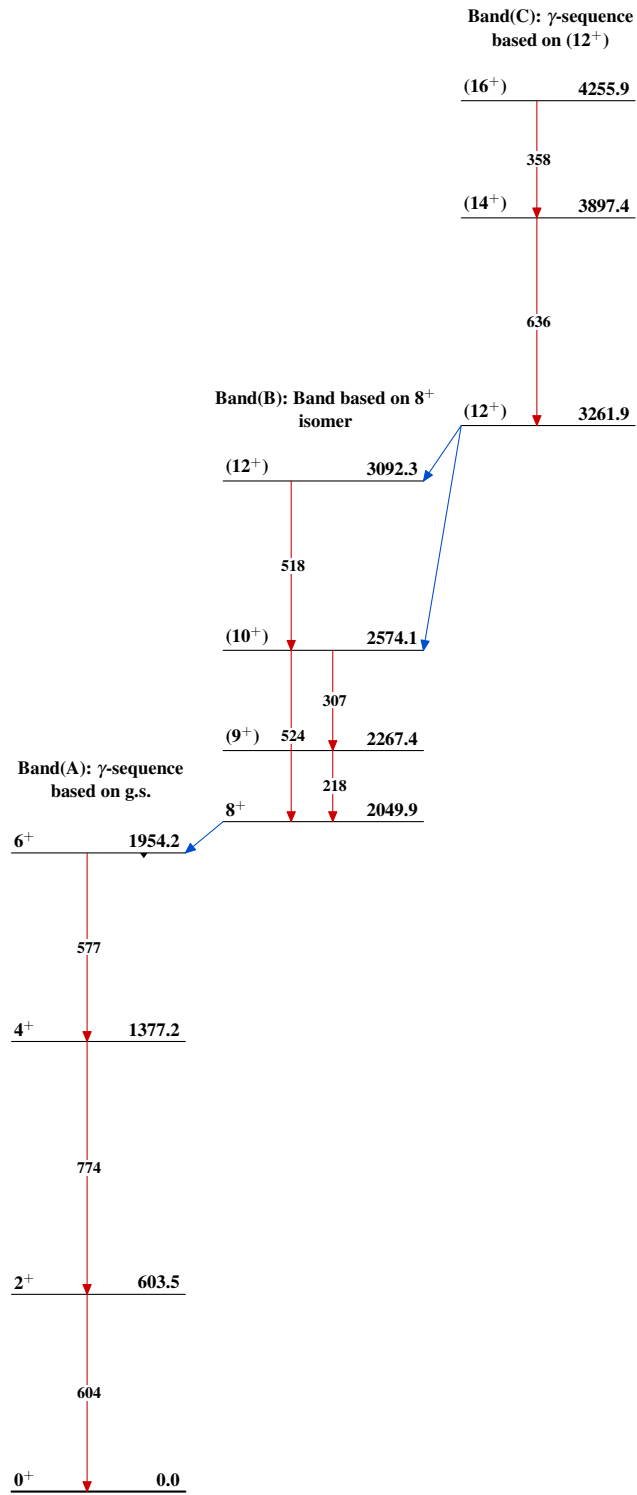
Level Scheme

Intensities: Relative I_γ

Legend

- \blacktriangleright $I_\gamma < 2\% \times I_\gamma^{\text{max}}$
- $\color{blue}\blacktriangleright$ $I_\gamma < 10\% \times I_\gamma^{\text{max}}$
- $\color{red}\blacktriangleright$ $I_\gamma > 10\% \times I_\gamma^{\text{max}}$



$^{184}\text{W}(\text{}^{30}\text{Si}, 4n\gamma)$ 2004Re04 $^{210}_{88}\text{Ra}_{122}$