# $^{112}$Rh $\beta^-$ decay (3.6 s) 1999Lh01

History

| Type | Author | Citation | Literature Cutoff Date |
|---|---|---|---|
| Full Evaluation | S. Lalkovski, F. G. Kondev | NDS 124, 157 (2015) | 1-Aug-2014 |

Parent: $^{112}$Rh: E=0.0; $J^\pi=(1^+)$; $T_{1/2}$=3.6 s *3*; Q($\beta^-$)=6589 *44*; %$\beta^-$ decay=100.0

1999Lh01: Facility: IGISOL at Jyvaskyla; Source: mass separated fission products from $^{238}$U(p,F). E(p)=25 MeV. Detectors: four Ge detectors from EUROGAM I, plastic scintillators; Measured: $\beta$-ce and $\gamma$-$\gamma$ coinc, $\gamma(\theta)$, $\beta$-$\gamma$(t), E$\gamma$, I$\gamma$; Deduced: $^{112}$Pd level scheme, I$\beta$(g.s.), log *ft*, upper limit of 0.5 ns for $T_{1/2}$ for all states from centroid shift measurements;

Others: 1998Lh04, 1988AyZZ, 1988Ay02, 1985Bu05, 1976MaYL, 1970WiZN.

## $^{112}$Pd Levels

| E(level)† | J$^\pi$‡ | E(level)† | J$^\pi$‡ | E(level)† | J$^\pi$‡ | E(level)† | J$^\pi$‡ |
|---|---|---|---|---|---|---|---|
| 0.0 | $0^+$ | 1422.66 *15* | $2^+$ | 2509.7 *6* | $(1,2^+)$ | 2836.4 *5* | $(0^+,1,2)$ |
| 348.63 *13* | $2^+$ | 1747.5? *5* | $(1,2^+)$ | 2540.5 *5* | $(0^+,1,2)$ | 2977.3? *6* | $(0^+,1,2)$ |
| 736.68 *14* | $2^+$ | 1774.4? *5* | $(1,2^+)$ | 2603.9 *5* | $(0^+,1,2)$ | 3013.8 *5* | $(0^+,1,2)$ |
| 882.92 *18* | $4^+$ | 2107.3 *4* | $(1,2^+)$ | 2665.5 *5* | $(1,2^+)$ | 3225.5 *6* | $(0^+,1,2)$ |
| 1096.22 *17* | $3^+$ | 2356.8 *6* | $(1,2^+)$ | 2688.11 *24* | $(0^+,1,2)$ | 3337.9? *9* | $(0^+,1,2)$ |
| 1125.54 *22* | $0^+$ | 2432.5? *5* | $(1,2^+)$ | 2747.18 *23* | $(1,2^+)$ | | |
| 1139.71 *21* | $(0,1,2)^+$ | 2466.1? *6* | $(1,2^+)$ | 2770.0 *7* | $(0^+,1,2)$ | | |
| 1402.59 *16* | $2^+$ | 2496.83 *23* | $(0^+,1,2)$ | 2795.8? *6* | $(0^+,1,2)$ | | |

† From a least squares fit to E$\gamma$.
‡ From the Adopted Levels.

## $\beta^-$ radiations

The level scheme is incomplete (pandemonium), and hence, I$\beta^-$ and log *ft* values should be considered as approximate.

| E(decay) | E(level) | I$\beta^-$†‡ | Log *ft* | Comments |
|---|---|---|---|---|
| (3.36×10$^3$ *5*) | 3225.5 | 0.75 *22* | 6.17 *14* | av E$\beta$=1425 *21* |
| (3.58×10$^3$ *5*) | 3013.8 | 1.20 *18* | 6.08 *8* | av E$\beta$=1525 *21* |
| (3.75×10$^3$ *5*) | 2836.4 | 0.54 *13* | 6.52 *12* | av E$\beta$=1609 *21* |
| (3.82×10$^3$ *5*) | 2770.0 | 0.39 *12* | 6.70 *14* | av E$\beta$=1640 *21* |
| (3.84×10$^3$ *5*) | 2747.18 | 3.1 *3* | 5.81 *6* | av E$\beta$=1651 *21* |
| (3.90×10$^3$ *5*) | 2688.11 | 1.92 *22* | 6.04 *7* | av E$\beta$=1679 *21* |
| (3.92×10$^3$ *5*) | 2665.5 | 0.48 *12* | 6.66 *12* | av E$\beta$=1690 *21* |
| (3.99×10$^3$ *5*) | 2603.9 | 1.17 *18* | 6.30 *8* | av E$\beta$=1719 *21* |
| (4.05×10$^3$ *5*) | 2540.5 | 0.27 *6* | 6.97 *11* | av E$\beta$=1749 *21* |
| (4.08×10$^3$ *5*) | 2509.7 | 0.36 *12* | 6.86 *15* | av E$\beta$=1764 *21* |
| (4.09×10$^3$ *5*) | 2496.83 | 1.65 *22* | 6.20 *8* | av E$\beta$=1770 *21* |
| (4.48×10$^3$ *5*) | 2107.3 | 1.3 *3* | 6.48 *11* | av E$\beta$=1955 *21* |
| (5.17×10$^3$ *5*) | 1422.66 | 2.3 *3* | 6.50 *7* | av E$\beta$=2282 *21* |
| (5.19×10$^3$ *5*) | 1402.59 | 0.8 *4* | 6.97 *22* | av E$\beta$=2291 *21* |
| (5.45×10$^3$ *5*) | 1139.71 | 1.23 *22* | 6.88 *9* | av E$\beta$=2417 *21* |
| (5.46×10$^3$ *5*) | 1125.54 | 2.8 *3* | 6.52 *6* | av E$\beta$=2424 *21* |
| (5.85×10$^3$ *5*) | 736.68 | 5 *3* | 6.4 *3* | av E$\beta$=2609 *21* |
| (6.24×10$^3$ *5*) | 348.63 | 10 *6* | 6.2 *3* | av E$\beta$=2795 *21* |
| (6.59×10$^3$ *5*) | 0.0 | ≈65 | ≈5.5 | av E$\beta$=2961 *21*<br>I$\beta^-$: From 65 *+11−29* in 1999Lh01. |

† From intensity imbalances.
‡ Absolute intensity per 100 decays.

## $\gamma(^{112}Pd)$

Iγ normalization: from (100-Iβ(g.s.))/Σ Ti(g.s.) and Iβ(g.s.)≈65, based on 65 *+11−29* estimate in 1999Lh01.

| $E_\gamma$ † | $I_\gamma$ †@ | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Mult. | δ†# | α‡ | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 213.3 *2* | 0.022 *8* | 1096.22 | $3^+$ | 882.92 | $4^+$ | [M1+E2] | | 0.0479 | α(K)=0.0418 *6*; α(L)=0.00505 *8*; α(M)=0.000949 *14*<br>α(N)=0.0001598 *23*<br>$E_\gamma$,$I_\gamma$: From adopted gammas with Iγ(213.3γ)/Iγ(359.6γ)=0.036 *7*. |
| 297.1 *4* | 0.5 *1* | 1422.66 | $2^+$ | 1125.54 | $0^+$ | [E2] | | 0.0306 | α(K)=0.0261 *4*; α(L)=0.00366 *6*; α(M)=0.000692 *11*<br>α(N)=0.0001135 *17* |
| 326.6 *3* | 1.0 *2* | 1422.66 | $2^+$ | 1096.22 | $3^+$ | [M1+E2] | | 0.01594 | α(K)=0.01392 *20*; α(L)=0.001658 *24*; α(M)=0.000311 *5*<br>α(N)=$5.25\times10^{-5}$ *8* |
| 348.7 *2* | 100 *15* | 348.63 | $2^+$ | 0.0 | $0^+$ | (E2) | | 0.0181 | α(K)=0.01552 *22*; α(L)=0.00210 *3*; α(M)=0.000396 *6*<br>α(N)=$6.53\times10^{-5}$ *10* |
| 359.6 *2* | 0.6 *2* | 1096.22 | $3^+$ | 736.68 | $2^+$ | M1+E2 | | 0.01252 | α(K)=0.01093 *16*; α(L)=0.001298 *19*; α(M)=0.000244 *4*<br>α(N)=$4.11\times10^{-5}$ *6*<br>Mult.: $A_{22}$=0.041 *35* gated on 348.7γ and 359.6γ in 1999Lh01. |
| 388.0 *2* | 23 *8* | 736.68 | $2^+$ | 348.63 | $2^+$ | E2(+M1) | −4.7 *+17−35* | 0.01276 *23* | α(K)=0.01099 *20*; α(L)=0.00145 *3*; α(M)=0.000274 *6*<br>α(N)=$4.52\times10^{-5}$ *10*<br>Mult.,δ: $A_{22}$=0.089 *34* gated on 348.7γ and 388.7γ in 1999Lh01. |
| 402.8 *4* | 1.3 *3* | 1139.71 | $(0,1,2)^+$ | 736.68 | $2^+$ | [E2] | | 0.01145 | α(K)=0.00987 *15*; α(L)=0.001298 *19*; α(M)=0.000245 *4*<br>α(N)=$4.05\times10^{-5}$ *6* |
| 519.8 *5* | 0.4 *1* | 1402.59 | $2^+$ | 882.92 | $4^+$ | [E2] | | 0.00534 | α(K)=0.00463 *7*; α(L)=0.000585 *9*; α(M)=0.0001101 *16*<br>α(N)=$1.83\times10^{-5}$ *3* |
| 534.3 *2* | 1.3 *2* | 882.92 | $4^+$ | 348.63 | $2^+$ | E2 | | 0.00494 | α(K)=0.00428 *6*; α(L)=0.000539 *8*; α(M)=0.0001014 *15*<br>α(N)=$1.688\times10^{-5}$ *24*<br>Mult.: $A_{22}$=0.105 *34* gated on 348.7γ and 534.3γ in 1999Lh01. |
| 539.7 *3* | 0.9 *2* | 1422.66 | $2^+$ | 882.92 | $4^+$ | [E2] | | 0.00480 | α(K)=0.00416 *6*; α(L)=0.000523 *8*; α(M)=$9.84\times10^{-5}$ *14*<br>α(N)=$1.638\times10^{-5}$ *23* |
| 665.8 *5* | 1.3 *5* | 1402.59 | $2^+$ | 736.68 | $2^+$ | [M1+E2] | | 0.00283 | α(K)=0.00248 *4*; α(L)=0.000289 *4*; α(M)=$5.42\times10^{-5}$ *8*<br>α(N)=$9.15\times10^{-6}$ *13* |
| 686.0 *2* | 3.6 *4* | 1422.66 | $2^+$ | 736.68 | $2^+$ | [M1+E2] | | 0.00264 | α(K)=0.00231 *4*; α(L)=0.000269 *4*; α(M)=$5.05\times10^{-5}$ *7*<br>α(N)=$8.53\times10^{-6}$ *12* |
| 736.7 *2* | 7.3 *25* | 736.68 | $2^+$ | 0.0 | $0^+$ | (E2) | | 0.00209 | α(K)=0.00182 *3*; α(L)=0.000220 *3*; α(M)=$4.13\times10^{-5}$ *6*<br>α(N)=$6.92\times10^{-6}$ *10* |
| 747.6 *2* | 0.47 *17* | 1096.22 | $3^+$ | 348.63 | $2^+$ | E2(+M1) | −1.65 *10* | 0.00205 | α(K)=0.00179 *3*; α(L)=0.000214 *3*; α(M)=$4.02\times10^{-5}$ *6*<br>α(N)=$6.75\times10^{-6}$ *10*<br>$I_\gamma$: From adopted gammas using Iγ(747.6γ)/Iγ(359.6γ)=0.79 *10*. |







$^{112}_{46}Pd_{66}$-2

## $^{112}$Rh $\beta^-$ decay (3.6 s) 1999Lh01 (continued)

### $\gamma(^{112}Pd)$ (continued)

| $E_\gamma$[†] | $I_\gamma$[†@] | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Mult. | $\alpha$[‡] | Comments |
|---|---|---|---|---|---|---|---|---|
| 776.9 *2* | 9.9 *10* | 1125.54 | $0^+$ | 348.63 | $2^+$ | E2 | 0.00183 | Mult.: $A_{22}=-0.485$ *47* gated on 348.7$\gamma$ and 747.6$\gamma$ in 1999Lh01. $\alpha$(K)=0.001593 *23*; $\alpha$(L)=0.000192 *3*; $\alpha$(M)=3.60×10$^{-5}$ *5* $\alpha$(N)=6.03×10$^{-6}$ *9* |
| 791.1 *2* | 4.2 *6* | 1139.71 | $(0,1,2)^+$ | 348.63 | $2^+$ | E2 | 1.75×10$^{-3}$ | Mult.: $A_{22}=0.493$ *66* gated on 348.7$\gamma$ E2 and 776.9 in 1999Lh01. $\alpha$(K)=0.001523 *22*; $\alpha$(L)=0.000183 *3*; $\alpha$(M)=3.44×10$^{-5}$ *5* $\alpha$(N)=5.76×10$^{-6}$ *8* |
| 1054.0 *2* | 4.3 *6* | 1402.59 | $2^+$ | 348.63 | $2^+$ | [M1+E2] | 1.01×10$^{-3}$ | Mult.: $A_{22}=0.34$ *8* in 1999Lh01. $\alpha$(K)=0.000881 *13*; $\alpha$(L)=0.0001015 *15*; $\alpha$(M)=1.90×10$^{-5}$ *3* $\alpha$(N)=3.21×10$^{-6}$ *5* |
| 1074.0 *2* | 2.0 *4* | 1422.66 | $2^+$ | 348.63 | $2^+$ | [M1+E2] | 9.65×10$^{-4}$ | $\alpha$(K)=0.000846 *12*; $\alpha$(L)=9.74×10$^{-5}$ *14*; $\alpha$(M)=1.82×10$^{-5}$ *3* $\alpha$(N)=3.08×10$^{-6}$ *5* |
| 1074.3 *3* | 1.3 *3* | 2496.83 | $(0^+,1,2)$ | 1422.66 | $2^+$ | | | |
| 1094.2 *4* | 1.2 *4* | 2496.83 | $(0^+,1,2)$ | 1402.59 | $2^+$ | | | |
| 1265.5 *4* | 1.0 *3* | 2688.11 | $(0^+,1,2)$ | 1422.66 | $2^+$ | | | |
| 1285.2 *5* | 0.9 *3* | 2688.11 | $(0^+,1,2)$ | 1402.59 | $2^+$ | | | |
| 1344.8 *3* | 1.8 *4* | 2747.18 | $(1,2^+)$ | 1402.59 | $2^+$ | | | |
| 1398.8[&] *4* | 1.6 *4* | 1747.5? | $(1,2^+)$ | 348.63 | $2^+$ | | | |
| 1402.6 *3* | 2.9 *4* | 1402.59 | $2^+$ | 0.0 | $0^+$ | [E2] | 5.40×10$^{-4}$ | $\alpha$(K)=0.000429 *6*; $\alpha$(L)=4.96×10$^{-5}$ *7*; $\alpha$(M)=9.28×10$^{-6}$ *13* $\alpha$(N)=1.564×10$^{-6}$ *22*; $\alpha$(IPF)=5.04×10$^{-5}$ *8* |
| 1413.5 *5* | 1.1 *3* | 2836.4 | $(0^+,1,2)$ | 1422.66 | $2^+$ | | | |
| 1422.6 *3* | 2.9 *6* | 1422.66 | $2^+$ | 0.0 | $0^+$ | [E2] | 5.32×10$^{-4}$ | $\alpha$(K)=0.000417 *6*; $\alpha$(L)=4.82×10$^{-5}$ *7*; $\alpha$(M)=9.01×10$^{-6}$ *13* $\alpha$(N)=1.519×10$^{-6}$ *22*; $\alpha$(IPF)=5.64×10$^{-5}$ *8* |
| 1425.7[&] *4* | 1.9 *5* | 1774.4? | $(1,2^+)$ | 348.63 | $2^+$ | | | |
| 1607.3 *4* | 1.4 *3* | 2747.18 | $(1,2^+)$ | 1139.71 | $(0,1,2)^+$ | | | |
| 1611.2 *5* | 1.3 *3* | 3013.8 | $(0^+,1,2)$ | 1402.59 | $2^+$ | | | |
| 1758.7 *3* | 4.2 *9* | 2107.3 | $(1,2^+)$ | 348.63 | $2^+$ | | | |
| 1760.1 *4* | 2.4 *4* | 2496.83 | $(0^+,1,2)$ | 736.68 | $2^+$ | | | |
| 1803.8 *4* | 0.9 *2* | 2540.5 | $(0^+,1,2)$ | 736.68 | $2^+$ | | | |
| 1823.1 *8* | 0.9 *5* | 3225.5 | $(0^+,1,2)$ | 1402.59 | $2^+$ | | | |
| 1867.2 *4* | 3.9 *6* | 2603.9 | $(0^+,1,2)$ | 736.68 | $2^+$ | | | |
| 1951.3 *4* | 1.3 *3* | 2688.11 | $(0^+,1,2)$ | 736.68 | $2^+$ | | | |
| 2008.1[&] *6* | 0.7 *3* | 2356.8 | $(1,2^+)$ | 348.63 | $2^+$ | | | |
| 2083.4[&] *7* | 0.9 *3* | 2432.5? | $(1,2^+)$ | 348.63 | $2^+$ | | | |
| 2106.6[&] *5* | 0.8 *2* | 2107.3 | $(1,2^+)$ | 0.0 | $0^+$ | | | |
| 2117.4[&] *5* | 0.7 *3* | 2466.1? | $(1,2^+)$ | 348.63 | $2^+$ | | | |
| 2147.7 *7* | 0.6 *3* | 2496.83 | $(0^+,1,2)$ | 348.63 | $2^+$ | | | |
| 2161.1 *5* | 1.2 *4* | 2509.7 | $(1,2^+)$ | 348.63 | $2^+$ | | | |
| 2316.8 *4* | 1.6 *4* | 2665.5 | $(1,2^+)$ | 348.63 | $2^+$ | | | |
| 2339.7 *4* | 3.2 *5* | 2688.11 | $(0^+,1,2)$ | 348.63 | $2^+$ | | | |
| 2398.7 *5* | 7.2 *9* | 2747.18 | $(1,2^+)$ | 348.63 | $2^+$ | | | |
| 2421.3 *6* | 1.3 *4* | 2770.0 | $(0^+,1,2)$ | 348.63 | $2^+$ | | | |





$^{112}_{46}Pd_{66}$-3

## $^{112}$Rh $\beta^-$ decay (3.6 s) 1999Lh01 (continued)

### $\gamma(^{112}Pd)$ (continued)

| $E_\gamma$ † | $I_\gamma$ †@ | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | $E_\gamma$ † | $I_\gamma$ †@ | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2432.7& *6* | 0.9 *3* | 2432.5? | (1,2$^+$) | 0.0 | 0$^+$ | 2664.7& | 1.1 *8* | 2665.5 | (1,2$^+$) | 0.0 | 0$^+$ |
| 2447.1& *6* | 0.9 *4* | 2795.8? | (0$^+$,1,2) | 348.63 | 2$^+$ | 2665.0 *7* | 2.7 *5* | 3013.8 | (0$^+$,1,2) | 348.63 | 2$^+$ |
| 2488.2 *7* | 0.7 *3* | 2836.4 | (0$^+$,1,2) | 348.63 | 2$^+$ | 2746.6 *5* | 1.5 *3* | 2747.18 | (1,2$^+$) | 0.0 | 0$^+$ |
| 2511.2& *7* | 0.3 *1* | 2509.7 | (1,2$^+$) | 0.0 | 0$^+$ | 2876.6 *7* | 1.6 *5* | 3225.5 | (0$^+$,1,2) | 348.63 | 2$^+$ |
| 2628.6& *5* | 1.4 *4* | 2977.3? | (0$^+$,1,2) | 348.63 | 2$^+$ | 2989.2& *9* | 0.5 *2* | 3337.9? | (0$^+$,1,2) | 348.63 | 2$^+$ |

† From 1999Lh01.
‡ Additional information 1.
# If No value given it was assumed $\delta$=0.00 for E2/M1, $\delta$=1.00 for E3/M2 and $\delta$=0.10 for the other multipolarities.
@ For absolute intensity per 100 decays, multiply by ≈0.30.
& Placement of transition in the level scheme is uncertain.



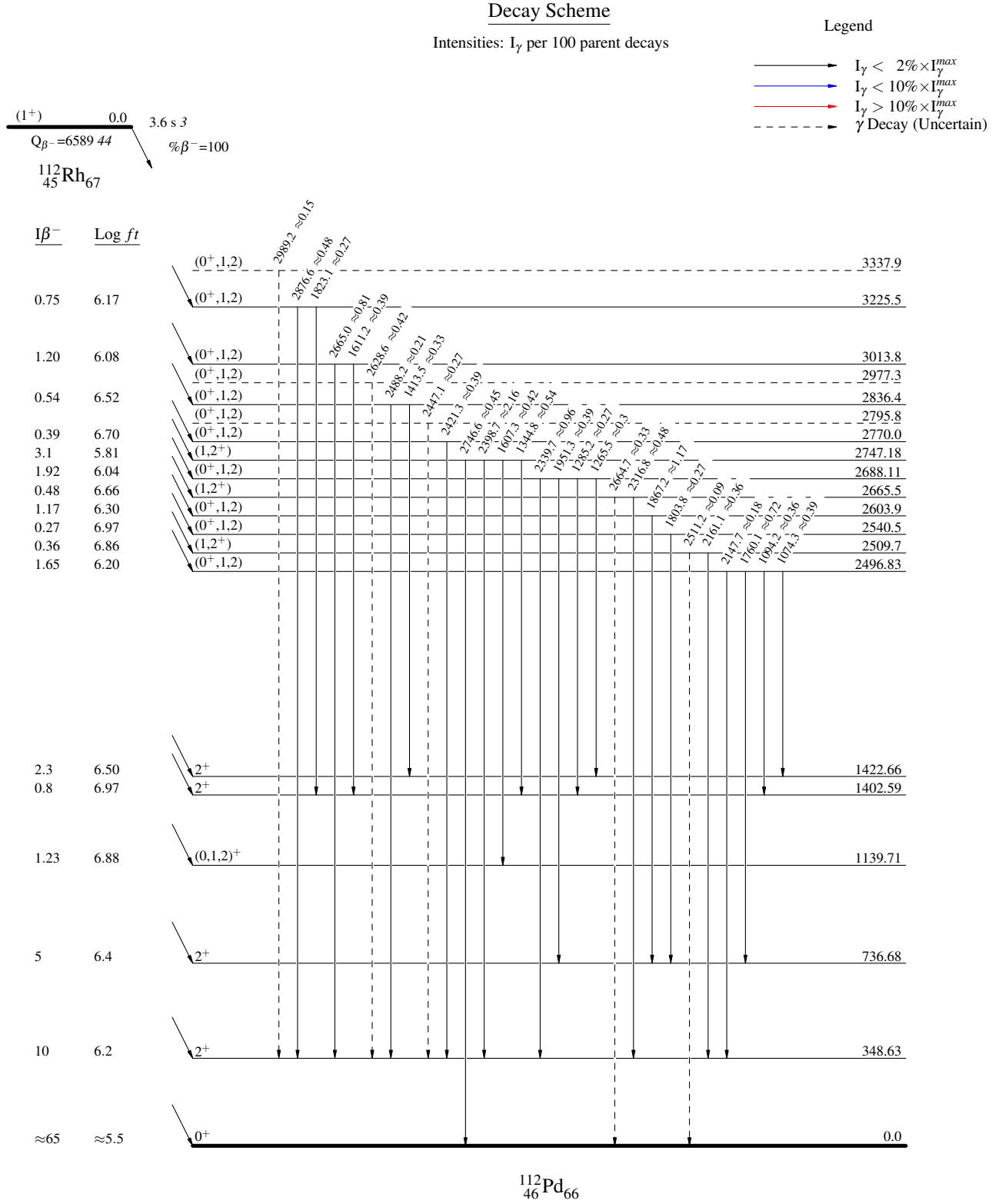


$^{112}_{46}Pd_{66}$-4

## $^{112}$Rh $\beta^-$ decay (3.6 s) 1999Lh01

### Decay Scheme

Intensities: $I_\gamma$ per 100 parent decays



## $^{112}$Rh $\beta^-$ decay (3.6 s) 1999Lh01

### Decay Scheme (continued)

Intensities: $I_\gamma$ per 100 parent decays