$^{140}_{56}$Ba $_{84}$

## 1 Decay Scheme

Le baryum 140 se désintègre par émissions bêta moins vers des niveaux excités de lanthane 140.
Le rapport au temps t des activités La-140/Ba-140 dans le Ba-140 initialement pur s'écrit :
$T1/(T1 - T2)(1 - e^{t\times(-ln2\,(T1-T2)/T1\times T2})$
T1 et T2 étant respectivement les périodes de Ba-140 et de La-140
A l'équilibre ( t $\geq$ 19 jours), ce rapport est égal à : T1/(T1-T2) = 1,1516 $\pm$ 0,0007.
*The Ba-140 disintegrates by beta minus emissions to La-140 excited levels.*
*At equilibrium (t $\geq$ 19 d), with T1 : Ba-140 half-life and, T2 : La-140 half-Life, the activity ratio is : T1/(T1-T2) = 1.1516 $\pm$ 0.0007.*

## 2 Nuclear Data

| | | | | |
|---|---|---|---|---|
| $T_{1/2}$($^{140}$Ba ) | : | 12,753 | (4) | d |
| $T_{1/2}$($^{140}$La ) | : | 1,67850 | (17) | d |
| $Q^-$($^{140}$Ba ) | : | 1047 | (8) | keV |

### 2.1 $\beta^-$ Transitions

| | Energy keV | Probability × 100 | Nature | lg $ft$ |
|---|---|---|---|---|
| $\beta^-_{0,6}$ | 469 (8) | 24,73 (23) | 1st forbidden | 7,05 |
| $\beta^-_{0,5}$ | 582 (8) | 9,63 (10) | 1st forbidden | 7,78 |
| $\beta^-_{0,4}$ | 887 (8) | 3,90 (11) | Unique 1st forbidden | 9,2 |
| $\beta^-_{0,3}$ | 987 (8) | <0,00000001 | Unique 3rd forbidden | >18 |
| $\beta^-_{0,2}$ | 1006 (8) | 39 (4) | 1st forbidden | 8 |
| $\beta^-_{0,1}$ | 1020 (8) | 23 (4) | Unique 1st forbidden | 8,8 |
| $\beta^-_{0,0}$ | 1050 (8) | ≤0,00001 | 3rd forbidden | ≥15 |

## 2.2 Gamma Transitions and Internal Conversion Coefficients

| | Energy keV | $P_{\gamma+ce}$ × 100 | Multipolarity | $\alpha_K$ | $\alpha_L$ | $\alpha_M$ | $\alpha_T$ |
|---|---|---|---|---|---|---|---|
| $\gamma_{2,1}$(La) | 13,849 (4) | 66,24 (3) | M1+E2 | | 44,7 (9) | 9,7 (20) | 56,6 (11) |
| $\gamma_{1,0}$(La) | 29,9656 (15) | 93,80 (25) | M1+E2 | | 4,4 (9) | 0,9 (2) | 5,55 (11) |
| $\gamma_{3,0}$(La) | 63,184 (13) | 0,000232 (15) | [M1,E2] | 4,0 (2) | 3 (2) | | 7 (3) |
| $\gamma_{4,3}$(La) | 99,479 (13) | 0,000061 (12) | [E2] | 1,230 (25) | 0,635 (13) | 0,17 (2) | 2,04 (4) |
| $\gamma_{6,5}$(La) | 113,582 (7) | 0,0303 (7) | E0 | 0,658 (13) | 0,0893 (18) | 0,027 (3) | 0,771 (15) |
| $\gamma_{4,2}$(La) | 118,849 (4) | 0,1015 (18) | M1 | 0,587 (18) | 0,0785 (18) | 0,024 (2) | 0,678 (14) |
| $\gamma_{4,1}$(La) | 132,6972 (25) | 0,301 (4) | M1 | 0,424 (8) | 0,0575 (11) | 0,017 (2) | 0,497 (10) |
| $\gamma_{4,0}$(La) | 162,6628 (24) | 8,03 (9) | M1(+E2) | 0,241 (5) | 0,0325 (7) | 0,0082 (8) | 0,282 (6) |
| $\gamma_{5,4}$(La) | 304,872 (4) | 4,52 (4) | M1(+E2) | 0,0444 (9) | 0,00589 (12) | 0,0016 (2) | 0,0519 (10) |
| $\gamma_{5,2}$(La) | 423,721 (4) | 3,18 (3) | M1 | 0,0190 (4) | 0,0027 (2) | | 0,0222 (4) |
| $\gamma_{5,1}$(La) | 437,569 (3) | 1,967 (19) | M1 | 0,0176 (4) | 0,00230 (5) | 0,0007 (1) | 0,0205 (4) |
| $\gamma_{6,2}$(La) | 537,304 (6) | 24,69 (22) | M1 | 0,0105 (2) | 0,00137 (3) | | 0,0122 (2) |
| $\gamma_{6,1}$(La) | 551,153 (8) | 0,0049 (20) | [E2] | 0,00671 (13) | 0,00101 (2) | | 0,00799 (16) |

# 3 Atomic Data

## 3.1 La

| | | | |
|---|---|---|---|
| $\omega_K$ | : | 0,905 | (4) |
| $\bar{\omega}_L$ | : | 0,117 | (5) |
| $n_{KL}$ | : | 0,888 | (4) |
| $\bar{n}_{LM}$ | : | 1,574 | |

### 3.1.1 X Radiations

| | | Energy keV | | Relative probability |
|---|---|---|---|---|
| $X_K$ | | | | |
| | $K\alpha_2$ | 33,0344 | | 54,44 |
| | $K\alpha_1$ | 33,4421 | | 100 |
| | $K\beta_3$ | 37,7206 | } | |
| | $K\beta_1$ | 37,8015 | } | |
| | $K\beta_5''$ | 38,075 | } | 29,8 |
| | $K\beta_5'$ | 39,095 | } | |
| | $K\beta_2$ | 38,7303 | } | |
| | $K\beta_4$ | 38,828 | } | 7,5 |
| | $KO_{2,3}$ | 39,91 | } | |

# 4 Electron Emissions

| | | Energy keV | | Electrons per 100 disint. |
|---|---|---|---|---|
| $e_{AL}$ | (La) | 2,7 - 6,2 | | 101,5 (12) |
| $e_{AK}$ | (La) | | | 0,20 (6) |
| | KLL | 26,240 - 27,795 | } | |
| | KLX | 31,231 - 33,428 | } | |
| | KXY | 36,2 - 38,9 | } | |
| $ec_{2,1\ L}$ | (La) | 7,560 - 8,363 | | 51,4 (13) |
| $ec_{2,1\ M}$ | (La) | 12,485 - 12,743 | | 11,2 (23) |
| $ec_{2,1\ N}$ | (La) | 13,576 - 13,655 | | 2,9 (5) |
| $ec_{1,0\ L}$ | (La) | 23,702 - 24,485 | | 63 (13) |
| $ec_{1,0\ M}$ | (La) | 28,606 - 28,844 | | 13 (3) |
| $ec_{1,0\ N}$ | (La) | 29,697 - 29,776 | | 3,2 (7) |
| $ec_{4,1\ K}$ | (La) | 93,767 (5) | | 0,0852 (23) |
| $ec_{4,0\ K}$ | (La) | 123,735 (2) | | 1,51 (4) |
| $ec_{4,0\ L}$ | (La) | 156,394 - 157,177 | | 0,203 (5) |
| $ec_{4,0\ M}$ | (La) | 161,299 - 161,537 | | 0,051 (5) |
| $ec_{5,4\ K}$ | (La) | 265,950 (4) | | 0,191 (19) |
| $ec_{5,2\ K}$ | (La) | 384,7979 (23) | | 0,0591 (14) |
| $ec_{6,2\ K}$ | (La) | 498,379 (7) | | 0,256 (6) |
| $\beta^-_{0,6}$ | max: | 469 (8) | | 24,73 (23) |
| $\beta^-_{0,6}$ | avg: | 136 (4) | | |
| $\beta^-_{0,5}$ | max: | 582 (8) | | 9,63 (10) |
| $\beta^-_{0,5}$ | avg: | 176 (4) | | |
| $\beta^-_{0,4}$ | max: | 887 (8) | | 3,90 (11) |
| $\beta^-_{0,4}$ | avg: | 305 (4) | | |
| $\beta^-_{0,3}$ | max: | 987 (8) | | < 0,00000001 |
| $\beta^-_{0,3}$ | avg: | | | |
| $\beta^-_{0,2}$ | max: | 1006 (8) | | 39 (4) |
| $\beta^-_{0,2}$ | avg: | 339 (4) | | |
| $\beta^-_{0,1}$ | max: | 1020 (8) | | 23 (4) |
| $\beta^-_{0,1}$ | avg: | 357 (4) | | |
| $\beta^-_{0,0}$ | max: | 1050 (8) | | ≤0,00001 |
| $\beta^-_{0,0}$ | avg: | | | |

# 5 Photon Emissions

## 5.1 X-Ray Emissions

| | | Energy keV | | Photons per 100 disint. | |
|---|---|---|---|---|---|
| $XK\alpha_2$ | (La) | 33,0344 | | 0,535 (11) | } $K\alpha$ |
| $XK\alpha_1$ | (La) | 33,4421 | | 0,982 (20) | } |
| $XK\beta_3$ | (La) | 37,7206 | } | | |
| $XK\beta_1$ | (La) | 37,8015 | } | 0,292 (7) | $K'\beta_1$ |
| $XK\beta_5''$ | (La) | 38,075 | } | | |
| $XK\beta_5'$ | (La) | 39,095 | } | | |
| $XK\beta_2$ | (La) | 38,7303 | } | | |
| $XK\beta_4$ | (La) | 38,828 | } | 0,074 (2) | $K'\beta_2$ |
| $XKO_{2,3}$ | (La) | 39,91 | } | | |

## 5.2 Gamma Emissions

| | Energy keV | Photons per 100 disint. |
|---|---|---|
| $\gamma_{2,1}$(La) | 13,849 (4) | 1,15 (3) |
| $\gamma_{1,0}$(La) | 29,9656 (15) | 14,32 (25) |
| $\gamma_{3,0}$(La) | 63,184 (13) | 0,000029 (15) |
| $\gamma_{4,3}$(La) | 99,479 (13) | 0,000020 (12) |
| $\gamma_{6,5}$(La) | 113,582 (7) | 0,0171 (7) |
| $\gamma_{4,2}$(La) | 118,849 (4) | 0,0605 (18) |
| $\gamma_{4,1}$(La) | 132,6972 (25) | 0,201 (4) |
| $\gamma_{4,0}$(La) | 162,6628 (24) | 6,26 (9) |
| $\gamma_{5,4}$(La) | 304,872 (4) | 4,30 (4) |
| $\gamma_{5,2}$(La) | 423,721 (4) | 3,11 (3) |
| $\gamma_{5,1}$(La) | 437,569 (3) | 1,927 (19) |
| $\gamma_{6,2}$(La) | 537,303 (6) | 24,39 (22) |
| $\gamma_{6,1}$(La) | 551,152 (8) | 0,0049 (20) |

# 6 Main Production Modes

{ Fission product
Possible impurities : None

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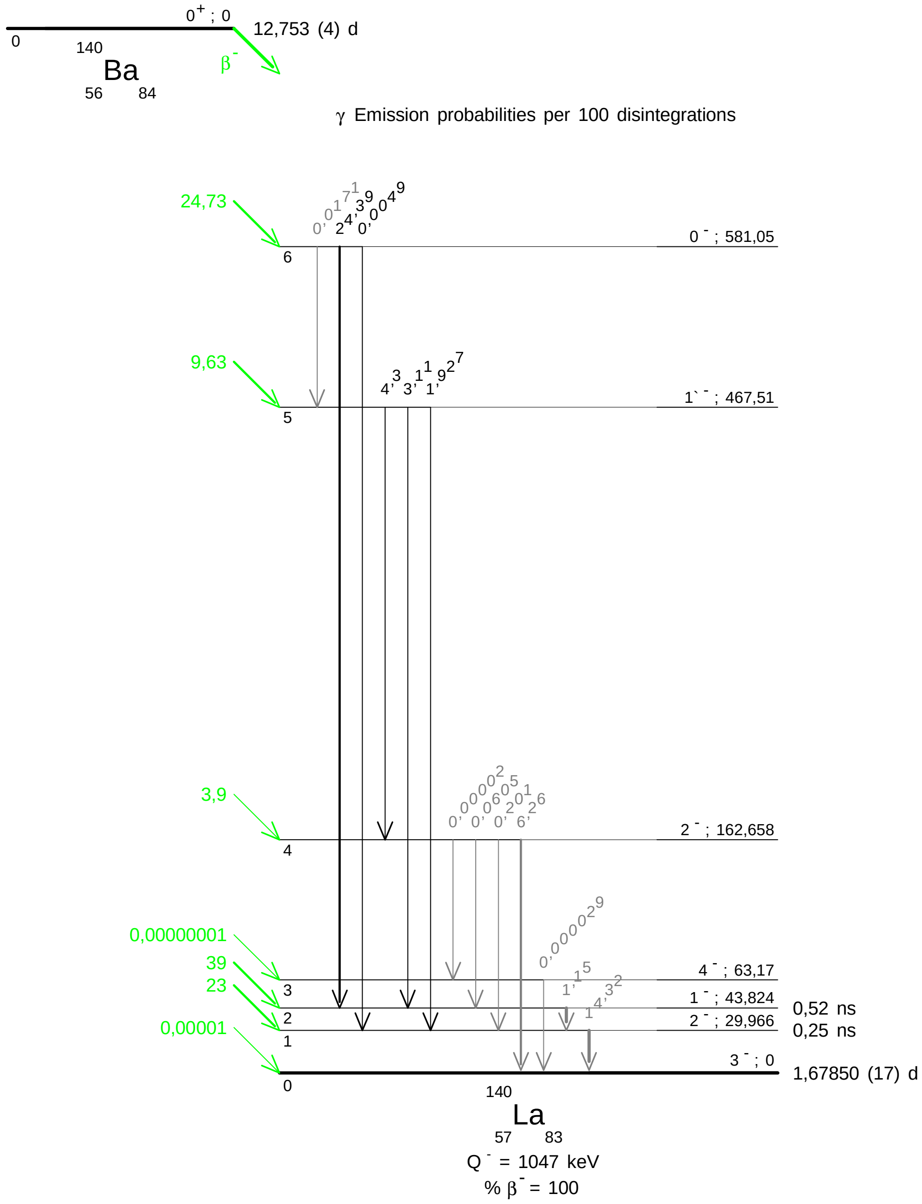
0+ ; 0
12,753 (4) d
0
140
Ba
56 84
β-
γ Emission probabilities per 100 disintegrations
24,73
9,63
3,9
0,00000001
39
23
0,00001
6
5
4
3
2
1
0
0 - ; 581,05
1 - ; 467,51
2 - ; 162,658
4 - ; 63,17
1 - ; 43,824
2 - ; 29,966
3 - ; 0
0,52 ns
0,25 ns
1,67850 (17) d
140
La
57 83
Q - = 1047 keV
% β- = 100