

$^{210}\text{Pb}(^{11}\text{B},4n\gamma)$  1988Ai02

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|-----------------|---------------------------|---------|---------------------|------------------------|
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1988Ai02: E( $^{11}\text{B}$ )=60 MeV Target:  $^{210}\text{Pb}$  radioactive target, chemical separation and isotopic enrichment of 50%. Detectors: four Ge detectors and 11 NaI detectors multiplicity filter. Measured:  $E\gamma$ ,  $I\gamma$ ,  $\gamma(\theta)$ ,  $\gamma\gamma$  coincidences, excitation function (52-68 MeV, step 2 MeV). Placement of gamma rays to  $^{217}\text{Fr}$  were based on coincidences with the francium x-rays and on the analysis of the excitation function data, as well as on comparison of the spectra taken with different folds.

 $^{217}\text{Fr}$  Levels

| E(level) <sup>†</sup>     | J $\pi$ <sup>‡</sup> | Comments                                                                                                                                                                                                    |
|---------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0.0 <sup>#</sup>          | 9/2 <sup>-</sup>     |                                                                                                                                                                                                             |
| 363.6 <sup>#</sup> 3      | 13/2 <sup>-</sup>    | E(level): since the ordering of the 363.6 $\gamma$ and 340.6 $\gamma$ is uncertain (1988Ai02), it is possible that E(13/2 <sup>-</sup> )=340.6 keV.                                                         |
| 704.2 <sup>#</sup> 5      | 17/2 <sup>-</sup>    |                                                                                                                                                                                                             |
| 1077.0 <sup>#</sup> 6     | 21/2 <sup>-</sup>    |                                                                                                                                                                                                             |
| 1256.2 <sup>&amp;</sup> 6 |                      | J $\pi$ : 21/2 <sup>+</sup> , 23/2 <sup>+</sup> was suggested by 1988Ai02 from 179.1 $\gamma$ to 21/2 <sup>-</sup> and the non-observation of a transition to the 17/2 <sup>-</sup> level of the g.s. band. |
| 1355.0 <sup>@</sup> 6     | 23/2 <sup>+</sup>    |                                                                                                                                                                                                             |
| 1509.7 <sup>#</sup> 6     | 25/2 <sup>-</sup>    |                                                                                                                                                                                                             |
| 1688.9 <sup>&amp;</sup> 6 |                      |                                                                                                                                                                                                             |
| 1713.7 <sup>@</sup> 6     | 27/2 <sup>+</sup>    |                                                                                                                                                                                                             |
| 1988.5 <sup>#</sup> 6     | 29/2 <sup>-</sup>    |                                                                                                                                                                                                             |
| 2111.0 <sup>@</sup> 7     | 31/2 <sup>+</sup>    |                                                                                                                                                                                                             |
| 2154.5 <sup>&amp;</sup> 7 |                      |                                                                                                                                                                                                             |
| 2516.4 <sup>@</sup> 7     | (35/2 <sup>+</sup> ) |                                                                                                                                                                                                             |
| 2582.0 <sup>&amp;</sup> 8 |                      |                                                                                                                                                                                                             |
| 2618.0? 7                 |                      |                                                                                                                                                                                                             |
| 3002.2 <sup>@</sup> 8     | (39/2 <sup>+</sup> ) |                                                                                                                                                                                                             |

<sup>†</sup> From least-squares fit to  $E\gamma$  data.

<sup>‡</sup> From 1988Ai02, based on deduced  $\gamma$ -ray transition multipolarities.

<sup>#</sup> Band(A): Ground state band.

<sup>@</sup> Band(B): Positive parity band.

<sup>&</sup> Band(C): Side band.

 $\gamma(^{217}\text{Fr})$ 

| $E_{\gamma}$ <sup>†</sup> | $I_{\gamma}$ | $E_i(\text{level})$ | $J_i^{\pi}$       | $E_f$  | $J_f^{\pi}$       | Mult. <sup>†</sup> | Comments                                                                                                                                                                                                                       |
|---------------------------|--------------|---------------------|-------------------|--------|-------------------|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 122.5 3                   | 19 6         | 2111.0              | 31/2 <sup>+</sup> | 1988.5 | 29/2 <sup>-</sup> | [E1]               | $I_{\gamma}$ : from B(E1)/B(E2)= $1.1 \times 10^{-6}$ 4 (1988Ai02).<br>Mult.: DCO=0.54 21.                                                                                                                                     |
| 154.4 3                   | 26 7         | 1509.7              | 25/2 <sup>-</sup> | 1355.0 | 23/2 <sup>+</sup> | E1                 | $I_{\gamma}$ : from B(E1)/B(E2)= $1.1 \times 10^{-6}$ 4 (1988Ai02).<br>Mult.: DCO=0.80 14; $A_2=-0.28$ 14.                                                                                                                     |
| 179.1 3                   |              | 1256.2              |                   | 1077.0 | 21/2 <sup>-</sup> | D                  | Mult.: DCO=0.85 11.                                                                                                                                                                                                            |
| 204.0 3                   | 62 5         | 1713.7              | 27/2 <sup>+</sup> | 1509.7 | 25/2 <sup>-</sup> | E1                 | $I_{\gamma}$ : from B(E1)/B(E2)= $0.9 \times 10^{-6}$ 2 (1988Ai02).<br>Mult.: DCO=0.75 8, $A_2=-0.19$ 6. Doublet consisting of 202.3 $\gamma$ and 204.0 $\gamma$ transition, the former is E1 in $^{215}\text{Fr}$ (1984Sc25). |
| 274.7 3                   | 52 8         | 1988.5              | 29/2 <sup>-</sup> | 1713.7 | 27/2 <sup>+</sup> | [E1]               | $I_{\gamma}$ : from B(E1)/B(E2)= $1.0 \times 10^{-6}$ 3 (1988Ai02).<br>Mult.: DCO=0.61 8.                                                                                                                                      |

Continued on next page (footnotes at end of table)

$^{210}\text{Pb}(^{11}\text{B},4n\gamma)$  **1988Ai02** (continued) $\gamma(^{217}\text{Fr})$  (continued)

| $E_\gamma$ <sup>†</sup> | $I_\gamma$ | $E_i(\text{level})$ | $J_i^\pi$            | $E_f$  | $J_f^\pi$            | Mult. <sup>†</sup> | Comments                                                                                                                                                                                                                                                         |
|-------------------------|------------|---------------------|----------------------|--------|----------------------|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 278.0 3                 |            | 1355.0              | 23/2 <sup>+</sup>    | 1077.0 | 21/2 <sup>-</sup>    | E1                 | Mult.: DCO=0.63 6, $A_2=-0.24$ 3. Total intensity for 278.0 $\gamma$ suggests E1 rather than M1 assignment, when considering the intensity balance at the 1077-keV level by gating on the preceding 154.4 $\gamma$ and 358.8 $\gamma$ .                          |
| 334.0 3                 |            | 1688.9              |                      | 1355.0 | 23/2 <sup>+</sup>    | (E2)               | Mult.: DCO=1.59 30, but it is also in agreement with a possible $\Delta J=0$ , J to J transition.                                                                                                                                                                |
| 340.6 3                 |            | 704.2               | 17/2 <sup>-</sup>    | 363.6  | 13/2 <sup>-</sup>    | E2                 | Mult.: DCO=1.37 8, $A_2=0.34$ 5, $A_4=-0.17$ 7.                                                                                                                                                                                                                  |
| 358.8 4                 | 38 5       | 1713.7              | 27/2 <sup>+</sup>    | 1355.0 | 23/2 <sup>+</sup>    | E2                 | $I_\gamma$ : from B(E1)/B(E2)= $0.9 \times 10^{-6}$ 2 ( <b>1988Ai02</b> ).<br>Mult.: DCO=1.28 23, $A_2=0.34$ 5, $A_4=-0.17$ 7.                                                                                                                                   |
| 363.6 3                 |            | 363.6               | 13/2 <sup>-</sup>    | 0.0    | 9/2 <sup>-</sup>     | E2                 | $E_\gamma$ : $\gamma\gamma$ coin analysis reveals that 363.6 $\gamma$ is multiplet and, therefore, the ordering of 340.6 $\gamma$ and 363.6 $\gamma$ is not unambiguous, as pointed out in <b>1988Ai02</b> .<br>Mult.: DCO=1.32 11; $A_2=0.24$ 6, $A_4=-0.13$ 8. |
| 372.8 3                 |            | 1077.0              | 21/2 <sup>-</sup>    | 704.2  | 17/2 <sup>-</sup>    | E2                 | Mult.: DCO=1.28 6, $A_2=0.34$ 5.                                                                                                                                                                                                                                 |
| 397.4 3                 | 81 6       | 2111.0              | 31/2 <sup>+</sup>    | 1713.7 | 27/2 <sup>+</sup>    | E2                 | $I_\gamma$ : from B(E1)/B(E2)= $1.1 \times 10^{-6}$ 4 ( <b>1988Ai02</b> ).<br>Mult.: DCO=1.58 20, $A_2=0.37$ 8.                                                                                                                                                  |
| 405.4 3                 |            | 2516.4              | (35/2 <sup>+</sup> ) | 2111.0 | 31/2 <sup>+</sup>    | (E2)               | Mult.: DCO=1.14 16.                                                                                                                                                                                                                                              |
| 427.5 3                 |            | 2582.0              |                      | 2154.5 |                      | E2                 | Mult.: DCO=1.46 19.                                                                                                                                                                                                                                              |
| 432.6 3                 |            | 1688.9              |                      | 1256.2 |                      | E2                 | Mult.: DCO=1.31 31, but it may be associated with 432.8 $\gamma$ , depopulating the 1509.7-keV level.                                                                                                                                                            |
| 432.8 3                 | 74 7       | 1509.7              | 25/2 <sup>-</sup>    | 1077.0 | 21/2 <sup>-</sup>    | E2                 | $I_\gamma$ : from B(E1)/B(E2)= $1.1 \times 10^{-6}$ 4 ( <b>1988Ai02</b> ).<br>Mult.: DCO=1.31 31, but it be associated with 432.6 $\gamma$ , depopulating the 1688.9-keV level.                                                                                  |
| 465.6 3                 |            | 2154.5              |                      | 1688.9 |                      |                    | Mult.: DCO=1.16 26.                                                                                                                                                                                                                                              |
| 478.8 3                 | 48 8       | 1988.5              | 29/2 <sup>-</sup>    | 1509.7 | 25/2 <sup>-</sup>    | E2                 | $I_\gamma$ : from B(E1)/B(E2)= $1.0 \times 10^{-6}$ 3 ( <b>1988Ai02</b> ).<br>Mult.: DCO=1.30 11.                                                                                                                                                                |
| 485.8 3                 |            | 3002.2              | (39/2 <sup>+</sup> ) | 2516.4 | (35/2 <sup>+</sup> ) | E2                 | Mult.: DCO=1.46 12.                                                                                                                                                                                                                                              |
| 507.0 <sup>‡</sup> 3    |            | 2618.0?             |                      | 2111.0 | 31/2 <sup>+</sup>    |                    |                                                                                                                                                                                                                                                                  |

<sup>†</sup> From **1988Ai02**. Multipolarities are based on the angular distributions and angular correlations data analysis, and on intensity balance consideration which allowed to differentiate between E1 from M1 alternatives. Since no delayed components were observed, M2 assignments were ruled out for quadrupole transitions. DCO ratios were obtained by gating on known stretched E2 transitions; expected values are >1 for stretched Q and <1 for stretched D.

<sup>‡</sup> Placement of transition in the level scheme is uncertain.

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## Level Scheme

Intensities: Relative  $I_\gamma$ 

## Legend

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



