

$^{231}\text{Th}$        $Z = 90$        $N = 141$       adopted link      ENSDF link

Based on ENSDF from Oct 2022, and mass evaluation from 2020

BE = 1760.247 ( 0.001) MeV

Qbeta- = 0.392 ( 0.002) MeV

|          | Energy T | J+       | J-    | J-other                | T1/2         |
|----------|----------|----------|-------|------------------------|--------------|
| -----    |          |          |       |                        |              |
| S-alpha= | -4.214   | ( 0.002) | ----- |                        |              |
| 231TH 1  | 0.000    | 5/2+     |       |                        | 1 25.52 H 1  |
| 231TH 2  | 0.042    | 7/2+     |       |                        | 2            |
| 231TH 3  | 0.096    | 9/2+     |       |                        | 3            |
| 231TH 4  | 0.162    | 11/2+    |       |                        | 4            |
| 231TH 5  |          |          | 0.186 | 5/2-                   | 5 1.07 NS 8  |
| 231TH 6  |          |          |       | 0.205 (7/2-)           | 6            |
| 231TH 7  | 0.221    | 3/2+     |       |                        | 7 74 PS LT   |
| 231TH 8  |          |          | 0.237 | 9/2-                   | 8            |
| 231TH 9  | 0.241    | 5/2+     |       |                        | 9            |
| 231TH 10 | 0.248    | 1/2+     |       |                        | 10 74 PS LT  |
| -----    |          |          |       |                        |              |
| 231TH 11 | 0.272    | 3/2+     |       |                        | 11           |
| 231TH 12 | 0.275    | 7/2+     |       |                        | 12           |
| 231TH 13 |          |          |       | 0.278 (11/2-)          | 13           |
| 231TH 14 | 0.302    | 5/2+     |       |                        | 14           |
| 231TH 15 | 0.317    | 5/2+     |       |                        | 15           |
| 231TH 16 |          |          |       | 0.325 (9/2+)           | 16           |
| 231TH 17 |          |          |       | 0.333 (13/2-)          | 17           |
| 231TH 18 | 0.352    | 7/2+     |       |                        | 18           |
| 231TH 19 |          |          |       | 0.378 (7/2+)           | 19           |
| 231TH 20 |          |          |       | 0.386 (11/2+)          | 20           |
| -----    |          |          |       |                        |              |
| 231TH 21 |          |          | 0.388 | 7/2-                   | 21           |
| 231TH 22 |          |          |       | 0.402 (15/2-)          | 22           |
| 231TH 23 |          |          |       | 0.447 (9/2+)           | 23           |
| 231TH 24 |          |          | 0.452 | 9/2-                   | 24           |
| 231TH 25 |          |          |       | 0.467 (1/2-, 3/2-)     | 25           |
| 231TH 26 |          |          |       | 0.490 (11/2+)          | 26           |
| 231TH 27 |          |          |       | 0.511 5/2+, 7/2+, 9/2+ | 27           |
| 231TH 28 |          |          |       | 0.530 (11/2+)          | 28           |
| 231TH 29 |          |          |       | 0.530 (11/2-)          | 29           |
| 231TH 30 |          |          |       | 0.555 (1/2-)           | 30 503 PS 12 |
| -----    |          |          |       |                        |              |
| 231TH 31 |          |          |       | 0.568                  | 31           |
| 231TH 32 |          |          |       | 0.579 (9/2+)           | 32           |
| 231TH 33 |          |          | 0.591 | 3/2-                   | 33           |
| 231TH 34 |          |          |       | 0.594 (3/2-)           | 34 0.10 NS 4 |
| 231TH 35 |          |          | 0.596 | 5/2-                   | 35           |
| 231TH 36 |          |          | 0.620 | 3/2-                   | 36           |

|          |  |       |      |       |      |  |       |               |    |
|----------|--|-------|------|-------|------|--|-------|---------------|----|
| 231TH 37 |  |       |      | 0.624 | 5/2- |  |       |               | 37 |
| 231TH 38 |  |       |      |       |      |  | 0.629 | (5/2)-        | 38 |
| 231TH 39 |  |       |      |       |      |  | 0.634 | (7/2-)        | 39 |
| 231TH 40 |  |       |      |       |      |  | 0.647 | (5/2-,7/2-)   | 40 |
| -----    |  |       |      |       |      |  |       |               |    |
| 231TH 41 |  |       |      | 0.656 | 7/2- |  |       |               | 41 |
| 231TH 42 |  |       |      |       |      |  | 0.684 | 5/2-,7/2-     | 42 |
| 231TH 43 |  | 0.688 | 1/2+ |       |      |  |       |               | 43 |
| 231TH 44 |  |       |      |       |      |  | 0.704 | (15/2-)       | 44 |
| 231TH 45 |  | 0.709 | 3/2+ |       |      |  |       |               | 45 |
| 231TH 46 |  |       |      | 0.714 | 3/2- |  |       |               | 46 |
| 231TH 47 |  |       |      |       |      |  | 0.720 | (7/2)-        | 47 |
| 231TH 48 |  |       |      |       |      |  | 0.735 | (5/2)+        | 48 |
| 231TH 49 |  |       |      |       |      |  | 0.750 | (5/2-,7/2-)   | 49 |
| 231TH 50 |  |       |      |       |      |  | 0.770 | (11/2+,13/2+) | 50 |
| -----    |  |       |      |       |      |  |       |               |    |
| 231TH 51 |  | 0.793 | 1/2+ |       |      |  |       |               | 51 |
| 231TH 52 |  |       |      |       |      |  | 0.802 |               | 52 |
| 231TH 53 |  | 0.809 | 3/2+ |       |      |  |       |               | 53 |
| 231TH 54 |  |       |      |       |      |  | 0.813 | [15/2-]       | 54 |
| 231TH 55 |  | 0.821 | 1/2+ |       |      |  |       |               | 55 |
| 231TH 56 |  |       |      |       |      |  | 0.833 | (1/2)-        | 56 |
| 231TH 57 |  | 0.839 | 3/2+ |       |      |  |       |               | 57 |
| 231TH 58 |  |       |      |       |      |  | 0.854 |               | 58 |
| 231TH 59 |  |       |      |       |      |  | 0.867 | 5/2-,7/2-     | 59 |
| 231TH 60 |  | 0.869 | 1/2+ |       |      |  |       |               | 60 |
| -----    |  |       |      |       |      |  |       |               |    |
| 231TH 61 |  |       |      |       |      |  | 0.871 | (9/2)+        | 61 |
| 231TH 62 |  |       |      |       |      |  | 0.876 | (3/2)-        | 62 |
| 231TH 63 |  | 0.890 | 5/2+ |       |      |  |       |               | 63 |
| 231TH 64 |  |       |      |       |      |  | 0.915 | (5/2)-        | 64 |
| 231TH 65 |  |       |      |       |      |  | 0.931 | (3/2+,5/2+)   | 65 |
| 231TH 66 |  |       |      |       |      |  | 0.936 | (5/2)-        | 66 |
| 231TH 67 |  |       |      |       |      |  | 0.944 |               | 67 |
| 231TH 68 |  |       |      |       |      |  | 0.947 |               | 68 |
| 231TH 69 |  | 0.961 | 3/2+ |       |      |  |       |               | 69 |
| 231TH 70 |  |       |      |       |      |  | 0.966 | (9/2+)        | 70 |
| -----    |  |       |      |       |      |  |       |               |    |
| 231TH 71 |  |       |      |       |      |  | 0.974 |               | 71 |
| 231TH 72 |  |       |      |       |      |  | 0.981 |               | 72 |
| 231TH 73 |  |       |      |       |      |  | 0.990 |               | 73 |
| 231TH 74 |  | 1.004 | 3/2+ |       |      |  |       |               | 74 |
| 231TH 75 |  |       |      |       |      |  | 1.012 |               | 75 |
| 231TH 76 |  |       |      |       |      |  | 1.016 |               | 76 |
| 231TH 77 |  |       |      | 1.021 | 3/2- |  |       |               | 77 |
| 231TH 78 |  |       |      |       |      |  | 1.033 | (1/2+)        | 78 |
| 231TH 79 |  |       |      |       |      |  | 1.056 | (3/2+)        | 79 |
| 231TH 80 |  |       |      |       |      |  | 1.066 | 5/2+,7/2+     | 80 |
| -----    |  |       |      |       |      |  |       |               |    |
| 231TH 81 |  |       |      |       |      |  | 1.074 | (3/2)-        | 81 |

|           |  |       |      |       |      |       |             |     |
|-----------|--|-------|------|-------|------|-------|-------------|-----|
| 231TH 82  |  |       |      |       |      | 1.081 | 1/2-,3/2-   | 82  |
| 231TH 83  |  | 1.087 | 5/2+ |       |      |       |             | 83  |
| 231TH 84  |  |       |      |       |      | 1.092 |             | 84  |
| 231TH 85  |  |       |      | 1.102 | 3/2- |       |             | 85  |
| 231TH 86  |  |       |      |       |      | 1.106 |             | 86  |
| 231TH 87  |  |       |      |       |      | 1.115 |             | 87  |
| 231TH 88  |  |       |      |       |      | 1.126 | (3/2+,5/2+) | 88  |
| 231TH 89  |  |       |      |       |      | 1.134 | (1/2+,3/2+) | 89  |
| 231TH 90  |  |       |      |       |      | 1.154 |             | 90  |
| -----     |  |       |      |       |      |       |             |     |
| 231TH 91  |  |       |      |       |      | 1.160 | (3/2)-      | 91  |
| 231TH 92  |  |       |      | 1.173 | 3/2- |       |             | 92  |
| 231TH 93  |  |       |      |       |      | 1.181 | (1/2-,3/2-) | 93  |
| 231TH 94  |  |       |      |       |      | 1.187 |             | 94  |
| 231TH 95  |  |       |      |       |      | 1.201 | (1/2-,3/2-) | 95  |
| 231TH 96  |  |       |      |       |      | 1.213 |             | 96  |
| 231TH 97  |  |       |      |       |      | 1.220 |             | 97  |
| 231TH 98  |  |       |      |       |      | 1.226 |             | 98  |
| 231TH 99  |  |       |      |       |      | 1.235 |             | 99  |
| 231TH 100 |  |       |      |       |      | 1.262 |             | 100 |
| -----     |  |       |      |       |      |       |             |     |
| 231TH 101 |  |       |      |       |      | 1.273 | (3/2+,5/2+) | 101 |
| 231TH 102 |  |       |      |       |      | 1.282 |             | 102 |
| 231TH 103 |  |       |      |       |      | 1.292 |             | 103 |
| 231TH 104 |  |       |      |       |      | 1.300 |             | 104 |
| 231TH 105 |  |       |      |       |      | 1.323 |             | 105 |
| 231TH 106 |  |       |      |       |      | 1.327 |             | 106 |
| 231TH 107 |  |       |      |       |      | 1.339 |             | 107 |
| 231TH 108 |  |       |      |       |      | 1.346 |             | 108 |
| 231TH 109 |  |       |      |       |      | 1.353 | (1/2-,3/2-) | 109 |
| 231TH 110 |  |       |      |       |      | 1.366 |             | 110 |
| -----     |  |       |      |       |      |       |             |     |
| 231TH 111 |  |       |      |       |      | 1.372 |             | 111 |
| 231TH 112 |  |       |      |       |      | 1.393 | (1/2-,3/2-) | 112 |
| 231TH 113 |  |       |      |       |      | 1.406 | (1/2-,3/2-) | 113 |
| 231TH 114 |  |       |      |       |      | 1.414 |             | 114 |
| 231TH 115 |  |       |      |       |      | 1.431 |             | 115 |
| 231TH 116 |  |       |      |       |      | 1.437 | (3/2+,5/2+) | 116 |
| 231TH 117 |  |       |      |       |      | 1.452 |             | 117 |
| 231TH 118 |  |       |      |       |      | 1.458 |             | 118 |
| 231TH 119 |  |       |      |       |      | 1.464 |             | 119 |
| 231TH 120 |  |       |      |       |      | 1.476 |             | 120 |
| -----     |  |       |      |       |      |       |             |     |
| 231TH 121 |  |       |      |       |      | 1.487 | (1/2-,3/2-) | 121 |
| 231TH 122 |  |       |      |       |      | 1.494 |             | 122 |
| 231TH 123 |  |       |      |       |      | 1.523 |             | 123 |
| 231TH 124 |  |       |      |       |      | 1.533 |             | 124 |
| 231TH 125 |  |       |      |       |      | 1.542 |             | 125 |
| 231TH 126 |  |       |      |       |      | 1.572 | (5/2-,7/2-) | 126 |
| 231TH 127 |  |       |      |       |      | 1.585 | (1/2-,3/2-) | 127 |

|           |  |  |  |       |             |     |
|-----------|--|--|--|-------|-------------|-----|
| 231TH 128 |  |  |  | 1.601 | (1/2-,3/2-) | 128 |
| 231TH 129 |  |  |  | 1.608 |             | 129 |
| 231TH 130 |  |  |  | 1.620 | (1/2-,3/2-) | 130 |
| -----     |  |  |  |       |             |     |
| 231TH 131 |  |  |  | 1.627 |             | 131 |
| 231TH 132 |  |  |  | 1.648 |             | 132 |
| 231TH 133 |  |  |  | 1.654 |             | 133 |
| 231TH 134 |  |  |  | 1.666 |             | 134 |
| 231TH 135 |  |  |  | 1.678 |             | 135 |
| 231TH 136 |  |  |  | 1.696 |             | 136 |
| 231TH 137 |  |  |  | 1.708 | (1/2-,3/2-) | 137 |
| 231TH 138 |  |  |  | 1.714 |             | 138 |

S-p = 7.311 ( 0.016)-----  
 S-n = 5.118 ( 0.002)-----  
 S-2p = 13.324 ( 0.015)-----  
 S-2n = 11.912 ( 0.003)-----  
 S-alpha= -4.214 ( 0.002)-----

S+p = -5.158 ( 0.008)  
 S+n = -6.441 ( 0.002)  
 S+2p = -11.475 ( 0.003)  
 S+2n = -11.227 ( 0.002)  
 S+alpha = 4.678 ( 0.002)

gap p = 2.153 ( 0.018)  
 gap n = -1.323 ( 0.003)  
 gap 2p = 1.849 ( 0.016)  
 gap 2n = 0.685 ( 0.003)  
 gap alpha = 0.464 ( 0.003)