## $^{64}$Zn(p,n$\gamma$)    **1974Ha42,1974Ro16**

### History

| Type | Author | Citation | Literature Cutoff Date |
|------|--------|----------|------------------------|
| Full Evaluation | Balraj Singh and Jun Chen | NDS 178, 41 (2021). | 12-Nov-2021 |

1974Ha42: E(p)=8.0-10.5 MeV. Measured E$\gamma$, I$\gamma$, excitation function, $\gamma(\theta)$, $\gamma$(t).
1974Ro16: E(p)=7.8-9.5 MeV. Measured E$\gamma$.
Others:
1999Ta29: $^{63}$Cu($^{3}$He,2n),E($^{3}$He)=16 MeV. Measured half-life of the first excited state by pulsed-beam method and time decay of
    42.88$\gamma$.
1984ScZO: E(p)=8-16 MeV. Details are not available.
1973WyZZ, 1972KiZQ: E(p)=7.5-16 MeV. Measured E$\gamma$, $\gamma\gamma$- and n$\gamma$-coin, conversion electrons.

### $^{64}$Ga Levels

| E(level)[†] | J$^{\pi}$[‡] | T$_{1/2}$ | Comments |
|-------------|--------------|-----------|----------|
| 0.0 | 0$^+$ | | |
| 42.82 _7_ | (2$^+$) | 21.9 $\mu$s _7_ | T$_{1/2}$: pulsed-beam method (1999Ta29). Other: >1 $\mu$s ($\gamma$(t),(1974Ha42)). |
| 127.98 _11_ | 1$^+$ | 6.9 ns _7_ | T$_{1/2}$: 85.2$\gamma$(t) (1974Ha42). |
| 170.93 _11_ | (3$^+$) | $\approx$3 ns | No 42.9$\gamma$ seen in prompt spectrum (I$\gamma$<3) (1974Ha42). |
| | | | T$_{1/2}$: $\approx$3 ns or less; based on two-component analysis of 128$\gamma$(t) curve. |
| 322.89 _8_ | (2$^+$) | | |
| 427.08 _6_ | 1$^+$ | | |
| 534.53 _12_ | (3$^+$) | | |
| 538.02 _12_ | (4$^+$) | | |
| 550.21 _11_ | (1,2$^+$) | | |
| 605.3 _4_ | (2$^+$,3$^-$) | | |
| 666.87 _19_ | 1$^+$ | | |
| 707.10 _13_ | (4$^+$) | | |
| 712.11 _15_ | | | |
| 765.25 _16_ | (3,2$^+$) | | |
| 817.4? _3_ | (1$^+$) | | Level population suggested by the evaluator on the basis of an 818 group reported in (p,n) and |
| | | |     ($^{3}$He,t). |
| 828.96 _18_ | | | |

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

### $\gamma(^{64}$Ga)

| E$_{\gamma}$[†] | I$_{\gamma}$[‡] | E$_i$(level) | J$^{\pi}_i$ | E$_f$ | J$^{\pi}_f$ | Mult. | $\alpha$[b] | Comments |
|-----------------|-----------------|--------------|-------------|-------|-------------|-------|-------------|----------|
| 42.88 _10_ | 17 _3_ | 42.82 | (2$^+$) | 0.0 | 0$^+$ | (E2) | 16.23 _12_ | Mult.: $\alpha \geq$12.5 (1974Ha42) (from observed and inferred yield of 42.9 level) suggests 43$\gamma$ not dipole. The detection of 43$\gamma$ as photons suggests that multipolarity is not higher than E2 or M2. For mult=M2, the half-life should be higher than 21.9 $\mu$s. |
| 85.29 _14_ | 44 _9_ | 127.98 | 1$^+$ | 42.82 | (2$^+$) | | | |
| $^x$123.2[@] _5_ | | | | | | | | |
| 128.2[d] _2_ | $\approx$121[d] | 127.98 | 1$^+$ | 0.0 | 0$^+$ | | | I$\gamma$(doublet)=242, equally divided amongst two components, on the basis of excitation functions by 1974Ha42. |
| | | | | | | | | Strong conversion line reported (1973WyZZ). |
| 128.2[d] _2_ | $\approx$121[d] | 170.93 | (3$^+$) | 42.82 | (2$^+$) | | | |

Continued on next page (footnotes at end of table)

$^{64}$Zn(p,n$\gamma$)　　**1974Ha42,1974Ro16 (continued)**

$\gamma$($^{64}$Ga) (continued)

| $E_\gamma^\dagger$ | $I_\gamma^\ddagger$ | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Comments |
|---|---|---|---|---|---|---|
| 152.06 *17* | 7.3 *15* | 322.89 | (2$^+$) | 170.93 | (3$^+$) | |
| 227.23$^{c\#}$ *10* | 3.6$^{ca}$ *7* | 550.21 | (1,2$^+$) | 322.89 | (2$^+$) | |
| 227.23$^c$ *10* | 3.6$^c$ *7* | 765.25 | (3,2$^+$) | 538.02 | (4$^+$) | |
| 280.10 *14* | 49 *10* | 322.89 | (2$^+$) | 42.82 | (2$^+$) | |
| 290.93 *12* | 16$^a$ *3* | 828.96 | | 538.02 | (4$^+$) | |
| 322.91 *10* | 15 *3* | 322.89 | (2$^+$) | 0.0 | 0$^+$ | |
| 363.61 *14* | 14 *3* | 534.53 | (3$^+$) | 170.93 | (3$^+$) | |
| 367.12 *15* | 18 *4* | 538.02 | (4$^+$) | 170.93 | (3$^+$) | |
| 384.59$^d$ *16* | 4.4$^d$ *10* | 427.08 | 1$^+$ | 42.82 | (2$^+$) | Placement based on $^{64}$Ge $\varepsilon$ decay (1974Ro16). $I_\gamma$: total intensity for doublet=10.6 (1974Ha42). |
| 384.59$^d$ *16* | 6.6$^d$ *23* | 707.10 | (4$^+$) | 322.89 | (2$^+$) | |
| $^x$420.6 *3* | 18$^a$ *4* | | | | | |
| 422.56$^\#$ *20* | 20$^a$ *4* | 550.21 | (1,2$^+$) | 127.98 | 1$^+$ | |
| 427.03 *6* | 35 *7* | 427.08 | 1$^+$ | 0.0 | 0$^+$ | |
| 434.4 *3* | 10 *2* | 605.3 | (2$^+$,3$^-$) | 170.93 | (3$^+$) | |
| 491.69 *12* | 20 *4* | 534.53 | (3$^+$) | 42.82 | (2$^+$) | |
| 495.18 *13* | 29 *6* | 538.02 | (4$^+$) | 42.82 | (2$^+$) | |
| 541.10$^\#$ *15* | 20$^a$ *4* | 712.11 | | 170.93 | (3$^+$) | |
| 550.2 *3* | 5.4$^a$ *10* | 550.21 | (1,2$^+$) | 0.0 | 0$^+$ | |
| 584.25 *19* | 11 *2* | 712.11 | | 127.98 | 1$^+$ | |
| $^x$592.8$^@$ *3* | | | | | | |
| $^x$656.6$^@$ *3* | | | | | | |
| 663.89$^\#$ *16* | 19$^a$ *4* | 707.10 | (4$^+$) | 42.82 | (2$^+$) | |
| 666.87 *19* | 30$^a$ *6* | 666.87 | 1$^+$ | 0.0 | 0$^+$ | |
| $^x$682.7$^@$ *4* | | | | | | |
| 774.6$^{@e}$ *3* | | 817.4? | (1$^+$) | 42.82 | (2$^+$) | |
| $^x$859$^{\&e}$ | | | | | | |
| $^x$885.9$^@$ *3* | | | | | | |
| $^x$1314$^{\&e}$ | | | | | | |
| $^x$1522$^{\&e}$ | | | | | | |

$^\dagger$ Weighted average of values from 1974Ha42 and 1974Ro16.

$^\ddagger$ $\gamma$-ray cross sections (in mb) at 10 MeV (1974Ha42), from Legendre polynomial fit to $\gamma(\theta)$ data.

$^\#$ Reported only by 1974Ha42.

$^@$ Reported only by 1974Ro16.

$^\&$ Reported only by 1973WyZZ.

$^a$ For 90° data.

$^b$ Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on $\gamma$-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

$^c$ Multiply placed with undivided intensity.

$^d$ Multiply placed with intensity suitably divided.

$^e$ Placement of transition in the level scheme is uncertain.
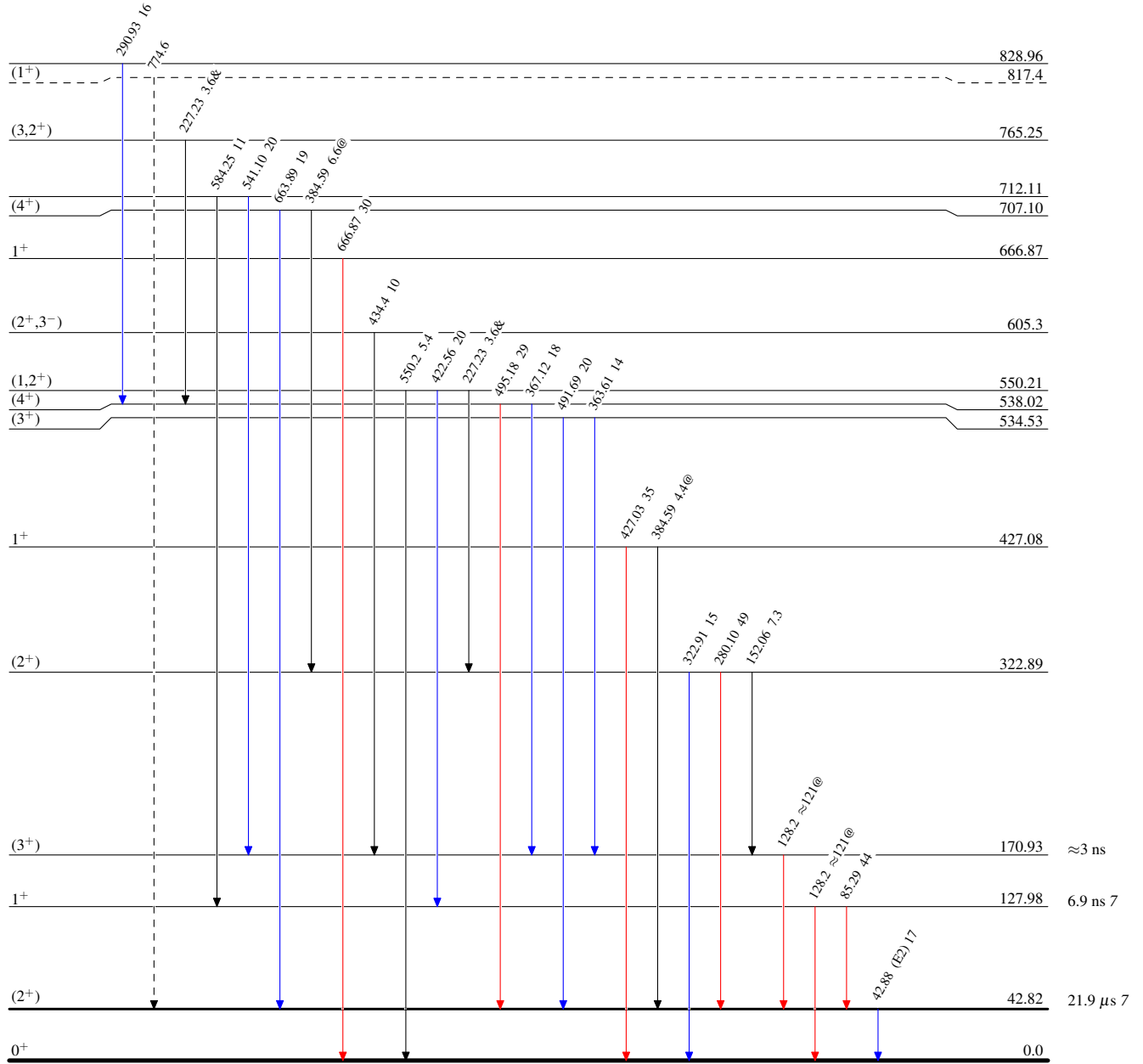
$^x$ $\gamma$ ray not placed in level scheme.

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<u>Level Scheme</u>

Intensities: Relative $I_\gamma$
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided

Legend

→ $I_\gamma < 2\% \times I_\gamma^{max}$
→ $I_\gamma < 10\% \times I_\gamma^{max}$
→ $I_\gamma > 10\% \times I_\gamma^{max}$
⇢ γ Decay (Uncertain)



$^{64}_{31}Ga_{33}$