## $^{64}$Ni($^{12}$C,p2n$\gamma$) 2015Ra20

History

| Type | Author | Citation | Literature Cutoff Date |
|---|---|---|---|
| Full Evaluation | Balraj Singh and Jun Chen | NDS 158, 1 (2019) | 16-May-2019 |

2015Ra20 (also 2012Ra22): 55 MeV $^{12}$C beam from the 15UD Pelletron at the Inter-University Accelerator Center (IUAC), New Delhi. Target=enriched, ≈1.5 mg/cm$^2$ thick $^{64}$Ni target with a thick Au backing. The $\gamma$-rays were detected using Gamma Detector Array (GDA) consisting of 12 Compton-suppressed n-type HPGe detectors with anti-Compton shields. Measured E$\gamma$, I$\gamma$, $\gamma\gamma$-coin, $\gamma\gamma(\theta)$(DCO). Deduced high-spin levels, $J^\pi$, multipolarities, alignments, configurations. Results discussed in the context of triaxial particle-rotor model, cranked shell model and relativistic mean-field calculations.

### $^{73}$As Levels

| E(level)[†] | J$^\pi$[‡] | Comments |
|---|---|---|
| 0.0 | 3/2$^-$ | |
| 67.0[#] *7* | 5/2$^-$ | |
| 428.1[&] *10* | 9/2$^+$ | |
| 577.0 *7* | 7/2$^-$ | J$^\pi$: 5/2$^-$ in Adopted Levels. |
| 861.0[@] *7* | 7/2$^-$ | |
| 929.2[#] *9* | 9/2$^-$ | |
| 1037.1[&] *10* | 13/2$^+$ | |
| 1177.9 *8* | 9/2$^-$ | |
| 1293.1 *12* | 11/2$^+$ | |
| 1657.9[@] *8* | 11/2$^-$ | |
| 1761.1 *12* | | |
| 1948.9[&] *12* | 17/2$^+$ | |
| 2039.8[#] *9* | 13/2$^-$ | |
| 2474.7[@] *10* | 15/2$^-$ | |
| 2847.7[#] *11* | 17/2$^-$ | |
| 2965.7[&] *14* | 21/2$^+$ | |
| 3049.9[a] *14* | 19/2$^{(+)}$ | |
| 3371.7[@] *12* | 19/2$^-$ | |
| 3490.1[b] *14* | 21/2$^{(+)}$ | |
| 3750.7[#] *15* | 21/2$^-$ | |
| 3841.7[c] *15* | 19/2$^{(-)}$ | |
| 4023.7[a] *14* | 23/2$^{(+)}$ | |
| 4082.7[&] *17* | 25/2$^+$ | |
| 4456.7[@] *16* | 23/2$^-$ | |
| 4586.5[b] *14* | (25/2$^+$) | |
| 4869.7[#] *18* | 25/2$^-$ | |
| 4963.7[c] *18* | (23/2$^-$) | |
| 5117.8 *18* | | |
| 5411.7[a] *18* | (27/2$^+$) | |
| 5411.8[&] *20* | 29/2$^+$ | |
| 5685.7[@] *19* | 27/2$^-$ | |
| 5953.5[b] *18* | (29/2$^+$) | |
| 6131.8[#] *20* | 29/2$^-$ | |
| 6310.8[c] *20* | (27/2$^-$) | |
| 6908.7[&] *22* | 33/2$^+$ | |
| 7433.8[#] *23* | 33/2$^-$ | |

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## $^{64}$Ni($^{12}$C,p2n$\gamma$) 2015Ra20 (continued)

### $^{73}$As Levels (continued)

| E(level)[†] | J$^\pi$[‡] |
|---|---|
| 8610.8[&] *24* | (37/2$^+$) |
| 8787.8[#] *25* | (37/2$^-$) |

[†] From least-squares fit to E$\gamma$ data, assuming $\Delta$E$\gamma$=1 keV for each E$\gamma$.
[‡] As proposed in 2015Ra20, based on previous assignments for low-lying low-spin levels, and DCO data and band assignments for high-spin levels.
[#] Band(A): Favored band based on 5/2$^-$,$\alpha$=+1/2. At low spins, configuration=$\pi(2p_{3/2}1f_{5/2}2p_{1/2})^5$. First band crossing at $\hbar\omega\approx$0.45 MeV due to pair of $g_{9/2}$ neutrons, second possible band crossing at $\hbar\omega\approx$0.6 MeV due to pair of $g_{9/2}$ protons; 3qp configuration after first crossing and 5qp configuration after second band crossing.
[@] Band(a): Unfavored band based on 7/2$^-$,$\alpha$=−1/2. At low spins, configuration=$\pi(2p_{3/2}1f_{5/2}2p_{1/2})^5$. First band crossing at $\hbar\omega\approx$0.45 MeV due to pair of $g_{9/2}$ neutrons, 3qp configuration after first crossing.
[&] Band(B): Band built on $\pi g_{9/2}$,$\alpha$=+1/2. Decoupled (favored) band. At low spins, configuration is $\pi g_{9/2}$, while at higher spins, configuration=$\pi g_{9/2}\otimes\nu g^2_{9/2}$. Unfavored partner of this band is not seen.
[a] Band(C): Band based on 19/2$^{(+)}$.
[b] Band(c): Band based on 21/2$^{(+)}$.
[c] Band(D): Band based on 19/2$^{(-)}$.

### $\gamma$($^{73}$As)

$R_{DCO}$ were measured by gating on $\Delta$J=2 stretched quadrupole transitions where expected DCO ratios are ≈1 for stretched quadrupole transitions, and ≈0.5 for stretched dipole transitions.

| E$_\gamma$ | I$_\gamma$ | E$_i$(level) | J$_i^\pi$ | E$_f$ | J$_f^\pi$ | Mult. | Comments |
|---|---|---|---|---|---|---|---|
| 67 | | 67.0 | 5/2$^-$ | 0.0 | 3/2$^-$ | | |
| 317 | 0.6 *3* | 1177.9 | 9/2$^-$ | 861.0 | 7/2$^-$ | | |
| 361 | | 428.1 | 9/2$^+$ | 67.0 | 5/2$^-$ | | |
| 373 | 1.8 *4* | 2847.7 | 17/2$^-$ | 2474.7 | 15/2$^-$ | | |
| 382 | 2.1 *4* | 2039.8 | 13/2$^-$ | 1657.9 | 11/2$^-$ | | |
| 434 | 3.3 *9* | 2474.7 | 15/2$^-$ | 2039.8 | 13/2$^-$ | | |
| 440 | 0.8 *4* | 3490.1 | 21/2$^{(+)}$ | 3049.9 | 19/2$^{(+)}$ | | |
| 468 | 1.2 *3* | 1761.1 | | 1293.1 | 11/2$^+$ | | |
| 480 | 4.2 *5* | 1657.9 | 11/2$^-$ | 1177.9 | 9/2$^-$ | (D) | DCO=0.68 *14* |
| 510 | 5.4 *9* | 577.0 | 7/2$^-$ | 67.0 | 5/2$^-$ | | |
| 524 | [†] | 3371.7 | 19/2$^-$ | 2847.7 | 17/2$^-$ | | |
| 526 | [†] | 2474.7 | 15/2$^-$ | 1948.9 | 17/2$^+$ | | |
| 563 | 2.2 *4* | 4586.5 | (25/2$^+$) | 4023.7 | 23/2$^{(+)}$ | | |
| 577 | 2.5 *3* | 577.0 | 7/2$^-$ | 0.0 | 3/2$^-$ | | |
| 601 | 3.7 *3* | 1177.9 | 9/2$^-$ | 577.0 | 7/2$^-$ | | |
| 609 | 100 | 1037.1 | 13/2$^+$ | 428.1 | 9/2$^+$ | | |
| 724 | 2.2 *4* | 1761.1 | | 1037.1 | 13/2$^+$ | | |
| 729 | 1.8 *4* | 1657.9 | 11/2$^-$ | 929.2 | 9/2$^-$ | | |
| 794 | 7.5 *8* | 861.0 | 7/2$^-$ | 67.0 | 5/2$^-$ | D | DCO=0.64 *11* |
| 797 | 10.7 *7* | 1657.9 | 11/2$^-$ | 861.0 | 7/2$^-$ | Q | DCO=1.02 *10* |
| 808 | 34.3 *10* | 2847.7 | 17/2$^-$ | 2039.8 | 13/2$^-$ | Q | DCO=1.10 *9* |
| 817 | 14.0 *12* | 2474.7 | 15/2$^-$ | 1657.9 | 11/2$^-$ | Q | DCO=1.12 *16* |
| 861 | 10.5 *9* | 861.0 | 7/2$^-$ | 0.0 | 3/2$^-$ | Q | DCO=1.12 *11* |
| 862[‡] | 71.2[‡] *11* | 929.2 | 9/2$^-$ | 67.0 | 5/2$^-$ | Q | DCO=1.01 *9* |

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## $^{64}$Ni($^{12}$C,p2n$\gamma$) 2015Ra20 (continued)

### $\gamma$($^{73}$As) (continued)

| $E_\gamma$ | $I_\gamma$ | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Mult. | Comments |
|---|---|---|---|---|---|---|---|
| 862‡ | 2.6‡ *5* | 2039.8 | 13/2$^-$ | 1177.9 | 9/2$^-$ | | |
| 865 | 2.1 *7* | 1293.1 | 11/2$^+$ | 428.1 | 9/2$^+$ | | |
| 897 | 9.6 *7* | 3371.7 | 19/2$^-$ | 2474.7 | 15/2$^-$ | Q | DCO=1.15 *15* |
| 903 | 20.3 *9* | 3750.7 | 21/2$^-$ | 2847.7 | 17/2$^-$ | Q | DCO=1.12 *7* |
| 912 | 78.3 *9* | 1948.9 | 17/2$^+$ | 1037.1 | 13/2$^+$ | Q | DCO=0.98 *4* |
| 974 | 3.1 *4* | 4023.7 | 23/2$^{(+)}$ | 3049.9 | 19/2$^{(+)}$ | Q | DCO=1.13 *18* |
| 994 | 4.5 *5* | 3841.7 | 19/2$^{(-)}$ | 2847.7 | 17/2$^-$ | D | DCO=0.54 *21* |
| 1002 | 6.4 *9* | 2039.8 | 13/2$^-$ | 1037.1 | 13/2$^+$ | D | DCO=0.92 *13*<br>Mult.: $\Delta$J=0, dipole transition. |
| 1017 | 48.9 *10* | 2965.7 | 21/2$^+$ | 1948.9 | 17/2$^+$ | Q | DCO=1.05 *11* |
| 1058 | 3.9 *6* | 4023.7 | 23/2$^{(+)}$ | 2965.7 | 21/2$^+$ | D | DCO=0.71 *14* |
| 1085 | 5.9 *8* | 4456.7 | 23/2$^-$ | 3371.7 | 19/2$^-$ | Q | DCO=1.15 *15* |
| 1096 | 3.6 *5* | 4586.5 | (25/2$^+$) | 3490.1 | 21/2$^{(+)}$ | | |
| 1101 | 9.2 *7* | 3049.9 | 19/2$^{(+)}$ | 1948.9 | 17/2$^+$ | D | DCO=0.72 *13* |
| 1110 | 41.3 *13* | 2039.8 | 13/2$^-$ | 929.2 | 9/2$^-$ | Q | DCO=0.99 *5* |
| 1111 | 4.6 *7* | 1177.9 | 9/2$^-$ | 67.0 | 5/2$^-$ | Q | DCO=1.17 *14* |
| 1117 | 26.5 *12* | 4082.7 | 25/2$^+$ | 2965.7 | 21/2$^+$ | Q | DCO=0.98 *10* |
| 1119 | 8.1 *9* | 4869.7 | 25/2$^-$ | 3750.7 | 21/2$^-$ | Q | DCO=1.10 *12* |
| 1122 | 1.3 *4* | 4963.7 | (23/2$^-$) | 3841.7 | 19/2$^{(-)}$ | | |
| 1229 | 4.3 *4* | 5685.7 | 27/2$^-$ | 4456.7 | 23/2$^-$ | Q | DCO=1.15 *16* |
| 1262 | 7.2 *7* | 6131.8 | 29/2$^-$ | 4869.7 | 25/2$^-$ | Q | DCO=1.16 *17* |
| 1276 | 0.7 *5* | 5117.8 | | 3841.7 | 19/2$^{(-)}$ | | |
| 1302 | 4.5 *6* | 7433.8 | 33/2$^-$ | 6131.8 | 29/2$^-$ | Q | DCO=1.20 *17* |
| 1329 | 9.7 *6* | 5411.8 | 29/2$^+$ | 4082.7 | 25/2$^+$ | Q | DCO=1.08 *11* |
| 1347 | 1.0 *5* | 6310.8 | (27/2$^-$) | 4963.7 | (23/2$^-$) | | |
| 1354 | 1.5 *7* | 8787.8 | (37/2$^-$) | 7433.8 | 33/2$^-$ | | |
| 1367 | 0.9 *4* | 5953.5 | (29/2$^+$) | 4586.5 | (25/2$^+$) | | |
| 1388 | 0.9 *5* | 5411.7 | (27/2$^+$) | 4023.7 | 23/2$^{(+)}$ | | |
| 1438 | 5.9 *7* | 2474.7 | 15/2$^-$ | 1037.1 | 13/2$^+$ | | DCO=1.65 *19*<br>DCO value is inconsistent with 15/2$^-$ to 13/2$^+$, dipole transition as given in Table I of 2015Ra20. DCO is also too large for $\Delta$J=2,Q or $\Delta$J=0, dipole. It seems consistent with $\Delta$J=0 or 1, dipole with significant quadrupole admixture. |
| 1497 | 4.0 *6* | 6908.7 | 33/2$^+$ | 5411.8 | 29/2$^+$ | Q | DCO=1.17 *17* |
| 1541 | 5.8 *7* | 3490.1 | 21/2$^{(+)}$ | 1948.9 | 17/2$^+$ | Q | DCO=1.21 *16* |
| 1621 | 3.6 *4* | 4586.5 | (25/2$^+$) | 2965.7 | 21/2$^+$ | Q | DCO=1.17 *18* |
| 1702 | 2.9 *5* | 8610.8 | (37/2$^+$) | 6908.7 | 33/2$^+$ | | |

† Intensity is not listed in Table I of 2015Ra20. From the width of the arrow in authors′ level-scheme Fig. 1, I$\gamma$ is estimated as <2.
‡ Multiply placed with intensity suitably divided.

## $^{64}$Ni($^{12}$C,p2n$\gamma$) 2015Ra20

Level Scheme

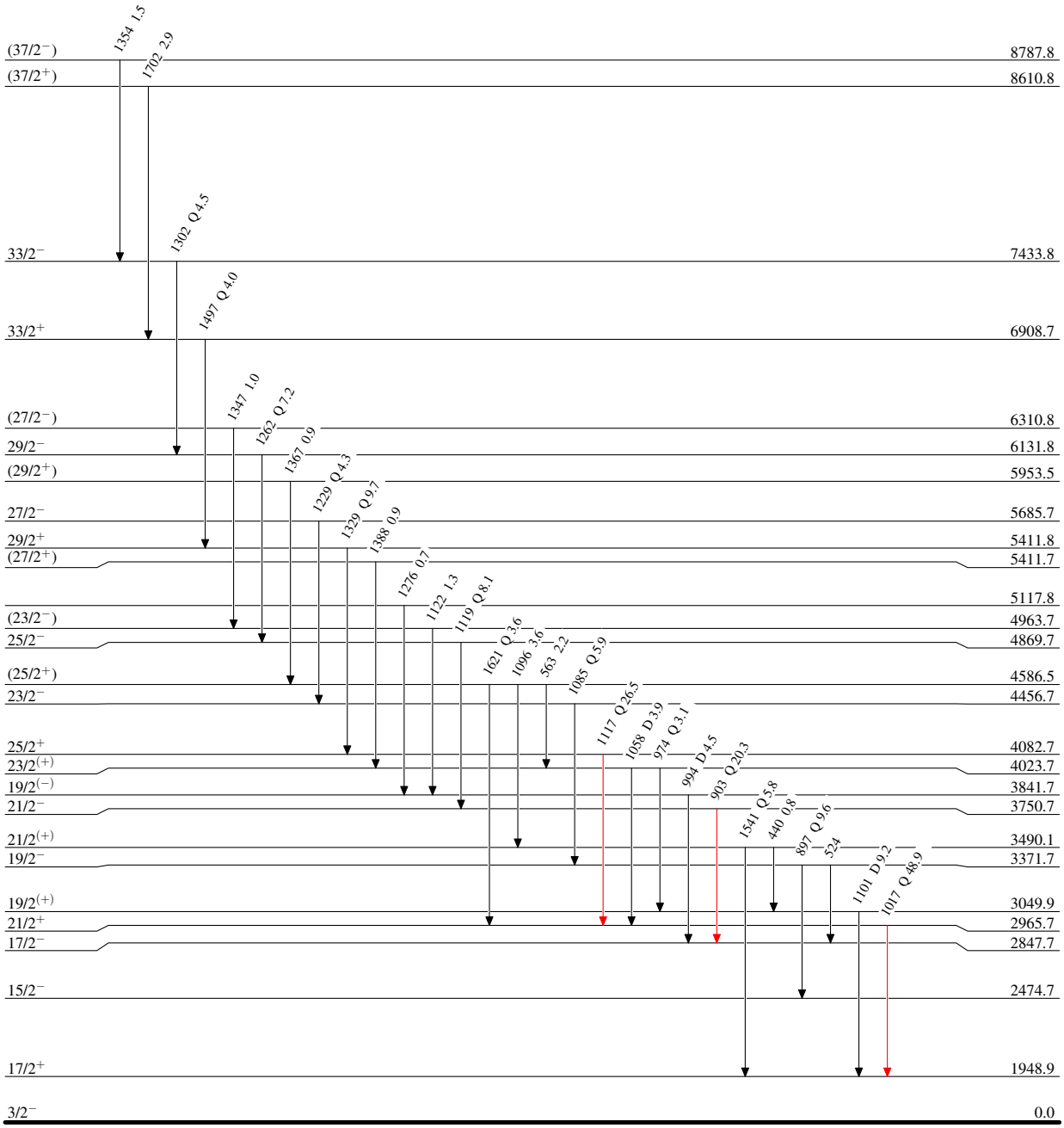
Intensities: Relative $I_\gamma$

Legend

$I_\gamma < 2\% \times I_\gamma^{max}$

$I_\gamma < 10\% \times I_\gamma^{max}$

$I_\gamma > 10\% \times I_\gamma^{max}$



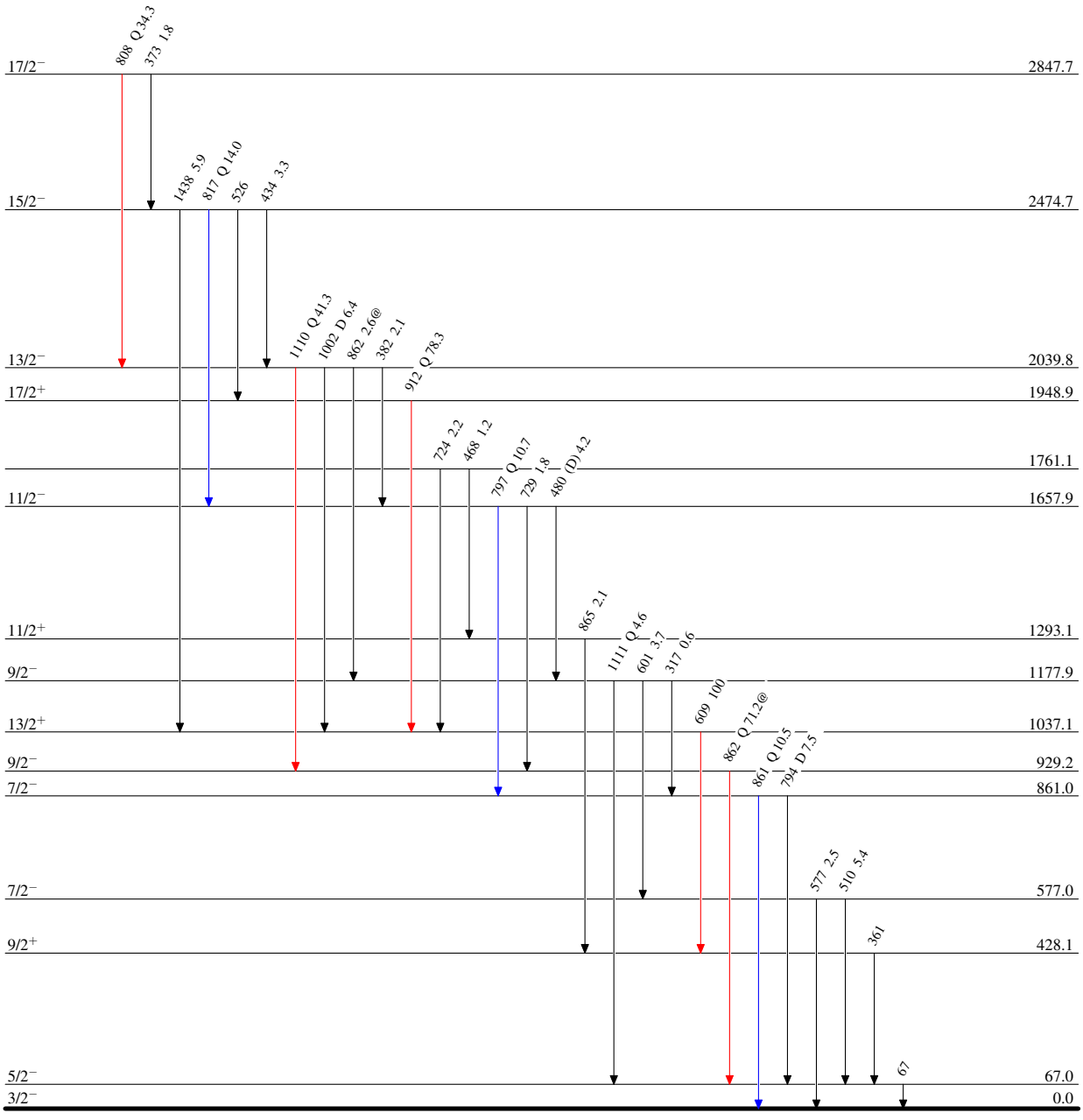

$^{73}_{33}As_{40}$

## $^{64}$Ni($^{12}$C,p2n$\gamma$) 2015Ra20

### Level Scheme (continued)

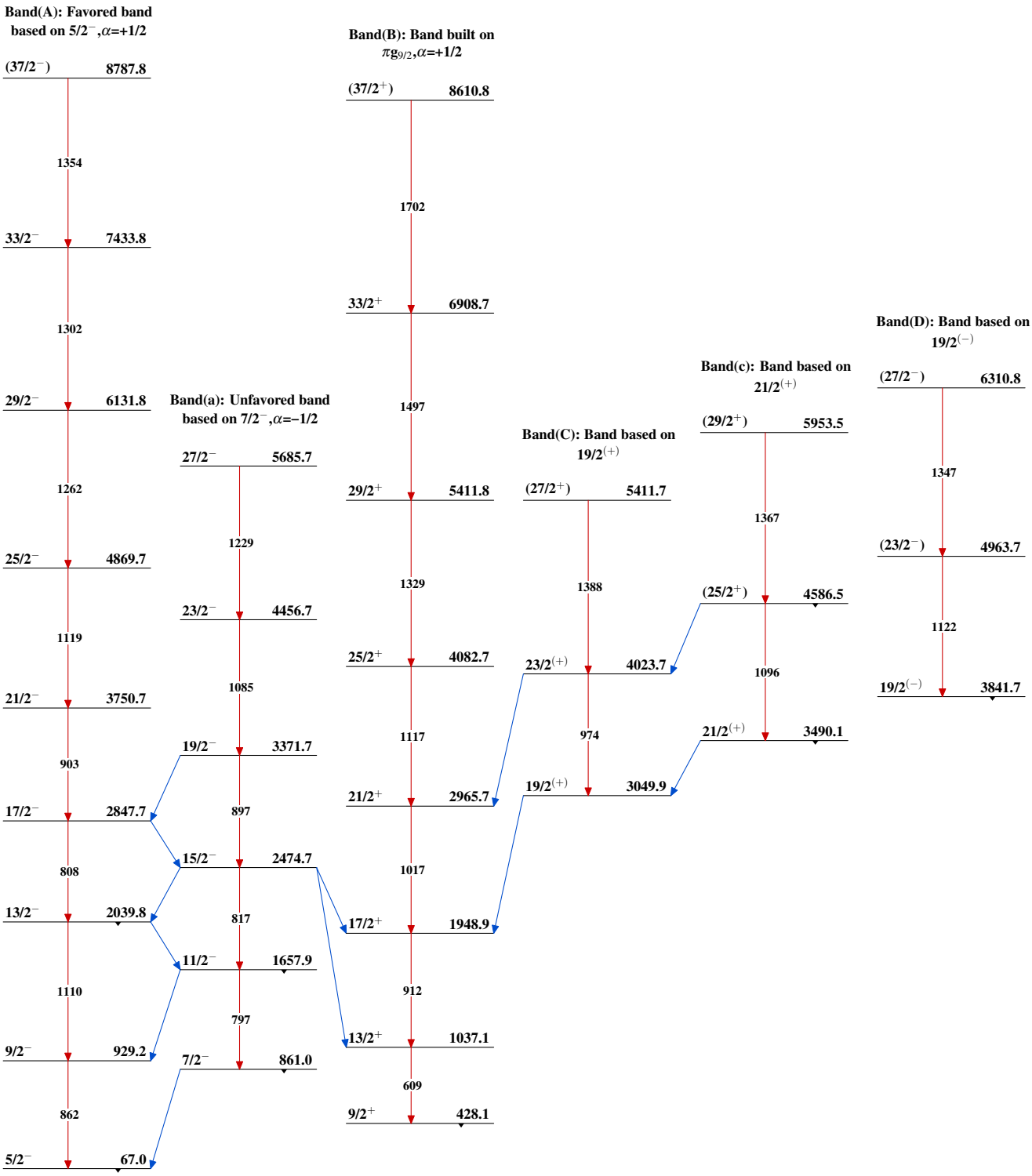
Intensities: Relative $I_\gamma$
@ Multiply placed: intensity suitably divided

Legend
$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$




$^{73}_{33}As_{40}$

## $^{64}Ni(^{12}C,p2n\gamma)$ 2015Ra20




$^{73}_{33}As_{40}$