## Adopted Levels, Gammas

| History | | | |
|---|---|---|---|
| Type | Author | Citation | Literature Cutoff Date |
| Full Evaluation | M. Shamsuzzoha Basunia, Anagha Chakraborty | NDS 186, 2 (2022) | 31-Mar-2022 |

Q($\beta^-$)=−10794 *19*; S(n)=14868.2 *4*; S(p)=1864.11 *23*; Q($\alpha$)=−9324.2 *11* 2021Wa16
S(2n)=34390 *400* (syst), S(2p)=9445.36 *26*, Q($\varepsilon$p)=2192.07 *23* (2021Wa16).
Mass measurement: 2015Ch58.

### $^{24}$Al Levels

Cross Reference (XREF) Flags

| | | | |
|---|---|---|---|
| A | $^{24}$Al IT decay (130.7 ms) | F | $^{23}$Na(pol p,$\pi^-$) |
| B | $^{24}$Si $\varepsilon$ decay (141.3 ms) | G | $^{24}$Mg(p,n) |
| C | $^{1}$H($^{23}$Mg,$\gamma$) | H | $^{24}$Mg($^{3}$He,t) |
| D | $^{1}$H($^{23}$Mg,p) | I | $^{27}$Al($^{3}$He,$^{6}$He) |
| E | $^{10}$B($^{16}$O,2n$\gamma$) | | |

| E(level)[†] | J$^\pi$ | T$_{1/2}$ | XREF | Comments |
|---|---|---|---|---|
| 0 | 4$^+$ | 2.053 s *4* | AB EFGH | %$\varepsilon$+%$\beta^+$=100; %$\varepsilon\alpha$=0.035 *6*; %$\varepsilon$p=0.0016 *3*<br>%$\varepsilon\alpha$: from 1979Ho08. %$\varepsilon$p/$\varepsilon\alpha$=0.047 *2* (1994Ba54). Other value: %$\varepsilon\alpha$=0.069 *10* (1971To12).<br>T$_{1/2}$: from 1985Ad10. Other values: 2.054 s *9* (1971Go18), 2.0 s ($\alpha$(t)−1969St14), 1.9 s *1* and 2.5 s *10* ($\alpha$(t) and p(t), respectively (1994Ba54 − measurement time was about 4 s), 2.10 s *4* (1953Gl32), 2.3 s *2* (1952Bi12).<br>J$^\pi$: Mirror state to $^{24}$Na ground state. L=4 in ($^{3}$He,t). |
| 425.81 *10* | 1$^+$ | 130.7 ms *13* | AB E GH | %IT=69.6 *7*; %$\varepsilon$+%$\beta^+$=30.4 *7*; %$\varepsilon\alpha$=0.028 *6*<br>T=1<br>$\mu$=2.99 *9*<br>XREF: G(441).<br>J$^\pi$: L=0 (p,n), L=0 (2008Ze05 − ($^{3}$He,t)), mirror state to $^{24}$Na first excited state at E=472 keV.<br>T$_{1/2}$: Weighted average of 129 ms *5* (1966Ar02,1968Ar03), 133 ms *10* (1971To12), 127 ms *6* (1979Ho08), 128 ms *6* (1979Sh11), and 132.7 ms *41* (1988Bu12), and 130.9 ms *13* (2011Ni18, 2011Ma88). Uncertainty is the lowest input.<br>%IT, %$\varepsilon$+%$\beta^+$ from 2011Ni18, 2011Ma88, and %$\varepsilon\alpha$ from 1979Ho08. Other %IT, %$\varepsilon$+%$\beta^+$: 82.5 *30*, 17.5 *30* (1979Ho08), and 78 *3*, 22 *3* (1979Sh11), respectively.<br>$\mu$: From 2019StZV, 2007Ni14 -$\beta$-NMR. Other: 3.00 *4* (2013Is07). |
| 500.12 *13* | 2$^+$ | | E GH | XREF: G(514).<br>J$^\pi$: L=2 in ($^{3}$He,t), mirror state to $^{24}$Na second excited state at E=563 keV. |
| 1088.35[‡] *22* | 1$^+$ | | B E H | XREF: H(1109).<br>J$^\pi$: L=0 in (p,n), L=0 (2008Ze05 − ($^{3}$He,t)). Populated from 0$^+$ in $^{24}$Si $\varepsilon$ decay (141.3 ms) − log *ft*=4.5 from 0$^+$. |
| 1107.92[‡] *23* | (2)$^+$ | | E GH | T=1<br>XREF: G(1116)H(1130).<br>J$^\pi$: L=2 in ($^{3}$He,t); 2$^+$ in ($^{16}$O,2n$\gamma$) based on $\gamma(\theta)$. |
| 1261.09 *22* | (3,4)$^+$ | | EFGH | XREF: G(1292).<br>E(level): Other: 1275 *5* ($^{3}$He,t).<br>J$^\pi$: L=4 in ($^{3}$He,t). $\gamma$ to (2$^+$). |
| 1538.55 *20* | (5$^+$)[#] | | E | |
| 1548.2 *4* | | | E | |
| 1553 *6* | (5)$^+$ | | GH | E(level): Weighted average of 1563 *10* from (p,n) and 1550 *6* from ($^{3}$He,t). |

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**Adopted Levels, Gammas (continued)**

$^{24}$Al Levels (continued)

| E(level)† | Jπ | XREF | Comments |
|---|---|---|---|
| | | | Jπ: L=4 in ($^3$He,t); 5$^+$ in (p,n) (1989Ki14), based on σ(θ) and DWBA. |
| 1617.0 *5* | (3)$^+$ | E H | Jπ: L=4 in ($^3$He,t); γ to (2$^+$); 3$^+$ in ($^3$He,t) (2008Ze05), based on σ(θ) and fitting. |
| 1645 *13* | (3)$^+$ | G | Jπ: 3$^+$ in 1991Gr03 based on measured σ(θ), DWBA analysis, shell model calculations; analogue state of $^{24}$Na at 1885.5 keV. Other: Authors (1989Ki14 – (p,n)) tentatively assign 2$^+$ for the weakly populated state, based on the DWBA analysis of measured σ(θ) for an L=2 transfer. |
| 2345.1 *14* | (3)$^+$ | C E GH | XREF: G(2380).<br>E(level): Other: 2349.8 *18* (p,γ).<br>Jπ: L=4,(0) ($^3$He,t) and from analogue state Jπ=3$^+$ of $^{24}$Na at 2513.2, γ to (2$^+$). Other: Authors (1989Ki14 – (p,n)) tentatively assign 2$^+$ for the weakly populated state, based on the DWBA analysis of measured σ(θ) for an L=2 transfer. |
| 2523 *6* | (3,4,5)$^+$ | GH | E(level): From ($^3$He,t). Other: 2550 *50* (p,n).<br>Jπ: L=4 in ($^3$He,t). |
| 2605 *10* | 1$^+$@ | H | Jπ: L=0 (2008Ze05 – ($^3$He,t)). |
| 2805 *10* | (1,2,3)$^+$ | gH | E(level): From ($^3$He,t).<br>Jπ: L=2 in ($^3$He,t). |
| 2878 *6* | (1,2,3)$^+$ | gH | E(level): From ($^3$He,t).<br>Jπ: L=2 in ($^3$He,t). |
| 2978 *6* | 1$^+$@ | B H | E(level): From ($^3$He,t).<br>Jπ: L=0 (2008Ze05 – ($^3$He,t)). Populated from 0$^+$ in $^{24}$Si ε decay (141.3 ms) – log *ft*=4.6 from 0$^+$. |
| 3019 *6* | 1$^+$ | GH | E(level): From ($^3$He,t).<br>Jπ: L=0 in (p,n). |
| 3236 *6* | (1,2,3)$^+$ | H | Jπ: L($^3$He,t)=2. Other: 3$^+$ in 1991Gr03 is questionable as a doublet, 2007Vi16 note. |
| 3269 *6* | (1,2,3)$^+$ | H | Jπ: L($^3$He,t)=2. Other: 3$^+$ in 1991Gr03 is questionable as a doublet, 2007Vi16 note. |
| 3328 *6* | | GH | E(level): Weighted average of 3317 *10* from (p,n) and 3332 *6* from ($^3$He,t).<br>L=2(+0) in (p,n) and L=3,4 in ($^3$He,t). |
| 3371 *10* | 1$^+$@ | B H | E(level): weighted average of 3364 *13* from $^{24}$Si ε decay (141.3 ms) and 3375 *10* from ($^3$He,t). Uncertainty lower input value.<br>Jπ: L=0 (2008Ze05 – ($^3$He,t)). Populated from 0$^+$ in $^{24}$Si ε decay (141.3 ms), log *ft*=4.2 from 0$^+$. |
| 3442 *7* | (1$^+$)@ | H | Jπ: L=(0) in ($^3$He,t). |
| 3490 *10* | (1,2,3)$^+$ | G | Jπ: L=2 in (p,n). |
| 3583 *7* | | H | |
| 3667 *7* | | GH | E(level): From ($^3$He,t). Other: 3700 *50* (p,n). |
| 3818 *7* | | H | |
| 3875.4 *11* | (6$^+$) | E H | XREF: H(3858).<br>Jπ: From ($^{16}$O,2nγ) – γ to (5$^+$) and assuming spin increase with excitation energy. |
| 3905 *10* | | D G | XREF: D(3880). |
| 4061 *10* | | D H | E(level): From (p,n). Other: 4060 ($^{23}$Mg,p). |
| 4129 *24* | | H | |
| 4254 *8* | (4,5,6)$^-$ | H | Jπ: L=5 in ($^3$He,t). |
| 4316 *10* | | G | |
| 4388 *10* | 1$^+$@ | B D H | E(level): Weighted average of 4389 *10* from $^{24}$Si ε decay (141.3 ms) and 4386 *10* from ($^3$He,t). Uncertainty lower input value.<br>Jπ: L=0 (2008Ze05 – ($^3$He,t)) and log *ft*=4.2 from 0$^+$. |
| 4448 *9* | | H | |
| 4491 *10* | | G | |
| 4704 *8* | 1$^+$@ | B D H | XREF: D(4670).<br>E(level): Weighted average of 4700 *8* from $^{24}$Si ε decay (141.3 ms) and 4711 *10* from ($^3$He,t). Uncertainty lower input value.<br>Jπ: L=0 (2008Ze05 – ($^3$He,t)). Populated from 0$^+$ in $^{24}$Si ε decay (141.3 ms), log *ft*=4.7 from 0$^+$. |
| 4760 *8* | | GH | E(level): Weighted average of 4758 *10* from (p,n) and 4762 *8* from ($^3$He,t). Uncertainty lower |

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## Adopted Levels, Gammas (continued)

### $^{24}$Al Levels (continued)

| E(level)† | Jπ | XREF | Comments |
|---|---|---|---|
| | | | input value. |
| 4848 *10* | | H | |
| 4976 *9* | $1^+$ | B D H | E(level): From $^{24}$Si ε decay (141.3 ms).<br>Jπ: Populated from $0^+$ in $^{24}$Si ε decay (141.3 ms), log *ft*=4.7 from $0^+$. |
| 5.19×10$^3$ *10* | | F | |
| 5313 *14* | | H | |
| 5382 *11* | $(1^+)$ | B | Jπ: Populated from $0^+$ in $^{24}$Si ε decay (141.3 ms), log *ft*=4.6 from $0^+$. |
| 5461 *16* | $(4,5,6)^-$ | GH | T=1<br>XREF: G(5545).<br>E(level): From ($^3$He,t). 5545 *25* in (p,n) assigned as $6^-$.<br>Jπ: L=5 in ($^3$He,t). |
| 5531 *19* | | H | |
| 5614 *22* | | H | |
| 5714 *10* | | H | |
| 5839 *16* | $1^+$ | B H | E(level): Weighted average of 5801 *50* from $^{24}$Si ε decay (141.3 ms) and 5843 *16* from ($^3$He,t). Uncertainty lower input value.<br>Jπ: Populated from $0^+$ in $^{24}$Si ε decay (141.3 ms), log *ft*=4.2 from $0^+$. |
| 5899 *16* | | H | |
| 5960 *9* | $0^+$ | B I | T=2<br>XREF: I(5971).<br>E(level): Weighted average of 5953 *8* from $^{24}$Si ε decay (141.3 ms) and 5971 *10* from ($^3$He,$^6$He).<br>Jπ: Superallowed log *ft*=3.2 from $0^+$. |
| 5996 *20* | | H | |
| 6164 *16* | | H | |
| 6239 *12* | $1^+$ | B H | E(level): Weighted average of 6243 *12* from $^{24}$Si ε decay (141.3 ms) and 6214 *30* from ($^3$He,t).<br>Jπ: log *ft*=3.7 from $0^+$. |
| 6324 *48* | | H | |
| 6481 *12* | $1^+$ | B H | E(level): Weighted average of 5487 *12* from $^{24}$Si ε decay (141.3 ms) and 6459 *24* from ($^3$He,t). Uncertainty is the lower input value.<br>Jπ: log *ft*=4.5 from $0^+$. |
| 6554 *15* | | H | |
| 6697 *19* | | H | |
| 6735 *12* | $1^+$ | B | Jπ: log *ft*=4.9 from $0^+$. |
| 6797 *23* | | H | |
| 6878 *30* | $1^+$@ | H | Jπ: L=0 (2008Ze05 – ($^3$He,t)). |
| 6910 *30* | | H | |
| 7086 *8* | | H | |
| 7360 *3* | | H | |
| 7441 *18* | | H | |
| 7679 *20* | | H | |

† From a least squares fit of the Eγ for levels with depopulating γ. Source of other E(level) listed in comments. In a few cases level energies reported by ($^3$He,t) studies vary significantly and there is no clue to judge if those are same or different levels. Please see the dataset for details.

‡ From ($^3$He,t) studies, 1977Tr04 report a doublet at 1120 keV separated by about 20 keV, confirmed by 1977Pe21. Evaluators assume these are corresponding levels of 1109 and 1130 in ($^3$He,t).

# From ($^{16}$O,2nγ) – 2008Lo04, based on γ decay, comparison with analogue states of $^{24}$Na. More arguments listed in comments, if available.

@ No excitation of the isobaric analog state (ΔL=0, ΔS=0) is expected for a $^{24}$Mg target (N=Z) in ($^3$He,t).

## Adopted Levels, Gammas (continued)

### γ($^{24}$Al)

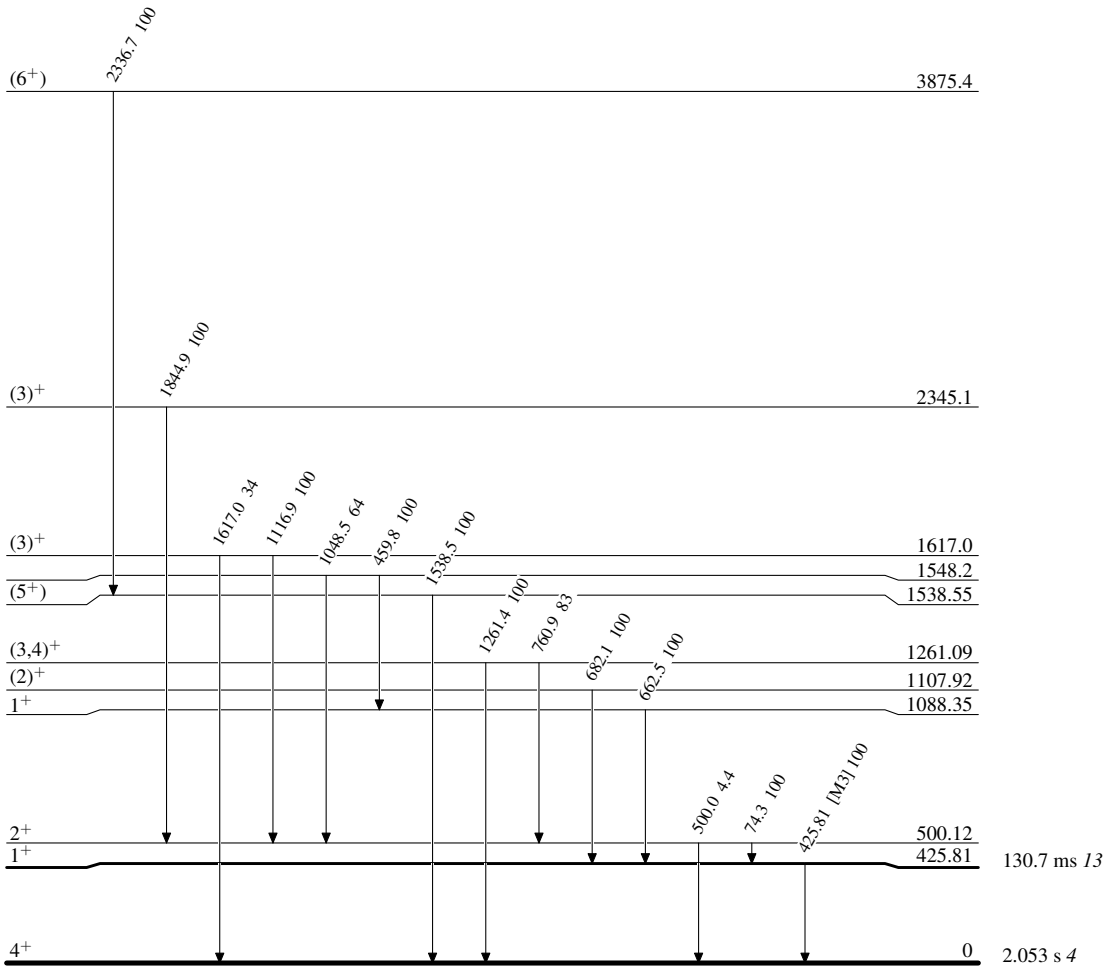
| $E_i$(level) | $J_i^\pi$ | $E_\gamma$[†] | $I_\gamma$[†] | $E_f$ | $J_f^\pi$ | Mult. | α[‡] | Comments |
|---|---|---|---|---|---|---|---|---|
| 425.81 | $1^+$ | 425.81 *10* | 100 | 0 | $4^+$ | [M3] | $1.14\times10^{-3}$ | B(M3)(W.u.)=2.016 *+27−29*<br>α(K)=0.001067 *15*; α(L)=$7.36\times10^{-5}$ *11*;<br>α(M)=$3.90\times10^{-6}$ *6*<br>$E_\gamma$: From $^{24}$Al IT decay (130.7 ms). |
| 500.12 | $2^+$ | 74.3 *1* | 100 *2* | 425.81 | $1^+$ | | | |
| | | 500.0 *5* | 4.4 *9* | 0 | $4^+$ | | | |
| 1088.35 | $1^+$ | 662.5 *2* | 100 | 425.81 | $1^+$ | | | |
| 1107.92 | $(2)^+$ | 682.1 *2* | 100 | 425.81 | $1^+$ | | | |
| 1261.09 | $(3,4)^+$ | 760.9 *2* | 83 *9* | 500.12 | $2^+$ | | | |
| | | 1261.4 *5* | 100 *13* | 0 | $4^+$ | | | |
| 1538.55 | $(5^+)$ | 1538.5 *2* | 100 | 0 | $4^+$ | | | |
| 1548.2 | | 459.8 *3* | 100 *17* | 1088.35 | $1^+$ | | | |
| | | 1048.5 *9* | 64 *13* | 500.12 | $2^+$ | | | |
| 1617.0 | $(3)^+$ | 1116.9 *5* | 100 *8* | 500.12 | $2^+$ | | | |
| | | 1617.0 *12* | 34 *11* | 0 | $4^+$ | | | |
| 2345.1 | $(3)^+$ | 1844.9 *14* | 100 | 500.12 | $2^+$ | | | |
| 3875.4 | $(6^+)$ | 2336.7 *10* | 100 | 1538.55 | $(5^+)$ | | | |

[†] From ($^{16}$O,2nγ), except where otherwise noted.
[‡] Additional information 1.

## Adopted Levels, Gammas

### Level Scheme

Intensities: Relative photon branching from each level




$^{24}_{13}Al_{11}$