## $^{24}$Mg($^{16}$O,2p$\gamma$) 1979Aa01,1976Va24,1974Va13

| Type | Author | History Citation | Literature Cutoff Date |
|---|---|---|---|
| Full Evaluation | Jun Chen | NDS 152, 1 (2018) | 30-Sep-2017 |

Also includes $^{24}$Mg($^{18}$O,$\alpha\gamma$).

1979Aa01: E=38 and 45 MeV $^{16}$O beams of 50-300 nA were produced from the Utrecht EN tandem. Targets were about 300 $\mu$g/cm$^2$ 99.94% enriched $^{24}$Mg on 30 $\mu$m Au backings. $\gamma$ rays were detected with a large-volume Ge(Li)-NaI(Tl) Compton suppression spectrometer (CSS) at −90° and a LEPS or a large Ge(Li) at +90° for coincidence measurements, with the CSS and a Ge(Li) for $\gamma(\theta)$ and with a three-crystal Ge(Li) Compton polarimeter for $\gamma$(lin pol). Measured E$\gamma$, I$\gamma$, $\gamma\gamma$-coin, $\gamma(\theta)$, $\gamma\gamma(\theta)$, $\gamma$(lin pol), Doppler pattern. Deduced levels, J, $\pi$, $T_{1/2}$, $\gamma$-ray branching ratios, multipolarities, mixing ratios, transition strengths. Comparisons with available data and shell-model calculations. 1979Aa01 also report data on $^{35}$Cl($\alpha$,p$\gamma$)$^{38}$Ar.

1976Va24 (same lab as 1979Aa01): E=38 and 45 MeV beams of 40-200 nA. Targets and detector set-up are similar to those in 1979Aa01. Measured E$\gamma$, I$\gamma$, $\gamma\gamma$-coin, $\gamma(\theta)$, $\gamma\gamma(\theta)$, $\gamma$(lin pol), $\gamma$(DCO). Deduced levels, J, $\pi$, $\gamma$-ray branchings, multipolarities, mixing ratios. The results of 1976Va24 supersede those of 1975Va17. The follow-up measurement by 1979Aa01 at the same lab report more $\gamma$ transitions and make different placements for some transitions.

1974Va13 (same lab as 1979Aa01,1976Va24): E=38 MeV beam of 100 nA. Targets were self-supporting natural Mg with a thickness of about 1 mg/cm$^2$. Measured E$\gamma$, I$\gamma$, lifetimes by recoil-distance method for 4590 and 6410 levels. Also measured lifetime for 6410 level using DSAM with $^{27}$Al($^{16}$O,$\alpha$p$\gamma$) and $^{24}$Mg($^{16}$O,2p$\gamma$) reactions.

2007LiZN: $^{24}$Mg($^{18}$O,$\alpha\gamma$) E= 70 MeV $^{18}$O beam was produced from the tandem accelerator of Japan Atomic Energy Agency (JAEA). $\gamma$ rays were detected with the GEMINI-2 array of 14 HPGe detectors with BGO shields and charged particles were detected with an array of 20 ΔE Si detectors. Measured E$\gamma$, I$\gamma$, particle-$\gamma$-coin. 2007LiZN only report a $\gamma$ spectrum for $^{38}$Ar.

### $^{38}$Ar Levels

| E(level)[†] | J$^\pi$[‡] | $T_{1/2}$ | Comments |
|---|---|---|---|
| 0.0 | $0^+$ | | |
| 2167.5 | $2^+$ | | Additional information 1.<br>E(level): rounded value from Adopted Levels. |
| 3809.9 *3* | $3^-$ | | |
| 4479.5 *5* | $4^-$ | | |
| 4585.4 *5* | $5^-$ | 136 ps *7* | $T_{1/2}$: from 1974Va13 using RDM. |
| 5658.0 *6* | $5^-$ | | |
| 6408.0 *5* | $6^+$ | 1.0 ps *3* | $T_{1/2}$: from 1974Va13 using DSAM. Other: <2 ps from 1974Va13 using RDM. |
| 6674.1 *6* | $5^-$ | | |
| 7069.4 *6* | $(6)^-$ | | J$^\pi$: $5^-$ in 1979Aa01. See comments in Adopted Levels. |
| 7507.8 *5* | $7^-$ | | |
| 8076.6 *5* | $7^+$ | | |
| 8490.3 *7* | | | |
| 8569.0 *5* | $8^+$ | <0.6 ps | $T_{1/2}$: from 1979Aa01 based on Doppler shift pattern. |
| 8972.4 *5* | $7^-$ | | E(level): the 1201-2564 cascade is reversed in 1976Va24, resulting in a level at 7609 instead which is removed by 1979Aa01. |
| 9933 *4* | | | |
| 10173.7 *5* | $9^-$ | | |
| 11297 *6* | | | |
| 11614.0 *6* | $11^-$ | | |

[†] From a least-squares fit to $\gamma$-ray energies, unless otherwise noted.

[‡] From Adopted Levels. Assignments in 1979Aa01 based on $\gamma(\theta)$ and $\gamma$(lin pol) data are the same, unless otherwise noted.

## $^{24}$Mg($^{16}$O,2p$\gamma$) 1979Aa01,1976Va24,1974Va13 (continued)

### $\gamma(^{38}Ar)$

| $E_i$(level) | $J_i^\pi$ | $E_\gamma$[†] | $I_\gamma$[†] | $E_f$ | $J_f^\pi$ | Mult.[@] | $\delta$[@] | Comments |
|---|---|---|---|---|---|---|---|---|
| 2167.5 | $2^+$ | 2167.5 | 100 | 0.0 | $0^+$ | | | Additional information 2. |
| 3809.9 | $3^-$ | 1642.4 *3* | 100 | 2167.5 | $2^+$ | E1(+M2) | +0.016 *13* | Additional information 3.<br>$E_\gamma$: from 1976Va24.<br>Mult.,$\delta$: $A_2$=−0.256 *7*, $A_4$=−0.004 *6*, POL=+0.39 *4* (1976Va24). |
| 4479.5 | $4^-$ | 669.6 *3* | 100 | 3809.9 | $3^-$ | M1(+E2) | +0.011 *13* | Additional information 4.<br>$E_\gamma$: 669.6 *3* (1976Va24).<br>Mult.,$\delta$: $A_2$=−0.224 *7*, $A_4$=+0.008 *7*, POL=−0.37 *3* (1976Va24). |
| 4585.4 | $5^-$ | 105.894 *12* | 100 | 4479.5 | $4^-$ | | | $E_\gamma$: from 1976Va24.<br>$A_2$=−0.265 *9*, $A_4$=−0.010 *7* (1976Va24). |
| 5658.0 | $5^-$ | 1072.5 *4* | 100 | 4585.4 | $5^-$ | | | |
| 6408.0 | $6^+$ | 1822.39 *16* | 100 | 4585.4 | $5^-$ | E1(+M2) | +0.007 *10* | Additional information 5.<br>$E_\gamma$: from 1976Va24. Other: 1822.4 *2* (1974Va13).<br>Mult.: $A_2$=−0.292 *10*, $A_4$=−0.004 *11*, POL=+0.38 *5* (1976Va24); $A_2$=−0.30 *2*, $A_4$=−0.01 *2*, POL=+0.40 *5* (1979Aa01).<br>$\delta$: from 1976Va24.<br>R(DCO)=0.98 *4* gating on 670$\gamma$ and 1.03 *6* gating on 1642$\gamma$ (1976Va24). |
| 6674.1 | $5^-$ | 2088.6 *3* | 100 | 4585.4 | $5^-$ | | | |
| 7069.4 | $(6)^-$ | 2483.9 *4* | 100 | 4585.4 | $5^-$ | | | |
| 7507.8 | $7^-$ | 1849.8 | <4 | 5658.0 | $5^-$ | | | |
| | | 2923.2 *4* | 100 | 4585.4 | $5^-$ | E2 | | Mult.: $A_2$=+0.57 *7*, $A_4$=−0.59 *8*, POL=+0.68 *11* (1979Aa01). |
| 8076.6 | $7^+$ | 1669.2 *3* | 100 | 6408.0 | $6^+$ | | | |
| 8490.3 | | 1420.8 *3* | 100 | 7069.4 | $(6)^-$ | | | |
| 8569.0 | $8^+$ | 492.7 *2* | 21 *4* | 8076.6 | $7^+$ | M1(+E2) | >−0.09 | Mult.,$\delta$: $A_2$=−0.08 *40*, POL=−0.56 *8* (1979Aa01). |
| | | 1061.5 *2* | 21 *6* | 7507.8 | $7^-$ | | | |
| | | 2160.6[#] *2* | 100 *6* | 6408.0 | $6^+$ | E2 | | $E_\gamma$: weighted average of 2160.8 *3* (1976Va24) and 2160.5 *2* (1979Aa01).<br>$E_\gamma$: placed by 1976Va24 from the 10174 level to a level at 8013.<br>Mult.: $A_2$=+0.56 *25*, $A_4$=−0.39 *20*, POL=+0.66 *22* (1976Va24). |
| 8972.4 | $7^-$ | 2564.5[‡] *4* | 100 *8* | 6408.0 | $6^+$ | E1(+M2) | −0.04 *2* | $E_\gamma$: weighted average of 2564.2 *5* (1976Va24) and 2564.7 *4* (1979Aa01).<br>Mult.: $A_2$=−0.30 *6*, $A_4$=−0.02 *8*, POL=+0.57 *13* (1979Aa01); $A_2$=−0.186 *33*, $A_4$=−0.017 *36*, POL=+0.48 *34* (1976Va24).<br>$\delta$: from 1979Aa01. |
| | | 3314.2 | 13 *3* | 5658.0 | $5^-$ | | | |
| | | 4386.2 *4* | 51 *8* | 4585.4 | $5^-$ | E2 | | Mult.: $A_2$=+0.43 *5*, $A_4$=−0.21 *5*, POL=+0.65 *44* (1979Aa01). |
| 9933 | | 1364[&] *4* | | 8569.0 | $8^+$ | | | |
| 10173.7 | $9^-$ | 1201.17[‡] *21* | 93 *4* | 8972.4 | $7^-$ | E2 | | $E_\gamma$: weighted average of 1200.98 *18* (1976Va24) and 1201.4 *2* (1979Aa01).<br>$I_\gamma$: Other: 100 *3* from ratio of relative intensities I(1201$\gamma$)/I(1604$\gamma$)=64 *2*/64 *4* (1976Va24).<br>Mult.,$\delta$: $A_2$=+0.40 *3*, $A_4$=−0.18 *3*, POL=+0.64 *6* (1979Aa01); $A_2$=+0.332 *20*, $A_4$=−0.131 *21*, POL=+0.66 *9* (1976Va24) |

Continued on next page (footnotes at end of table)

## $^{24}$Mg($^{16}$O,2p$\gamma$) 1979Aa01,1976Va24,1974Va13 (continued)

### $\gamma(^{38}Ar)$ (continued)

| $E_i$(level) | $J_i^\pi$ | $E_\gamma$[†] | $I_\gamma$[†] | $E_f$ | $J_f^\pi$ | Mult.[@] | $\delta$[@] | Comments |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Others: $\delta$(M3/E2)=0 *1* (1976Va24), <0.1 (1979Aa01). |
| 10173.7 | $9^-$ | 1604.68[#] *11* | 100 *4* | 8569.0 | $8^+$ | E1(+M2) | −0.04 *2* | Additional information 6.<br>$E_\gamma$: from 1976Va24. Placed by 1976Va24 from a level at 8013.<br>$I_\gamma$: Other: 100 6 (1976Va24).<br>Mult.: $A_2$=−0.20 *6*, $A_4$=+0.01 *6*, POL=+0.40 *6* (1979Aa01); $A_2$=−224 *34*, $A_4$=−0.037 *34*, POL=+0.33 *12* (1976Va24).<br>$\delta$: from 1979Aa01. |
| 11297 | | 1364[&] *4* | | 9933 | | | | |
| 11614.0 | $11^-$ | 1440.2 *2* | 100 | 10173.7 | $9^-$ | E2 | | $A_2$=+0.38 *3*, $A_4$=−0.20 *3*, POL=+0.57 *8* (1979Aa01). |

[†] From 1979Aa01, unless otherwise noted. Energy values without uncertainties are from level-energy differences.
[‡] Ordering of the 1201-2564 cascade is from 1979Aa01. It was shown reversed in 1976Va24.
[#] Ordering of the 1605-2161 cascade is from 1979Aa01. It was shown reversed in 1976Va24.
[@] From $\gamma(\theta)$ and $\gamma$(lin pol) in 1979Aa01 and 1976Va24.
[&] Multiply placed.

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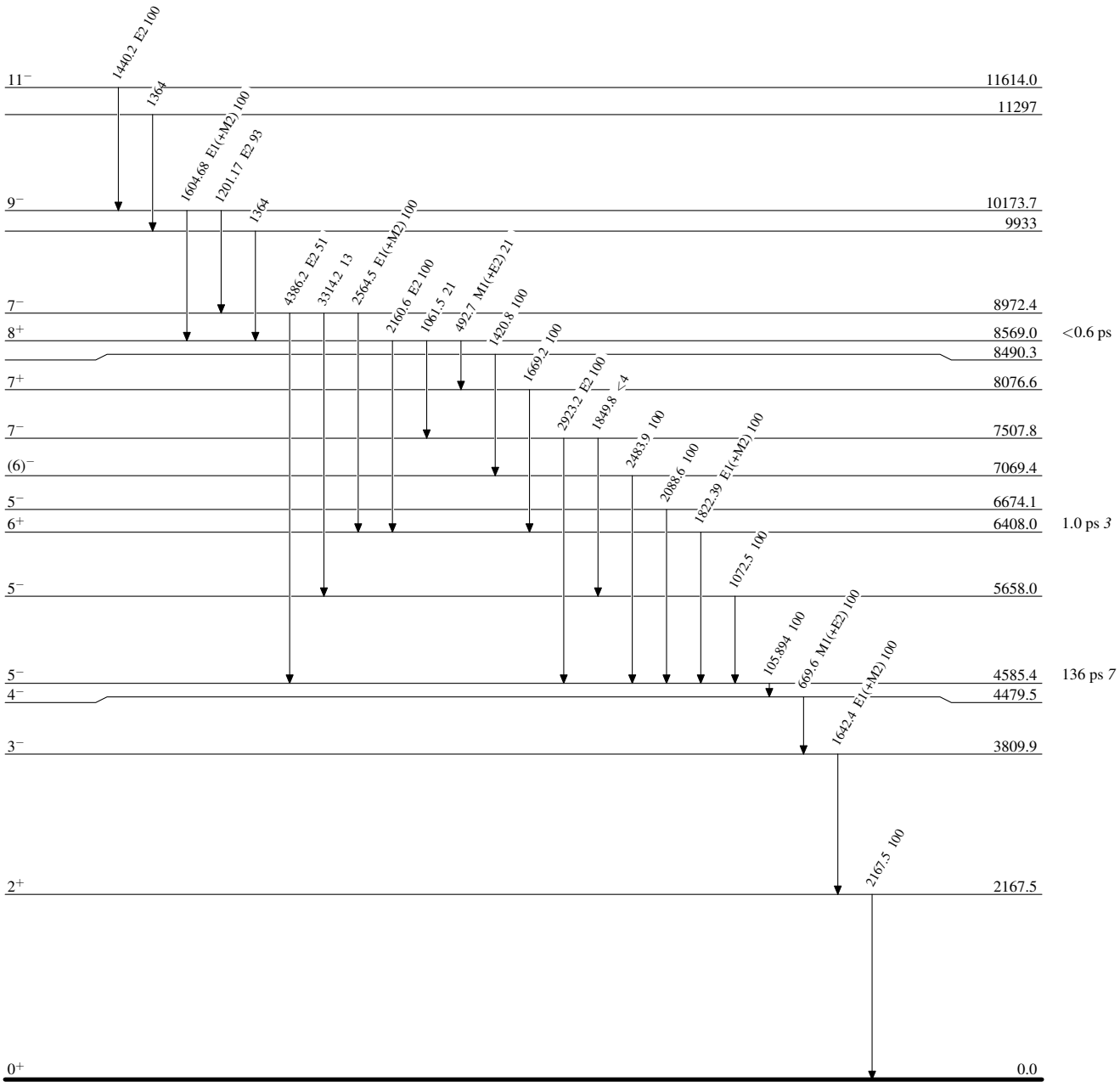
### Level Scheme

Intensities: Relative photon branching from each level




$^{38}_{18}Ar_{20}$