

$^{23}\text{Na}(\text{d},\text{p}\gamma)$ 1974Ke12

| Type | Author | History | Citation | Literature Cutoff Date |
|-----------------|--|---------|-------------------|------------------------|
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Others: 1980Jo11, 1978KaZO, 1973Ek02, 1973Sm06, 1970Ch37, 1968Me05, 1961Sc09.

1974Ke12: $^{23}\text{Na}(\text{d},\text{p}\gamma)$, $E=2.60$ MeV. Target: $5 \mu\text{g}/\text{cm}^2$ elemental Na was sandwiched between gold layers of $200 \mu\text{g}/\text{cm}^2$ and $1500 \mu\text{g}/\text{cm}^2$ thicknesses. With the use of metallic target, level lifetime to a very short range could be extracted by Doppler shift attenuation method. The gamma rays were detected by a Ge(Li) detector. The emitted proton groups were detected in an annular solid state Si-detector. The γ -ray spectra were collected in coincidence with the emitted proton groups. Measured E_γ , I_γ , τ , deduced spin-parity. Also studied (d,p) at $E_d = 1.8, 2.0, 2.59,$ and 4.0 MeV. Measured $\sigma(\text{Ep})$.

1973Sm06: $^{23}\text{Na}(\text{d},\text{p}\gamma)$, $E=2.45$ MeV. Target $300 \mu\text{g}/\text{cm}^2$ NaCl on a $900 \mu\text{g}/\text{cm}^2$ nickel backing. Ge(Li) detector was used for the detection of gamma rays. Solid state particle detector was used for the detection of proton groups. The γ -ray spectra were measured in coincidence with the emitted proton groups. Deduce level lifetimes (by Doppler shift attenuation method), γ -ray branching, spin-parity of excited levels.

 ^{24}Na Levels

| E(level) [†] | $T_{1/2}$ [‡] | Comments |
|-----------------------|------------------------|--|
| 0 | | |
| 472.29 5 | | |
| 563.29 11 | <347 ps | $T_{1/2}$: From $\tau=5\times 10^{-10}$ s (1968Me05). Other: $T_{1/2} > 0.693$ ps from $\tau > 1000$ fs (1974Ke12). |
| 1341.5 3 | 46 fs 10 | $T_{1/2}$: Weighted average of 66 fs 21 (1974Ke12) and 43 fs 10 (1973Sm06). |
| 1344.4 2 | 26 fs 8 | |
| 1346.4 2 | 4.4 ps 3 | $T_{1/2}$: From 1978KaZO. Other: >1.04 ps (1974Ke12). |
| 1511.8 3 | 26 fs 8 | |
| 1845.9 3 | 160 fs 35 | $T_{1/2}$: Weighted average of 180 fs 35 (1974Ke12) and 139 fs 35 (1973Sm06). |
| 1885.2 3 | 25 fs 6 | |
| 2513.0 2 | 10 fs 5 | |
| 2562.6 3 | <17 fs | |
| 2903.7 3 | 35 fs 10 | |
| 2977.6 2 | <17 fs | |
| 3216.0 4 | 15 fs 6 | |
| 3371.6 5 | 13 fs 3 | |
| 3413.3 7 | <24 fs | |
| 3589.2 6 | <10 fs | |
| 3628.3 11 | <17 fs | |
| 3656.1 6 | <14 fs | |
| 3681.7 6 | <21 fs | |
| 3745.0 8 | <17 fs | |
| 3933.9 9 | <17 fs | |
| 3943.1 15 | <14 fs | |
| 3977.7 6 | <21 fs | |
| 4144.5 25 | <21 fs | |
| 4186 3 | <14 fs | |
| 4196.6 14 | <17 fs | |
| 4206.8 9 | <35 fs | |
| 4220 3 | | E(level): from 1973Ek02. |

[†] From 1974Ke12, except where otherwise noted.

[‡] From 1974Ke12, except where otherwise noted. Doppler Shift Attenuation (DSA) method.

$^{23}\text{Na}(\text{d,p}\gamma)$ **1974Ke12 (continued)** $\gamma(^{24}\text{Na})$

| $E_i(\text{level})$ | E_γ^\dagger | I_γ^\ddagger | E_f | Comments |
|---------------------|--------------------|---------------------|--------|---|
| 472.29 | 472 | 100 | 0 | |
| 563.29 | 91 | 97.5 5 | 472.29 | |
| | 563 | 2.5 5 | 0 | |
| 1341.5 | 778 | 7 3 | 563.29 | |
| | 869 | 93 3 | 472.29 | |
| 1344.4 | 781 | 42 3 | 563.29 | |
| | 1344 | 58 3 | 0 | |
| 1346.4 | 874 | 100 | 472.29 | |
| 1511.8 | 1512 | 100 | 0 | |
| 1845.9 | 500 | 43 2 | 1346.4 | |
| | 502 | 12 2 | 1344.4 | |
| | 1283 | 17 1 | 563.29 | |
| | 1374 | 28 1 | 472.29 | |
| 1885.2 | 1322 | 64 2 | 563.29 | |
| | 1885 | 36 2 | 0 | |
| 2513.0 | 1950 | 96 1 | 563.29 | |
| | 2513 | 4 1 | 0 | |
| 2562.6 | 1051 | 15 2 | 1511.8 | |
| | 1219 | 52 2 | 1344.4 | |
| | 2563 | 33 2 | 0 | |
| 2903.7 | 1058 | 3 1 | 1845.9 | |
| | 1560 | 30 3 | 1344.4 | |
| | 1563 | 53 3 | 1341.5 | |
| | 2341 | 2 1 | 563.29 | |
| | 2904 | 12 2 | 0 | |
| 2977.6 | 1634 | 9 2 | 1344.4 | |
| | 1637 | 31 3 | 1341.5 | |
| | 2415 | 36 2 | 563.29 | |
| | 2506 | 24 2 | 472.29 | |
| 3216.0 | 1872 | 100 | 1344.4 | E $_\gamma$: A comparable 1875.6 γ placed from 6072.76 keV level in (n, γ). |
| 3371.6 | 2026 | 44 6 | 1344.4 | |
| | 2031 | 36 6 | 1341.5 | |
| | 2809 | 20 3 | 563.29 | |
| 3413.3 | 2069 | 31 8 | 1344.4 | |
| | 2072 | 31 8 | 1341.5 | |
| | 2850 | 10 2 | 563.29 | |
| | 2941 | 28 2 | 472.29 | |
| 3589.2 | 2245 | 8 2 | 1344.4 | |
| | 3026 | 41 2 | 563.29 | |
| | 3117 | 51 2 | 472.29 | |
| 3628.3 | 2287 | 50 2 | 1341.5 | |
| | 3628 | 50 2 | 0 | |
| 3656.1 | 1771 | 13 4 | 1885.2 | |
| | 1810 | 7 2 | 1845.9 | |
| | 2315 | 7 2 | 1341.5 | |
| | 3093 | 58 3 | 563.29 | |
| | 3184 | 15 6 | 472.29 | |
| 3681.7 | 3210 | 100 | 472.29 | |
| 3745.0 | 1232 | 6 1 | 2513.0 | |
| | 1860 | 7 1 | 1885.2 | |
| | 1899 | 42 2 | 1845.9 | |
| | 2401 | 21 4 | 1344.4 | |
| | 2404 | 11 4 | 1341.5 | |
| | 3182 | 11 2 | 563.29 | |
| | 3745 | 2.0 5 | 0 | |
| 3933.9 | 2593 | 39 6 | 1341.5 | |

Continued on next page (footnotes at end of table)

$^{23}\text{Na}(\text{d,p}\gamma)$ **1974Ke12 (continued)** $\gamma(^{24}\text{Na})$ (continued)

| $E_i(\text{level})$ | E_γ^\dagger | I_γ^\ddagger | E_f | Comments |
|---------------------|--------------------|---------------------|--------|--|
| 3933.9 | 3371 | 61 6 | 563.29 | |
| 3943.1 | 3943 | 100 | 0 | |
| 3977.7 | 3415 | 42 4 | 563.29 | |
| | 3506 | 58 4 | 472.29 | |
| 4144.5 | 1581 | 50 10 | 2562.6 | |
| | 4144 | 50 10 | 0 | |
| 4186 | 2301 | 64 3 | 1885.2 | |
| | 2842 | 36 3 | 1344.4 | |
| 4196.6 | 2351 | 32 10 | 1845.9 | |
| | 3634 | 18 8 | 563.29 | |
| | 3725 | 50 9 | 472.29 | |
| 4206.8 | 835 | 18 2 | 3371.6 | |
| | 2361 | 17 3 | 1845.9 | |
| | 2863 | 55 2 | 1344.4 | |
| | 3644 | 10 3 | 563.29 | |
| 4220 | 2707 | 90 6 | 1511.8 | E_γ, I_γ : Placement in 1973Ek02 . |
| | 4220 | 10 6 | 0 | E_γ, I_γ : Placement in 1973Ek02 . |

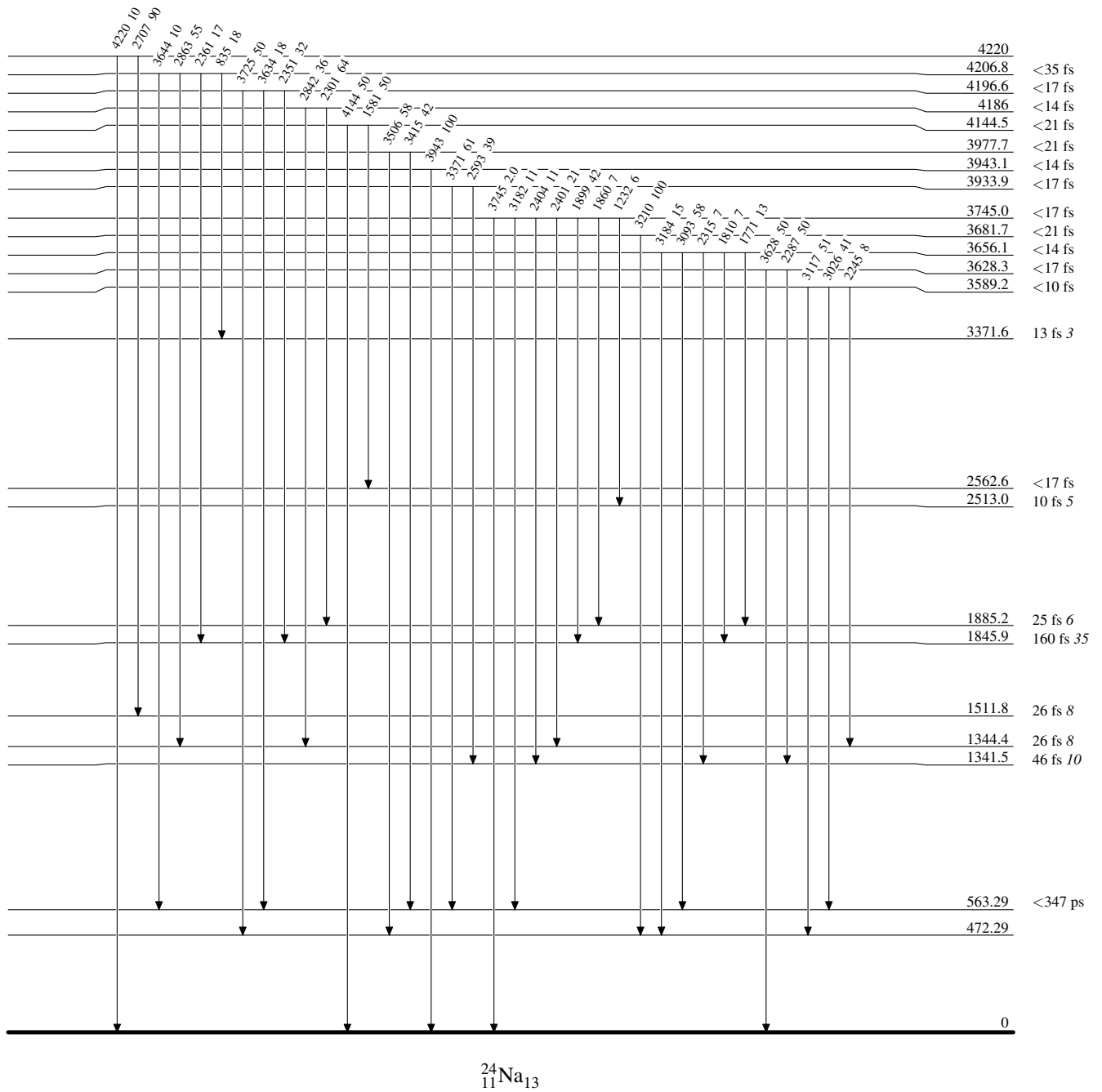
† From level energy difference, recoil energy subtracted (rounded value). Placement as of Fig. 3 in [1974Ke12](#).

‡ From [1974Ke12](#).

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Level Scheme

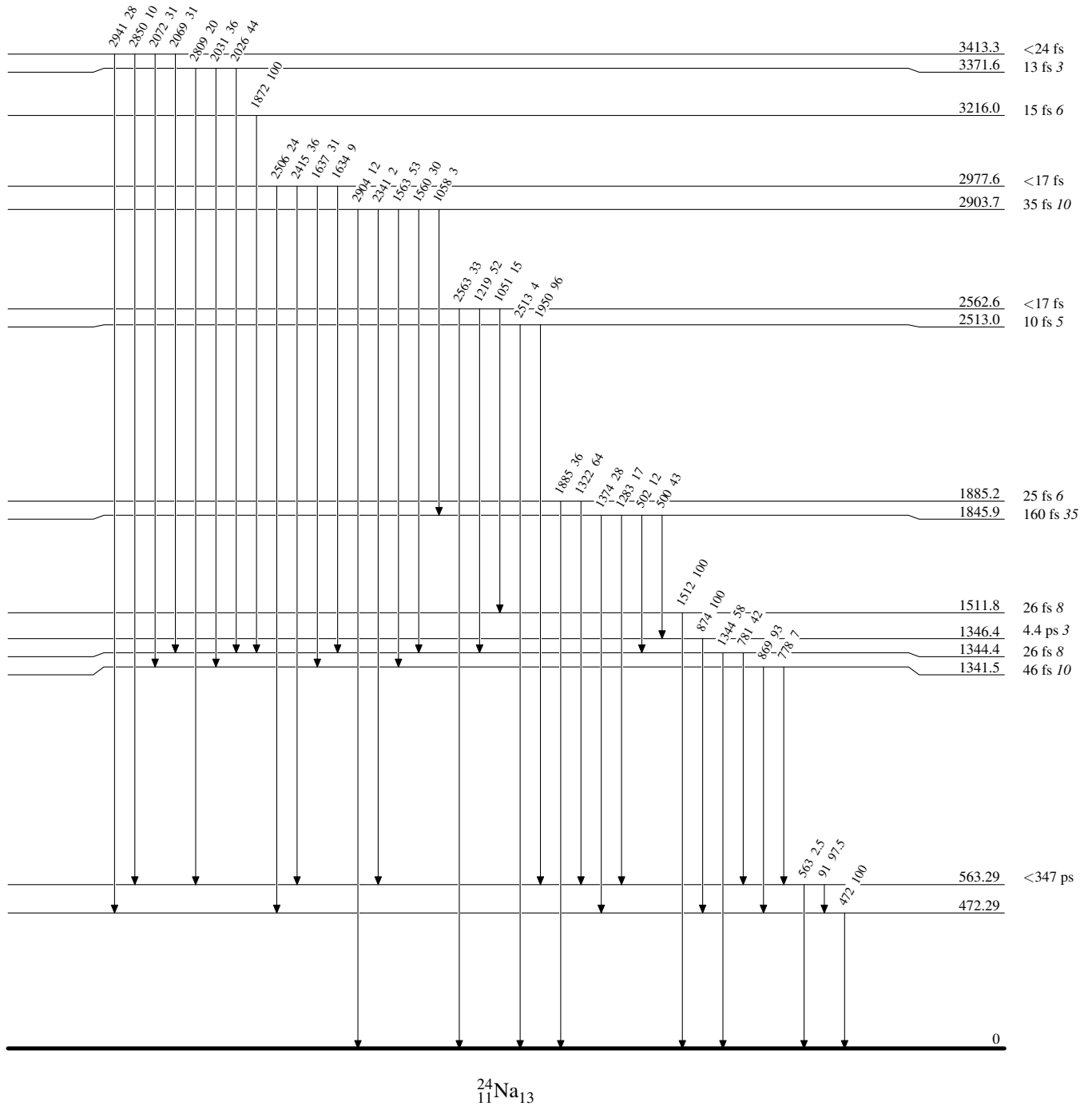
Intensities: % photon branching from each level



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Level Scheme (continued)

Intensities: % photon branching from each level

 $^{24}_{11}\text{Na}_{13}$