^{23}Na(p,p′γ)   1972Du05,1968So07,1970Ma15

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	M. S. Basunia[#], A. Chakraborty[##]	NDS 171,1 (2021)	1-Jun-2020

Other references: 1959Ra10, 1969Po06, 1973Eh01.
1972Du05: ^{23}Na(p,p′γ) E=3.6-7.0 MeV. Measured mean lifetime by DSA.
1968So07: ^{23}Na(p,p′γγ) E=4.71, 5.12 MeV; measured γγ(θ). Deduced spin, γ-ray mixing ratios.
1970Ma15: ^{23}Na(p,p′γ) E=4.12, 5.15 MeV. Measured mean lifetime by DSA.

^{23}Na Levels

E(level)[†]	J^{π}[#]	T$_{1/2}$[†]	Comments
0.0	3/2^{+}		
440.2[‡] 4	5/2^{+}	1.25 ps +28−21	T$_{1/2}$: From mean lifetime of 1.8 ps +4−3 (1959Ra10).
2076.7 5	7/2^{+}	146 fs 42	J^{π}: 7/2 from γ-ray angular correlation studies (1968So07).
			T$_{1/2}$: From τ=210 fs 60 in Table 2 (1972Du05) − two values are given − other one τ=210 fs 25 (25%) (syst) in Table 1 yields 210 fs 31. Evaluators list the one with larger uncertainty. Other values: <230 fs (1970Ma15), <160 fs (1969Po06).
2391.7 7	1/2^{+}	652 fs 139	T$_{1/2}$: From τ=940 fs 200; Wt. ave. of τ=950 fs 200 (1969Po06), 700 fs 250 (1970Ma15), and 1550 fs 400 in Table 2 (1972Du05). 1972Du05 also give τ=1550 fs 90 (25%) (syst) in Table 1 − yields 1550 fs 113.
2639.4 7	1/2^{-}	147 fs 55	T$_{1/2}$: From τ=212 fs 80; Wt. ave. of τ=200 fs 80 (1969Po06), 100 fs +80−40 (1970Ma15), and 370 fs 90 in Table 2 (1972Du05). 1972Du05 also give τ=365 fs 40 (25%) (syst) in Table 1 − yields 365 fs 50.
2704.4 7	9/2^{+}	85 fs 17	J^{π}: 9/2 from γ-ray angular correlation studies (1968So07).
			T$_{1/2}$: From τ=122 fs 25; Wt. ave. of τ=200 fs 100 (1969Po06), 100 fs +80−40 (1970Ma15), and 100 fs 25 (1972Du05).
2983.0 5	3/2^{+}	<17 fs	T$_{1/2}$: From 1972Du05. Other values: <79 fs (1970Ma15), <50 fs (1969Po06).
3678.9 7	3/2^{-}	49 fs 28	A γ branch to g.s. in 1972Du05 was not confirmed by later studies − evaluators did not list the transition in this data set.
			T$_{1/2}$: From 1972Du05. Other value: 617 fs 110 (1970Ma15), <120 fs (1969Po06).
3849.5 7	5/2^{-}	118 fs 28	
3915.6 7	5/2^{+}	42 fs 10	T$_{1/2}$: From 1972Du05. Other value <70 fs (1969Po06).
4432.7 7	1/2^{+}	<31 fs	
4776.2 7	7/2^{+}	<24 fs	

[†] From 1972Du05, except where otherwise noted.
[‡] From 1969Po06.
[#] From Adopted Levels, except otherwise noted.

γ(^{23}Na)

E$_i$(level)	J$^{π}_i$	E$_γ$[†]	I$_γ$[‡]	E$_f$	J$^{π}_f$	Mult.[#]	δ[#]	Comments
440.2	5/2^{+}	441.1 4	100	0.0	3/2^{+}	D+Q	+0.06 4	δ: From 1968So07.
2076.7	7/2^{+}	1637.4 12	93 3	440.2	5/2^{+}	D+Q	+0.18 2	δ: From 1970Ma15. Other value: +0.24 7 (1968So07).
		2077.5 11	7 3	0.0	3/2^{+}			
2391.7	1/2^{+}	1950.4 7	35 2	440.2	5/2^{+}	E2		I$_γ$: Weighted average of 34 2 (1972Du05) and 38 3 (1970Ma15).
		2390.1 9	65 2	0.0	3/2^{+}			I$_γ$: Weighted average of 66 2 (1972Du05) and 62 3 (1970Ma15).
2639.4	1/2^{-}	2639.3 14	100	0.0	3/2^{+}			
2704.4	9/2^{+}	627.9 4	36 4	2076.7	7/2^{+}	D(+Q)	+0.05 9	I$_γ$: Other: 37 4 (1970Ma15).
								δ: Average of +0.07 9 (1970Ma15) and +0.02 9 (1968So07).

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^{23}Na(p,p′γ)   **1972Du05,1968So07,1970Ma15 (continued)**

γ(^{23}Na) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[#]	δ[#]	Comments
2704.4	9/2$^+$	2263.9 *13*	64 *4*	440.2	5/2$^+$	E2		I_γ: Other: 63 *4* (1970Ma15).
2983.0	3/2$^+$	2540.2 *12*	39 *2*	440.2	5/2$^+$	D(+Q)	−0.09 *9*	I_γ: Other: 52 *4* (1970Ma15).
								δ: or +4.5 *20* (1970Ma15).
		2980.9 *15*	61 *2*	0.0	3/2$^+$			I_γ: Other: 48 *4* (1970Ma15).
3678.9	3/2$^-$	1039.5		2639.4	1/2$^-$			
		3237.7 *16*		440.2	5/2$^+$	D(+Q)	−0.04 *10*	δ: or +3.7 *2* (1970Ma15).
3849.5	5/2$^-$	1772.7	80 *5*	2076.7	7/2$^+$			
		3409.0	5 *2*	440.2	5/2$^+$			
		3849.2	15 *3*	0.0	3/2$^+$			
3915.6	5/2$^+$	932.6	2 *1*	2983.0	3/2$^+$			
		1838.8	9 *3*	2076.7	7/2$^+$			
		3475.1	9 *3*	440.2	5/2$^+$			
		3915.2	80 *5*	0.0	3/2$^+$			E_γ: Other: 3911.4 *21* (1969Po06).
4432.7	1/2$^+$	2040.9	15 *10*	2391.7	1/2$^+$			
		4432.2	85 *10*	0.0	3/2$^+$			
4776.2	7/2$^+$	2699.33	26 *4*	2076.7	7/2$^+$			
		4335.56	74 *4*	440.2	5/2$^+$			

[†] From 1969Po06. Those without uncertainty are from level energy difference − recoil energy subtracted.
[‡] From 1972Du05.
[#] From γ-ray angular correlation studies by 1968So07, 1970Ma15 and RUL.

$^{23}\text{Na}(p,p'\gamma)$ 1972Du05,1968So07,1970Ma15

Level Scheme

Intensities: % photon branching from each level

Level energies, spins, and lifetimes:

Level	J^π	Energy (keV)	Lifetime
	$7/2^+$	4776.2	<24 fs
	$1/2^+$	4432.7	<31 fs
	$5/2^+$	3915.6	42 fs 10
	$5/2^-$	3849.5	118 fs 28
	$3/2^-$	3678.9	49 fs 28
	$3/2^+$	2983.0	<17 fs
	$9/2^+$	2704.4	85 fs 17
	$1/2^-$	2639.4	147 fs 55
	$1/2^+$	2391.7	652 fs 139
	$7/2^+$	2076.7	146 fs 42
	$5/2^+$	440.2	1.25 ps +28−21
	$3/2^+$	0.0	

Gamma transitions:
4435.56 74, 2699.33 26, 4432.2 85, 2040.9 15, 3915.2 80, 3475.1 9, 1838.8 9, 932.6 2, 3849.2 15, 3409.0 5, 1772.7 80, 3237.7 D(+Q), 1039.5, 2980.9 61, 2540.2 D(+Q) 39, 2263.9 E2 64, 627.9 D(+Q) 36, 2639.3 100, 2390.1 65, 1950.4 E2 35, 2077.5 7, 1637.4 D+Q 93, 441.1 D+Q 100

$^{23}_{11}\text{Na}_{12}$