^{27}Al(α,γ):resonances 1971De34,1991Wa13

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen and Balraj Singh	NDS 184, 29 (2022)	24-Jun-2022

Target J^π(^{27}Al g.s.)=5/2$^+$.

1971De34: E=2.3-3.3 MeV from Utrecht University Van de Graaff accelerator. Ge(Li) detectors. Measured Eγ, Iγ and lifetimes using DSAM.

1991Wa13: E=3.4-6.4 MeV from Pelletron accelerator at Academia Sinica. Natural Al target. Ge and NaI detectors for γ detection. Measured γ ray spectrum.

All data below 12670 keV are from 1971De34 and above this energy from 1991Wa13.

^{31}P Levels

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$[#]	(2J+1)($\Gamma_\alpha\Gamma_\gamma$)/$\Gamma$ (eV)[@]	Comments
0.0	1/2$^+$			
1266.13 *12*	3/2$^+$			
2233.8 *3*	5/2$^+$			
3295.0 *2*	5/2$^+$	90 fs *35*		$T_{1/2}$: τ=130 fs *50* (1971De34).
3414.6 *3*	7/2$^+$	208 fs *56*		$T_{1/2}$: τ=300 fs *80* (1971De34).
4190.9 *10*	5/2$^+$	≤28 fs		$T_{1/2}$: τ≤40 fs (1971De34).
4431.2 *4*	7/2$^-$	≥208 fs		$T_{1/2}$: τ≥300 fs (1971De34).
4634.2 *8*	7/2$^+$	62 fs *14*		$T_{1/2}$: τ=90 fs *20* (1971De34).
4783.4 *11*	5/2$^+$	62 fs *35*		$T_{1/2}$: τ=90 fs *50* (1971De34).
5344 *2*	9/2$^+$	≤21 fs		$T_{1/2}$: τ≤30 fs (1971De34).
5529 *2*	(5/2)$^+$			
5773 *3*	(5/2,7/2$^+$)	≤10 fs		$T_{1/2}$: τ≤15 fs (1971De34).
5892 *2*	9/2$^+$,(7/2$^+$)	≤62 fs		$T_{1/2}$: τ≤90 FS 1971De34).
6078.1 *18*	(7/2$^-$,9/2$^-$)	≤42 fs		$T_{1/2}$: τ≤60 fs (1971De34).
6452.2 *10*	≥3/2	24 fs *12*		$T_{1/2}$: τ=35 fs *18* (1971De34).
6503 *3*	(7/2$^-$,9/2)	≤76 fs		$T_{1/2}$: τ≤110 fs (1971De34).
6792 *3*	(7/2$^-$,9/2,11/2$^-$)	152 fs *62*		$T_{1/2}$: τ=220 fs *90* (1971De34).
6828 *3*	(7/2,9/2)$^-$	83 fs *35*		$T_{1/2}$: τ=120 fs *50* (1971De34).
6932 *2*	5/2$^+$			
7117.7 *10*	≥3/2	≤69 fs		$T_{1/2}$: τ≤100 FS (1971De34).
7441.4 *10*	≥3/2	12 fs *10*		$T_{1/2}$: τ=17 fs *14* (1971De34).
7466 *3*	(7/2$^-$,9/2,11/2$^-$)	≤21 fs		$T_{1/2}$: τ≤30 fs (1971De34).
8345.5 *15*	(7/2$^-$,9/2)	27 fs *7*		$T_{1/2}$: τ=39 fs *10* (1971De34).
11873 *2*			0.20 *10*	Eα=2531 *2*.
11929 *2*	3/2		0.6 *3*	Eα=2596 *2*.
12077 *2*			0.4 *2*	Eα=2766 *2*.
12155 *2*			1.2 *6*	Eα=2855 *2*.
12204 *2*	11/2$^-$		1.8 *9*	Eα=2911 *2*.
12221.9 *10*			3.8 *10*	Eα=2931.9 *10*.
12236 *2*			2.0 *6*	Eα=2948 *2*.
12311 *2*			2.9 *12*	Eα=3034 *2*.
12329 *2*	5/2$^-$		1.1 *4*	Eα=3055 *2*.
12380 *2*			1.2 *4*	Eα=3113 *2*.
12386 *2*			0.4 *2*	Eα=3120 *2*.
12420 *2*			0.9 *4*	Eα=3159 *2*.
12447 *2*	7/2$^-$		1.1 *4*	Eα=3190 *2*.
12458 *2*			1.2 *4*	Eα=3203 *2*.
12481 *2*			1.2 *6*	Eα=3230 *2*.
12498 *2*			1.5 *7*	Eα=3249 *2*.
12549 *2*			2.9 *12*	Eα=3308 *2*.
12682 *6*				Eα=3460 *6*.
12807 *6*				Eα=3604 *6*.
12875 *6*				Eα=3682 *6*.

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^{27}Al(α,γ):resonances 1971De34,1991Wa13 (continued)

^{31}P Levels (continued)

E(level)†	Comments
12980 *6*	Eα=3802 *6*.
13001 *6*	Eα=3826 *6*.
13074 *6*	Eα=3910 *6*.
13084 *6*	Eα=3922 *6*.
13105 *6*	Eα=3946 *6*.
13183 *6*	Eα=4036 *6*.
13194 *6*	Eα=4048 *6*.
13225 *6*	Eα=4084 *6*.
13246 *6*	Eα=4108 *6*.
13298 *6*	Eα=4168 *6*.
13319 *6*	Eα=4192 *6*.
13340 *6*	Eα=4216 *6*.
13366 *6*	Eα=4246 *6*.
13486 *6*	Eα=4384 *6*.
13497 *6*	Eα=4396 *6*.
13502 *6*	Eα=4402 *6*.
13518 *6*	Eα=4420 *6*.
13523 *6*	Eα=4426 *6*.
13528 *6*	Eα=4432 *6*.
13539 *6*	Eα=4444 *6*.
13549 *6*	Eα=4456 *6*.
13591 *6*	Eα=4504 *6*.
13601 *6*	Eα=4516 *6*.
13607 *6*	Eα=4522 *6*.
13622 *6*	Eα=4540 *6*.
13638 *6*	Eα=4558 *6*.
13643 *6*	Eα=4564 *6*.
13654 *6*	Eα=4576 *6*.
13669 *6*	Eα=4594 *6*.
13675 *6*	Eα=4600 *6*.
13706 *6*	Eα=4636 *6*.
13711 *6*	Eα=4642 *6*.
13716 *6*	Eα=4648 *6*.
13727 *6*	Eα=4660 *6*.
13732 *6*	Eα=4666 *6*.
13742 *6*	Eα=4678 *6*.
13753 *6*	Eα=4690 *6*.
13769 *6*	Eα=4708 *6*.
13779 *6*	Eα=4720 *6*.
13800 *6*	Eα=4744 *6*.
13805 *6*	Eα=4750 *6*.
13816 *6*	Eα=4762 *6*.
13836 *6*	Eα=4786 *6*.
13842 *6*	Eα=4792 *6*.
13852 *6*	Eα=4804 *6*.
13857 *6*	Eα=4810 *6*.
13863 *6*	Eα=4816 *6*.
13873 *6*	Eα=4828 *6*.
13878 *6*	Eα=4834 *6*.
13889 *6*	Eα=4846 *6*.
13899 *6*	Eα=4858 *6*.
13910 *6*	Eα=4870 *6*.
13920 *6*	Eα=4882 *6*.
13925 *6*	Eα=4888 *6*.
13931 *6*	Eα=4894 *6*.
13936 *6*	Eα=4900 *6*.
13951 *6*	Eα=4918 *6*.

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^{27}Al(α,γ):resonances 1971De34,1991Wa13 (continued)

^{31}P Levels (continued)

E(level)†	Comments
14004 *6*	Eα=4978 *6*.
14014 *6*	Eα=4990 *6*.
14051 *6*	Eα=5032 *6*.
14056 *6*	Eα=5038 *6*.
14082 *6*	Eα=5068 *6*.
14103 *6*	Eα=5092 *6*.
14145 *6*	Eα=5140 *6*.
14176 *6*	Eα=5176 *6*.
14187 *6*	Eα=5188 *6*.
14197 *6*	Eα=5200 *6*.
14207 *6*	Eα=5212 *6*.
14213 *6*	Eα=5218 *6*.
14218 *6*	Eα=5224 *6*.
14223 *6*	Eα=5230 *6*.
14244 *6*	Eα=5254 *6*.
14254 *6*	Eα=5266 *6*.
14275 *6*	Eα=5290 *6*.
14281 *6*	Eα=5296 *6*.
14291 *6*	Eα=5308 *6*.
14296 *6*	Eα=5314 *6*.
14317 *6*	Eα=5338 *6*.
14338 *6*	Eα=5362 *6*.
14349 *6*	Eα=5374 *6*.
14354 *6*	Eα=5380 *6*.
14396 *6*	Eα=5428 *6*.
14401 *6*	Eα=5434 *6*.
14427 *6*	Eα=5464 *6*.
14432 *6*	Eα=5470 *6*.
14443 *6*	Eα=5482 *6*.
14453 *6*	Eα=5494 *6*.
14458 *6*	Eα=5500 *6*.
14505 *6*	Eα=5554 *6*.
14547 *6*	Eα=5602 *6*.
14578 *6*	Eα=5638 *6*.
14594 *6*	Eα=5656 *6*.
14620 *6*	Eα=5686 *6*.
14646 *6*	Eα=5716 *6*.
14693 *6*	Eα=5770 *6*.
14704 *6*	Eα=5782 *6*.
14714 *6*	Eα=5794 *6*.
14725 *6*	Eα=5806 *6*.
14740 *6*	Eα=5824 *6*.
14824 *6*	Eα=5920 *6*.
14845 *6*	Eα=5944 *6*.
14855 *6*	Eα=5956 *6*.
14866 *6*	Eα=5968 *6*.
14871 *6*	Eα=5974 *6*.
14876 *6*	Eα=5980 *6*.
14881 *6*	Eα=5986 *6*.
14887 *6*	Eα=5992 *6*.
14897 *6*	Eα=6004 *6*.
14902 *6*	Eα=6010 *6*.
14923 *6*	Eα=6034 *6*.
14939 *6*	Eα=6052 *6*.
14955 *6*	Eα=6070 *6*.
15012 *6*	Eα=6136 *6*.
15017 *6*	Eα=6142 *6*.

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^{27}Al(α,γ):resonances 1971De34,1991Wa13 (continued)

^{31}P Levels (continued)

E(level)†	Comments
15023 *6*	Eα=6148 *6*.
15028 *6*	Eα=6154 *6*.
15033 *6*	Eα=6160 *6*.
15049 *6*	Eα=6178 *6*.
15054 *6*	Eα=6184 *6*.
15059 *6*	Eα=6190 *6*.
15075 *6*	Eα=6208 *6*.
15080 *6*	Eα=6214 *6*.
15085 *6*	Eα=6220 *6*.
15090 *6*	Eα=6226 *6*.
15122 *6*	Eα=6262 *6*.
15127 *6*	Eα=6268 *6*.
15148 *6*	Eα=6292 *6*.
15153 *6*	Eα=6298 *6*.
15164 *6*	Eα=6310 *6*.
15169 *6*	Eα=6316 *6*.
15174 *6*	Eα=6322 *6*.
15179 *6*	Eα=6328 *6*.
15185 *6*	Eα=6334 *6*.
15200 *6*	Eα=6352 *6*.
15211 *6*	Eα=6364 *6*.
15216 *6*	Eα=6370 *6*.
15221 *6*	Eα=6376 *6*.

† Determined from E(α)(c.m.)+S(α), where E(c.m.) deduced from E(α)(lab) values listed under comments and S(α)=9668.60 *5* from 2021Wa16.

‡ As proposed by 1971De34, based on literature assignments for low-lying levels (up to 5529 and for 6932 levels) and γ decay patterns combined with RUL for possible γ-ray multipolarities where measured $T_{1/2}$ is available. See adopted J^π assignments in Adopted Levels.

From DSAM (1971De34). Quoted uncertainties include a systematic uncertainty of 25% due to uncertainties in the stopping powers.

@ From 1971De34.

$\gamma(^{31}P)$

E_i(level)	J_i^π	E_γ†	I_γ†	E_f	J_f^π	E_i(level)	J_i^π	E_γ†	I_γ†	E_f	J_f^π
1266.13	$3/2^+$	1266.1	100	0.0	$1/2^+$	4783.4	$5/2^+$	3517.1	12 *3*	1266.13	$3/2^+$
2233.8	$5/2^+$	2233.7	100	0.0	$1/2^+$			4783.0	42 *3*	0.0	$1/2^+$
3295.0	$5/2^+$	1061.2	16 *2*	2233.8	$5/2^+$	5344	$9/2^+$	1929	50 *10*	3414.6	$7/2^+$
		2028.8	84 *2*	1266.13	$3/2^+$			2049	21 *8*	3295.0	$5/2^+$
3414.6	$7/2^+$	1180.8	100	2233.8	$5/2^+$			3110	29 *8*	2233.8	$5/2^+$
4190.9	$5/2^+$	1957.0	24 *2*	2233.8	$5/2^+$	5529	$(5/2)^+$	2114	50 *30*	3414.6	$7/2^+$
		2924.6	76 *2*	1266.13	$3/2^+$			3295	50 *30*	2233.8	$5/2^+$
4431.2	$7/2^-$	1016.6	4 *1*	3414.6	$7/2^+$	5773	$(5/2,7/2^+)$	1139	25 *10*	4634.2	$7/2^+$
		1136.2	41 *2*	3295.0	$5/2^+$			2358	40 *15*	3414.6	$7/2^+$
		2197.3	55 *2*	2233.8	$5/2^+$			3539	15 *5*	2233.8	$5/2^+$
4634.2	$7/2^+$	1219.6	28 *3*	3414.6	$7/2^+$			4507	20 *10*	1266.13	$3/2^+$
		1339.2	47 *5*	3295.0	$5/2^+$	5892	$9/2^+,(7/2^+)$	3658	100	2233.8	$5/2^+$
		2400.3	25 *3*	2233.8	$5/2^+$	6078.1	$(7/2^-,9/2^-)$	3844.0	>70	2233.8	$5/2^+$
4783.4	$5/2^+$	1488.4	31 *3*	3295.0	$5/2^+$	6452.2	≥3/2	3037.4	90 *10*	3414.6	$7/2^+$
		2549.5	15 *3*	2233.8	$5/2^+$			4218.1	10 *10*	2233.8	$5/2^+$

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^{27}Al(α,γ):resonances 1971De34,1991Wa13 (continued)

$\gamma(^{31}P)$ (continued)

E_i(level)	J_i^π	E_γ †	I_γ †	E_f	J_f^π
6503	(7/2$^-$,9/2)	2072	50 *20*	4431.2	7/2$^-$
		3088	50 *20*	3414.6	7/2$^+$
6792	(7/2$^-$,9/2,11/2$^-$)	2361	100	4431.2	7/2$^-$
6828	(7/2,9/2)$^-$	2397	60 *15*	4431.2	7/2$^-$
		3413	15 *10*	3414.6	7/2$^+$
		4594	25 *10*	2233.8	5/2$^+$
6932	5/2$^+$	2298	20 *10*	4634.2	7/2$^+$
		2501	17 *6*	4431.2	7/2$^-$
		4698	63 *12*	2233.8	5/2$^+$
7117.7	≥3/2	3702.9	>50	3414.6	7/2$^+$
7441.4	≥3/2	2807.1	50 *10*	4634.2	7/2$^+$
		4026.5	40 *10*	3414.6	7/2$^+$
		5207.1	10 *5*	2233.8	5/2$^+$
7466	(7/2$^-$,9/2,11/2$^-$)	3035	>60	4431.2	7/2$^-$
8345.5	(7/2$^-$,9/2)	4154.3	20 *15*	4190.9	5/2$^+$
		4930.5	60 *20*	3414.6	7/2$^+$
		6111.1	20 *10*	2233.8	5/2$^+$
11873		8457	100	3414.6	7/2$^+$
11929	3/2	7145	25	4783.4	5/2$^+$
		7737	15	4190.9	5/2$^+$
		8513	30	3414.6	7/2$^+$
		8633	30	3295.0	5/2$^+$
12077		4959	10	7117.7	≥3/2
		5998	10	6078.1	(7/2$^-$,9/2$^-$)
		8661	80	3414.6	7/2$^+$
12155		5037	10	7117.7	≥3/2
		5702	50	6452.2	≥3/2
		6810	35	5344	9/2$^+$
		8739	5	3414.6	7/2$^+$
12204	11/2$^-$	3858	15	8345.5	(7/2$^-$,9/2)
		4738	10	7466	(7/2$^-$,9/2,11/2$^-$)
		5375	20	6828	(7/2,9/2)$^-$
		5411	10	6792	(7/2$^-$,9/2,11/2$^-$)
		5751	15	6452.2	≥3/2
		6125	15	6078.1	(7/2$^-$,9/2$^-$)
		6311	10	5892	9/2$^+$,(7/2$^+$)
		7772	5	4431.2	7/2$^-$
12221.9		5103.7	10	7117.7	≥3/2
		5289	5	6932	5/2$^+$
		6329	5	5892	9/2$^+$,(7/2$^+$)
		6448	10	5773	(5/2,7/2$^+$)
		6692	10	5529	(5/2)$^+$
		6877	15	5344	9/2$^+$
		7586.7	10	4634.2	7/2$^+$
		7789.6	5	4431.2	7/2$^-$
		8806.0	30	3414.6	7/2$^+$
12236		5118	15	7117.7	≥3/2
		6157	5	6078.1	(7/2$^-$,9/2$^-$)
		6343	5	5892	9/2$^+$,(7/2$^+$)
		6462	20	5773	(5/2,7/2$^+$)
		6891	20	5344	9/2$^+$
		7601	10	4634.2	7/2$^+$
		7804	5	4431.2	7/2$^-$
		8820	15	3414.6	7/2$^+$
		10000	5	2233.8	5/2$^+$
12311		3965	20	8345.5	(7/2$^-$,9/2)

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^{27}Al(α,γ):resonances 1971De34,1991Wa13 (continued)

$\gamma(^{31}P)$ (continued)

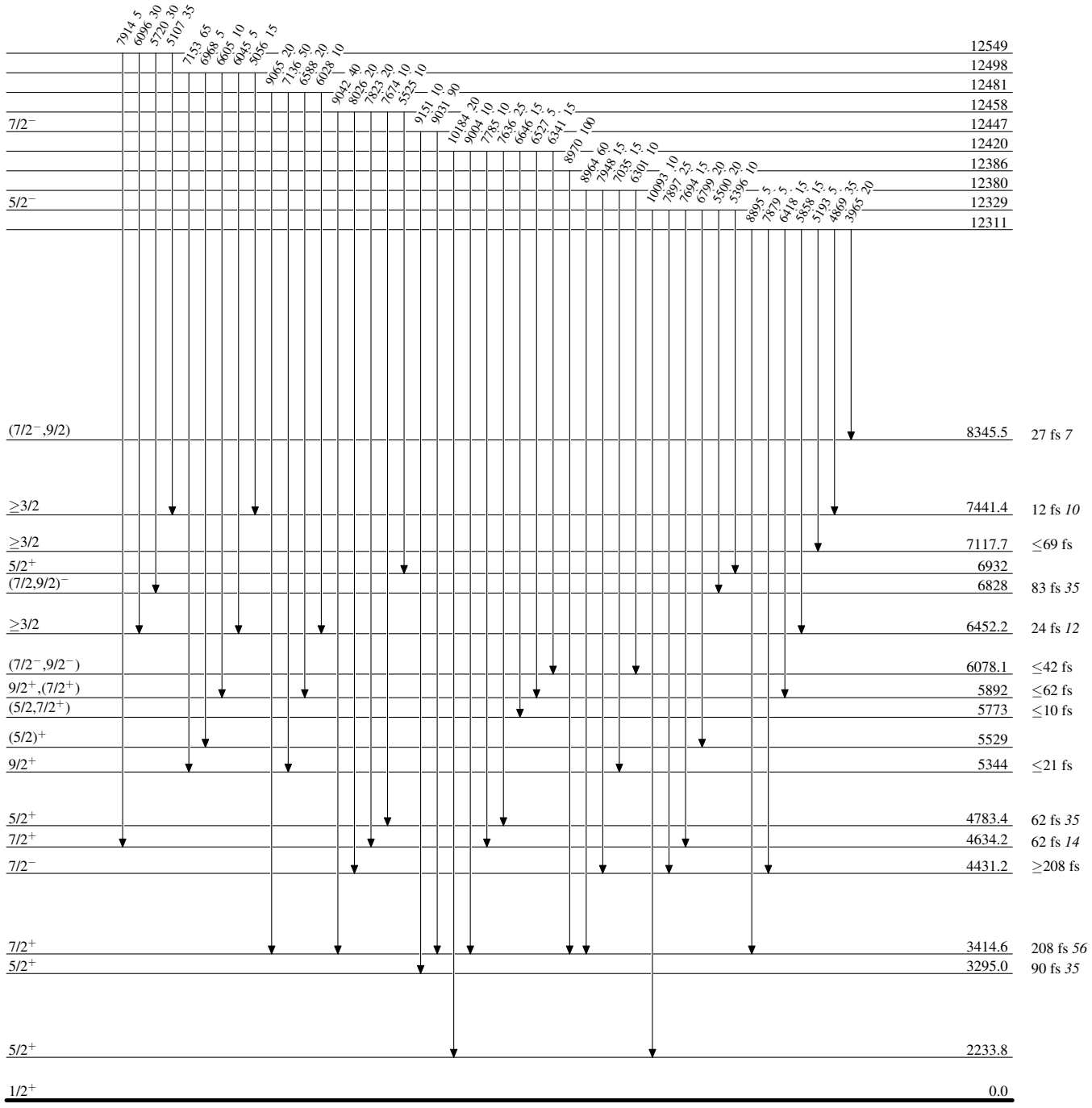
E_i(level)	J_i^π	E_γ †	I_γ †	E_f	J_f^π
12311		4869	35	7441.4	≥3/2
		5193	5	7117.7	≥3/2
		5858	15	6452.2	≥3/2
		6418	15	5892	$9/2^+$,$(7/2^+)$
		7879	5	4431.2	$7/2^-$
		8895	5	3414.6	$7/2^+$
12329	$5/2^-$	5396	10	6932	$5/2^+$
		5500	20	6828	$(7/2,9/2)^-$
		6799	20	5529	$(5/2)^+$
		7694	15	4634.2	$7/2^+$
		7897	25	4431.2	$7/2^-$
		10093	10	2233.8	$5/2^+$
12380		6301	10	6078.1	$(7/2^-,9/2^-)$
		7035	15	5344	$9/2^+$
		7948	15	4431.2	$7/2^-$
		8964	60	3414.6	$7/2^+$
12386		8970	100	3414.6	$7/2^+$
12420		6341	15	6078.1	$(7/2^-,9/2^-)$
		6527	5	5892	$9/2^+$,$(7/2^+)$
		6646	15	5773	$(5/2,7/2^+)$
		7636	25	4783.4	$5/2^+$
		7785	10	4634.2	$7/2^+$
12420		9004	10	3414.6	$7/2^+$
		10184	20	2233.8	$5/2^+$
12447	$7/2^-$	9031	90	3414.6	$7/2^+$
		9151	10	3295.0	$5/2^+$
12458		5525	10	6932	$5/2^+$
		7674	10	4783.4	$5/2^+$
		7823	20	4634.2	$7/2^+$
		8026	20	4431.2	$7/2^-$
		9042	40	3414.6	$7/2^+$
12481		6028	10	6452.2	≥3/2
		6588	20	5892	$9/2^+$,$(7/2^+)$
		7136	50	5344	$9/2^+$
		9065	20	3414.6	$7/2^+$
12498		5056	15	7441.4	≥3/2
		6045	5	6452.2	≥3/2
		6605	10	5892	$9/2^+$,$(7/2^+)$
		6968	5	5529	$(5/2)^+$
		7153	65	5344	$9/2^+$
12549		5107	35	7441.4	≥3/2
		5720	30	6828	$(7/2,9/2)^-$
		6096	30	6452.2	≥3/2
		7914	5	4634.2	$7/2^+$

† All data below 12670 keV are from 1971De34 and above this energy from 1991Wa13. Energy values are not explicitly listed in those references and are deduced from level-energy differences by evaluators.

^{27}Al(α,γ):resonances 1971De34,1991Wa13

Level Scheme

Intensities: % photon branching from each level

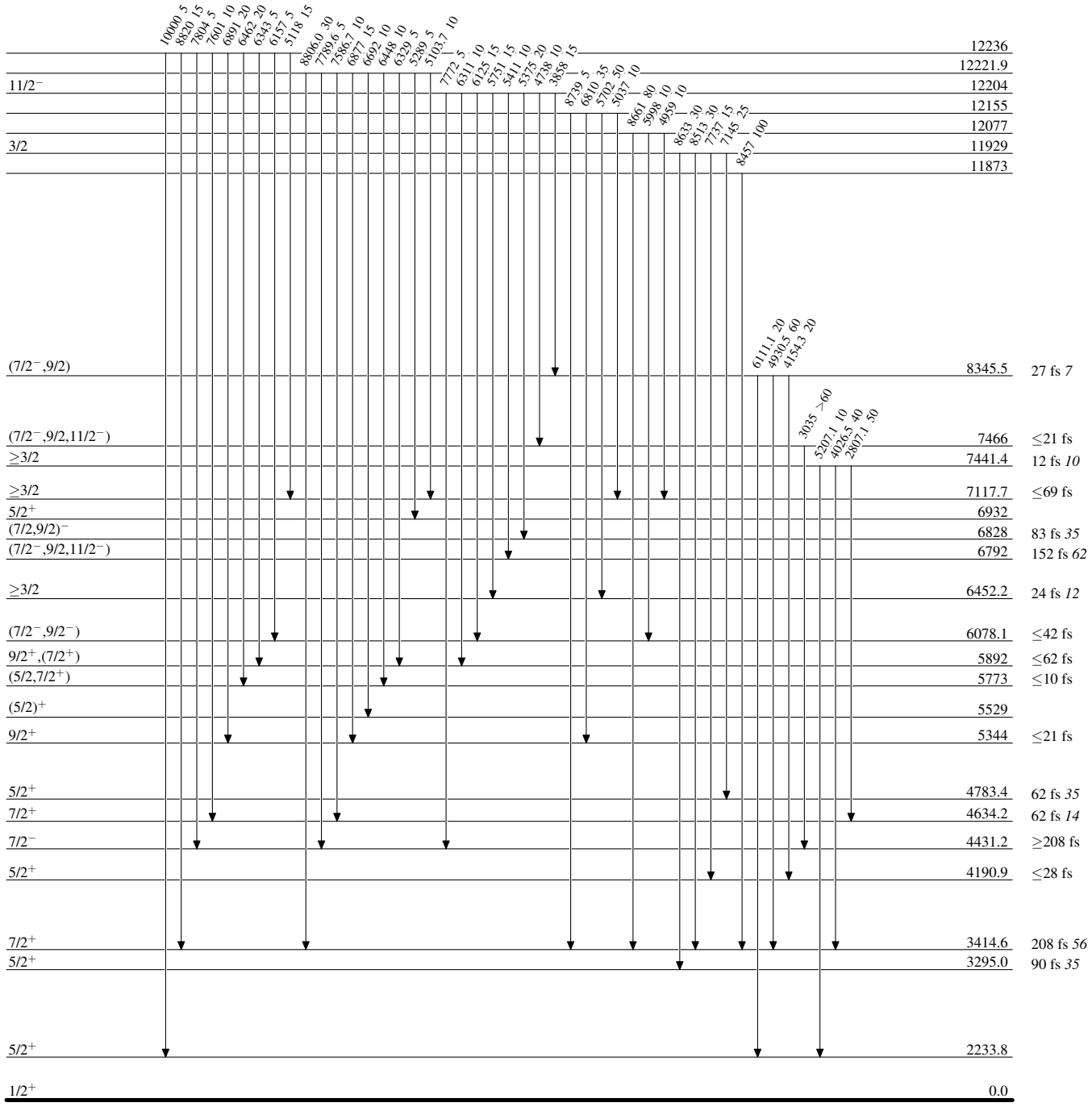


$^{31}_{15}P_{16}$

^{27}Al(α,γ):resonances 1971De34,1991Wa13

Level Scheme (continued)

Intensities: % photon branching from each level

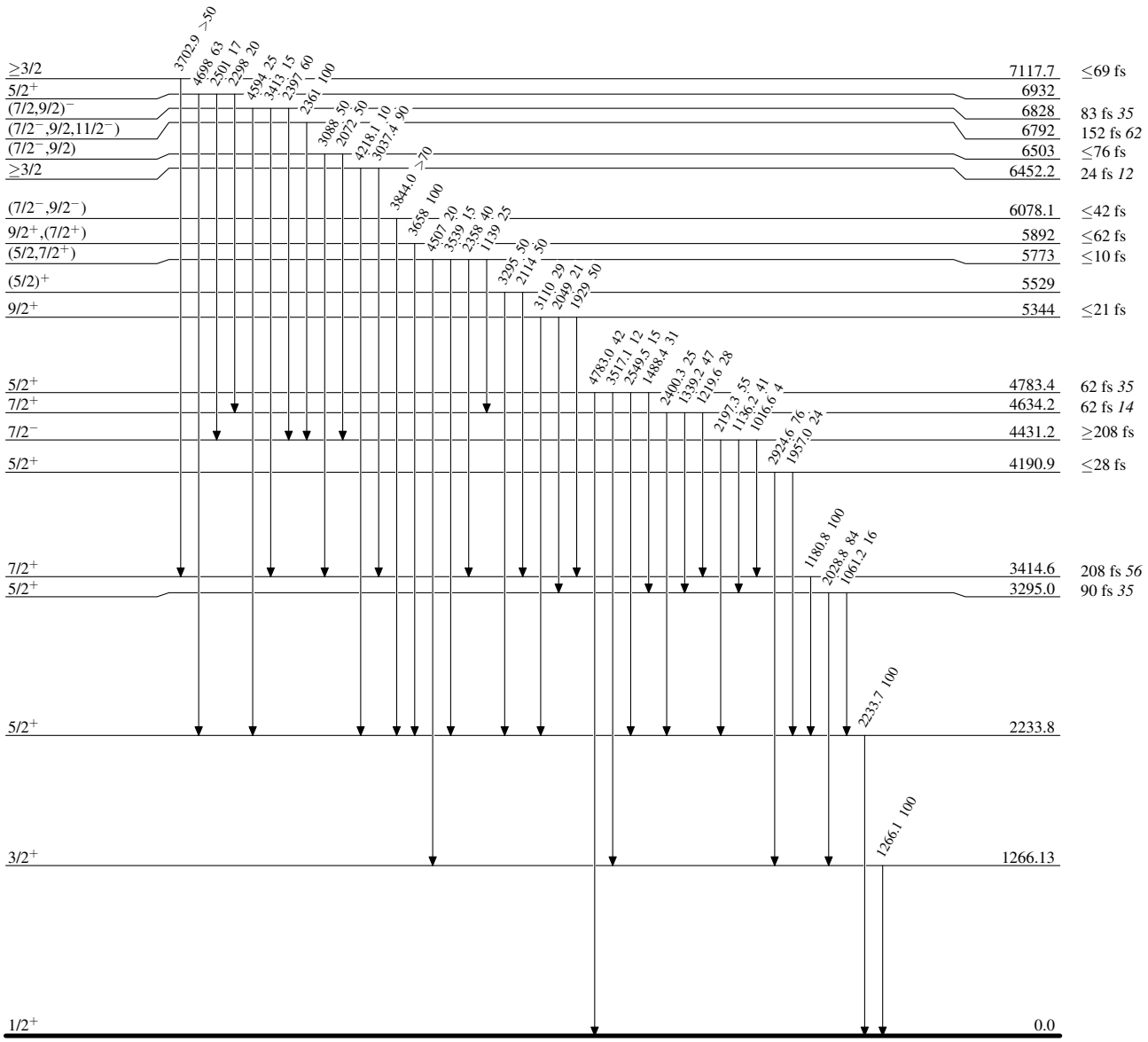


$^{31}_{15}P_{16}$

^{27}Al(α,γ):resonances 1971De34,1991Wa13

Level Scheme (continued)

Intensities: % photon branching from each level



$^{31}_{15}P_{16}$