^{31}P(t,pγ) 1973Po02,1973Po03,1970Ha48

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen and Balraj Singh	NDS 199,1 (2025)	30-Sep-2024

1973Po02,1973Po03: 2.9 MeV triton beam was produced from the Lockheed Palo Alto Research laboratory. Targets were about 700 μg/cm^2 Zn_2P_3 evaporated onto 0.003-cm-thick tantalum for γ-ray spectroscopy (1973Po02) and 200 μg/cm^2 elemental red phosphorus for p$\gamma(\theta)$ (1973Po03). Charged particles were detected with an annular detector and γ rays were detected with Ge(Li) and NaI(Tl) detectors. Measured Eγ, Iγ, pγ-coin, p$\gamma(\theta)$, p$\gamma\gamma(\theta)$, Doppler-shift attenuation (DSA). Deduced levels, J, π, $T_{1/2}$, γ-ray branching ratios, multipolarities and mixing ratios. Report 23 levels.

1970Ha48: E=2.45 and 3.10 MeV triton beams were produced from the BNL 3.5-MV Van de Graaff accelerator. Targets were 600 and 500 μg/cm^2 Zn_3P_2 evaporated onto a molybdenum backing for γ singles and a nickel backing for p$\gamma(\theta)$, respectively. Charged particles were detected with a silicon surface-barrier detector (FWHM=28 keV) and γ rays were detected with a Ge(Li) and a NaI(Tl) detector. Measured Eγ, Iγ, pγ-coin, p$\gamma(\theta)$, p$\gamma\gamma(\theta)$. Deduced levels, J, π, γ ray branching ratios, multipolarities and mixing ratios. Comparisons with available data and theoretical calculations.

1973Wa14: E=2.5 and 3.1 MeV triton beams were produced from the 3-MV Van de Graaff of the Centre de Recherches Nucleaires de Strasbourg-Cronenbourg. Targets were 300 and 100 μg/cm^2 Zn_2P_3 evaporated onto 0.03 mm molybdenum backings. Charged particles were detected with an annular silicon surface-barrier detector and γ rays were detected with a Ge(Li) detector. Measured Eγ, Iγ, pγ-coin, Doppler-shift attenuation. Deduced levels, $T_{1/2}$, γ-ray branching ratios, transition strengths. Report 10 levels.

1972Go09: E=3 MeV triton beam was produced from the BNL 3.5-MV Van de Graaff accelerator. Targets was 500 μg/cm^2 Zn_2P_3 on a thick Ta backing. The γ rays were detected with a Ge(Li) detector. Measured Eγ from the first two excited states.

^{33}P Levels

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$[#]	Comments
0.0	1/2$^+$		J$^\pi$: from the Adopted Levels.
1431.35 *20*	3/2$^+$	0.44 ps *7*	J$^\pi$: 3/2 from p$\gamma(\theta)$ and p$\gamma\gamma(\theta)$ of 1431γ in 1970Ha48 and 1973Po03; 1431.5γ M1+E2 to 1/2$^+$. $T_{1/2}$: from τ=0.63 ps *10*, weighted average of 0.70 ps *15* (1973Po03) and 0.60 ps *10* (1973Wa14).
1847.53 *14*	5/2$^+$	0.64 ps *17*	J$^\pi$: 5/2 from p$\gamma(\theta)$ of 1848γ in 1970Ha48 and 1973Po03; 1847γ E2 to 1/2$^+$. $T_{1/2}$: from τ=0.92 ps *24*, weighted average of 1.40 ps *30* (1973Po03) and 0.80 ps *15* (1973Wa14).
2538.15 *25*	3/2	35 fs *14*	J$^\pi$: 3/2 from p$\gamma(\theta)$ of 2537γ in 1970Ha48. $T_{1/2}$: from τ=50 fs *20*, unweighted average of 30 fs *10* (1973Po03) and 70 fs *12* (1973Wa14).
3276.0 *4*	3/2,5/2	0.14 ps *3*	J$^\pi$: 3/2,5/2 from p$\gamma(\theta)$ of 3275γ in 1970Ha48. $T_{1/2}$: from τ=0.20 ps *4*, weighted average of 0.19 ps *4* (1973Po03) and 0.21 ps *4* (1973Wa14).
3490.29 *28*	5/2$^+$	69 fs *14*	J$^\pi$: 3/2,5/2 from p$\gamma(\theta)$ of 2059γ in 1970Ha48 and 1973Po03; 5/2 from p$\gamma(\theta)$ of 3490γ in 1973Po03; 3490.4γ E2(+M3) to 1/2$^+$. Additional information 1. $T_{1/2}$: from τ=0.10 ps *2*, weighted average of 0.09 ps *2* (1973Po03) and 0.11 ps *2* (1973Wa14).
3627.0 *6*	7/2$^+$	0.17 ps *3*	J$^\pi$: 7/2 from p$\gamma(\theta)$ of 1779γ and 2196γ in 1970Ha48; 2195.8γ E2(+M3) to 3/2$^+$. $T_{1/2}$: from τ=0.24 ps *4*, weighted average of 0.26 ps *4* (1973Po03) and 0.17 ps *8* (1973Wa14).
4047.9 *5*	3/2,5/2	59 fs *21*	J$^\pi$: 3/2,5/2 from p$\gamma(\theta)$ of 2617γ in 1970Ha48. $T_{1/2}$: from τ=85 fs *30*, weighted average of 80 fs *40* (1973Po03) and 85 fs *30* (1973Wa14).
4192.2 *20*	5/2$^+$	104 fs *35*	J$^\pi$: ≤=5/2 in 1973Po02 and 5/2,7/2 in 1970Ha48 from p$\gamma(\theta)$ of 4194γ; 4193.5γ E2(+M3) to 1/2$^+$. $T_{1/2}$: from τ=0.15 ps *5* in 1973Wa14. Other: <28 fs from τ<0.04 ps in 1973Po02.
4224.5 *7*	7/2$^-$	0.32 ps *7*	J$^\pi$: 7/2 from p$\gamma(\theta)$ of 2377γ in 1970Ha48; parity from the Adopted Levels. $T_{1/2}$: from τ=0.46 fs *10*, weighted average of 0.52 ps *10* (1973Po03) and 0.39 fs *10* (1973Wa14).
4855.8 *11*	3/2,5/2	<76 fs	J$^\pi$: 3/2,5/2 from p$\gamma(\theta)$ of 4855γ and p$\gamma\gamma(\theta)$ of 3008γ in 1973Po03, with 3/2 favored.

Continued on next page (footnotes at end of table)

^{31}P(t,pγ) 1973Po02,1973Po03,1970Ha48 (continued)

^{33}P Levels (continued)

E(level)[†]	J$^{\pi}$[‡]	T$_{1/2}$[#]	Comments
			T$_{1/2}$: from τ<0.11 ps in 1973Po02.
5052.3 *15*	3/2	<62 fs	J$^{\pi}$: 3/2 from p$\gamma(\theta)$ of 5048γ in 1973Po03. T$_{1/2}$: from τ<0.09 ps in 1973Po02.
5190.4 *29*	3/2,5/2	<0.13 ps	J$^{\pi}$: 3/2,5/2 from p$\gamma\gamma(\theta)$ of 3759γ in 1973Po03. T$_{1/2}$: from τ<0.18 ps in 1973Po02.
5405.1 *28*	(3/2,5/2,7/2,9/2)	<76 fs	J$^{\pi}$: 1/2 ruled out by p$\gamma\gamma(\theta)$ of 3557γ in 1973Po03. T$_{1/2}$: from τ<0.11 ps in 1973Po02.
5450.5 *9*		>1.3 ps	J$^{\pi}$: 1/2 ruled out by p$\gamma\gamma(\theta)$ of 1226γ in 1973Po03. T$_{1/2}$: from τ>1.8 ps in 1973Po02.
5499.0 *9*		<62 fs	T$_{1/2}$: from τ<0.09 ps in 1973Po02.
5547.2 *21*		0.33 ps *12*	T$_{1/2}$: from τ=0.47 ps *17* in 1973Po02.
5557.3 *24*	3/2	<56 fs	J$^{\pi}$: 3/2 from p$\gamma(\theta)$ of 5557γ in 1973Po03. T$_{1/2}$: from τ<0.08 ps in 1973Po02.
5645.3 *31*			
5674.1 *30*	1/2,3/2	<49 fs	J$^{\pi}$: from p$\gamma(\theta)$ of 5674γ in 1973Po03. T$_{1/2}$: from τ<0.07 ps in 1973Po02.
5730	3/2		Additional information 2. J$^{\pi}$: 3/2 from p$\gamma(\theta)$ of 5730γ in 1973Po03.
5785.1 *30*		<35 fs	T$_{1/2}$: from τ<0.05 ps in 1973Po02.
5813.8 *14*		76 fs *42*	J$^{\pi}$: (3/2,5/2,7/2) proposed in 1973Po03. T$_{1/2}$: from τ=0.11 ps *6* in 1973Po02.
5972.6 *30*		<56 fs	E(level): 1973Po03 show two levels near this energy: 5930 and 5990; the first one with a possible transition to the g.s., the second with a transition to 1850 level and a possible transition to g.s. Based on the data from 1973Po02, the evaluators adopt only one level. T$_{1/2}$: from τ<0.08 ps in 1973Po02.
6114.5 *21*		<0.14 ps	T$_{1/2}$: from τ<0.20 ps in 1973Po02.
6125 *5*		55 fs *42*	E(level): note that this level is reported only in 1973Po02 not in authors' companion paper 1973Po03. T$_{1/2}$: from τ=0.08 ps *6* in 1973Po02.
6182.3 *35*		<62 fs	E(level): from 1973Po02; 6170 level in 1973Po03 is probably the same as 6180 in 1973Po02. T$_{1/2}$: from τ<0.09 ps in 1973Po02.

[†] From a least-squares fit to γ-ray energies with uncertainties, unless otherwise noted.

[‡] Spin from p$\gamma(\theta)$ and p$\gamma\gamma(\theta)$ in 1970Ha48 and 1973Po03 as given under comments and parity from deduced electric or magnetic nature of γ-ray multipolarities, unless otherwise noted.

[#] From DSAM in 1973Po02, unless otherwise noted. Uncertainty due to stopping power theory has been taken into account in results of 1973Po02 and 1973Wa14.

^{31}P(t,pγ) 1973Po02,1973Po03,1970Ha48 (continued)

$\gamma(^{33}P)$

A_2 and A_4 coefficients given under comments are from p$\gamma(\theta)$ and p$\gamma\gamma(\theta)$ data of 1973Po03, unless otherwise noted. Values from 1970Ha48 are also listed as indicated. All quoted values are those of the primary transitions of $\gamma\gamma(\theta)$. See 1973Po03 for other values from the secondary transitions of $\gamma\gamma(\theta)$ for 1431γ and 1848γ.

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[#]	δ[#]	Comments
1431.35	3/2$^+$	1431.5 *3*	100	0.0	1/2$^+$	M1+E2	−0.58 *+25−30*	A_2=−0.60 *2*; A_4=+0.01 *2* A_2=+0.42 *4*; A_4=+0.05 *5* (1970Ha48) E_γ: from 1973Wa14 and 1972Go09. Mult.: E1+M2 ruled out by RUL. δ: from 1970Ha48. Others: +0.64<δ<+20.4 or −1.56<δ<−0.05 (1973Po03). Note that the two $\gamma(\theta)$ results are in severe disagreement. (416γ)(1431γ)(θ): A_2=−0.16 *10* (1973Po03). (2059γ)(1431γ)(θ): A_2=−0.36 *6*, A_4=+0.03 *6* (1973Po03). (2196γ)(1431γ)(θ): A_2=−0.60 *6*, A_4=0.00 *5* (1973Po03); A_2=−0.65 *8* (1970Ha48). (2617γ)(1431γ)(θ): A_2=−0.48 *7*, A_4=+0.08 *6* (1973Po03); A_2=−0.38 *5* or A_2=−0.65 *7* (1970Ha48). (3759γ)(1431γ)(θ): A_2=−0.58 *7*, A_4=−0.03 *7* (1973Po03).
1847.53	5/2$^+$	416.3[@] *3*	8 *2*	1431.35	3/2$^+$	(M1(+E2))	+0.09 *18*	A_2=−0.22 *12*; A_4=+0.06 *11* Additional information 3. I_γ: others: 8 *3* (1970Ha48), 7 *3* (1973Wa14). Mult.: D(+Q) from 1973Po03; $\Delta\pi$=no from level scheme.
		1847.52 *16*	92 *2*	0.0	1/2$^+$	E2		A_2=+0.48 *3*; A_4=−0.49 *4* A_2=+0.51 *5*; A_4=−0.31 *6* (1970Ha48) E_γ: weighted average of 1847.2 *3* (1973Wa14) and 1847.60 *15* (1972Go09). I_γ: others: 92 *3* (1970Ha48), 93 *4* (1973Wa14). Mult.,δ: δ(O/Q)=+0.02 *4* (1970Ha48) and −0.048 *40* (1973Po03); O component (E3 or M3) is ruled out by RUL. 1429γ-1848$\gamma(\theta)$: A_2=0.00 *5*, A_4=0.00 *5* (1973Po03); A_2=+0.14 *8*, A_4=+0.03 *9* (1970Ha48). (1643γ)(1848γ)(θ): A_2=+0.29 *5*, A_4=−0.10 *5* (1973Po03). (1779γ)(θ)+(1779γ)(1848γ)(θ): A_2=−0.31 *7*, A_4=+0.12 *7* (1973Po03). (1779γ)(1848γ)(θ): A_2=+0.10 *10*, A_4=−0.33 *11* (1970Ha48). (2377γ)(1848γ)(θ): A_2=+0.45 *6*, A_4=−0.26 *6* (1973Po03); A_2=+0.47 *7*, A_4=−0.12 *8* or A_2=+0.64 *8*, A_4=−0.58 *9* (1970Ha48). (3008γ)(1848γ)(θ): A_2=−0.18 *7*, A_4=+0.01 *7* (1973Po03). (3206γ)(1848γ)(θ): A_2=+0.28 *5*, A_4=+0.01 *5* (1973Po03). (3343γ)(1848γ)(θ): A_2=+0.19 *12*, A_4=−0.02 *12* (1973Po03). (3557γ)(1848γ)(θ): A_2=+0.25 *6*, A_4=−0.03 *6* (1973Po03). (1226γ)(2377γ)(1848γ)(θ): A_2=+0.27 *7*, A_4=−0.07 *7* (1973Po03). (4122γ)(1848γ)(θ): A_2=+0.36 *10*, A_4=+0.03 *11* (1973Po03).

$^{33}_{15}P_{18}$-3

^{31}P(t,pγ) 1973Po02,1973Po03,1970Ha48 (continued)

$\gamma(^{33}P)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[#]	δ[#]	Comments
2538.15	3/2	691.0[@] *4*	7 *1*	1847.53	5/2$^+$			Additional information 4. I_γ: others: 4 *4* (1970Ha48), 8 *3* (1973Wa14).
		1106.8[@] *3*	8 *1*	1431.35	3/2$^+$			Additional information 5. I_γ: others: 8 *4* (1970Ha48), 10 *3* (1973Wa14).
		2537.3 *5*	85 *3*	0.0	1/2$^+$			A_2=−0.09 *2*; A_4=−0.02 *2* A_2=−0.12 *3*; A_4=+0.05 *4* (1970Ha48) E_γ: weighted average of 2537.1 *5* (1973Wa14) and 2537.5 *6* (1973Po02). I_γ: others: 88 *8* (1970Ha48), 82 *3* (1973Wa14).
3276.0	3/2,5/2	737.8	<3	2538.15	3/2			
		1428.6[@] *4*	52 *3*	1847.53	5/2$^+$	D+Q		A_2=+0.01 *4*; A_4=+0.02 *4* A_2=−0.08 *7*; A_4=0.00 *8* (1970Ha48) Additional information 6. I_γ: others: 53 *4* (1973Wa14); In 1970Ha48 the authors stated that the 3275-1848-0 cascade and the 3275-1431-0 cannot be distinguished from each other and gave a total γ-branching of 51 *8* for the two transitions. δ: 1973Po03 give δ<−5.7, or −1.0<δ<+0.4, or δ>+2.1 for J(3275)=5/2.
		1844.6	<5	1431.35	3/2$^+$			
		3275.1 *10*	48 *3*	0.0	1/2$^+$	D+Q		A_2=−0.03 *4*; A_4=+0.10 *4* A_2=+0.31 *7*; A_4=0.00 *8* (1970Ha48) E_γ: weighted average of 3275.1 *10* (1973Wa14) and 3274.7 *20* (1973Po02). I_γ: others: 49 *8* (1970Ha48), 47 *4* (1973Wa14). δ: <+0.36 (1973Po03), and δ>5 or δ<−0.57 (1970Ha48) for J(3275)=5/2. Note that the two $\gamma(\theta)$ results are in disagreement.
3490.29	5/2$^+$	214.3	<3	3276.0	3/2,5/2			
		952.1	<3	2538.15	3/2			
		1642.7 *3*	49 *3*	1847.53	5/2$^+$	(M1+E2)		A_2=+0.31 *6*; A_4=0.00 *6* E_γ: weighted average of 1642.6 *3* (1973Wa14) and 1643.0 *5* (1973Po02). I_γ: others: 62 *15* (1970Ha48); 62 *4* (1973Wa14) is discrepant. Mult.: D+Q from 1973Po03; $\Delta\pi$=no from level scheme. δ: −0.27<δ<+2.1 (1973Po03).
		2058.9 *4*	44 *3*	1431.35	3/2$^+$	M1+E2	−0.37 *28*	A_2=−0.48 *7*; A_4=+0.01 *6* A_2=−0.60 *13*; A_4=−0.02 *12* (1970Ha48) E_γ: weighted average of 2058.8 *4* (1973Wa14) and 2059.4 *10* (1973Po02). I_γ: others: 38 *15* (1970Ha48), 38 *4* (1973Wa14). Mult.: D+Q from 1973Po03; E1+M2 ruled out by RUL. δ: others: −2.8<δ<0 for J(3490)=5/2 and δ=−1.4 *3* or 0<δ<3.8 for J=3/2 in 1970Ha48.
		3490.1	7 *2*	0.0	1/2$^+$	E2(+M3)	+0.07 *7*	A_2=+0.06 *9*; A_4=+0.09 *9* I_γ: others: <25 (1970Ha48), <4 (1973Wa14). Mult.: Q(+O) from 1973Po03; M2 ruled out by RUL.
3627.0	7/2$^+$	136.7	<4	3490.29	5/2$^+$			

$^{33}_{15}P_{18}$-4

^{31}P(t,pγ) 1973Po02,1973Po03,1970Ha48 (continued)

$\gamma(^{33}P)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[#]	δ[#]	Comments
3627.0	7/2$^+$	351.0	<6	3276.0	3/2,5/2			
		1088.8	<5	2538.15	3/2			
		1779.3 *8*	30 *3*	1847.53	5/2$^+$	(M1(+E2))	+0.01 *8*	E_γ: weighted average of 1779.1 *8* (1973Wa14) and 1782.2 *30* (1973Po02). I_γ: weighted average of 31 *6* (1970Ha48), 33 *4* (1973Po03), and 28 *3* (1973Wa14). Mult.: D(+Q) from 1973Po03; $\Delta\pi$=no from level scheme. δ: other: −0.05 *+7−11* (1970Ha48).
		2195.8 *10*	70 *3*	1431.35	3/2$^+$	E2(+M3)	+0.03 *13*	A_2=+0.47 *5*; A_4=−0.18 *5* A_2=+0.31 *9*; A_4=−0.34 *9* (1970Ha48) E_γ: weighted average of 2195.1 *10* (1973Wa14) and 2197.1 *13* (1973Po02). I_γ: weighted average of 69 *6* (1970Ha48), 67 *4* (1973Po03), and 72 *3* (1973Wa14). Mult.: Q(+O) from 1973Po03; M2 ruled out by RUL. δ: other: −0.14 *12* (1970Ha48).
		3626.8[a]	<1	0.0	1/2$^+$			I_γ: others: <6 (1970Ha48), <3 (1973Wa14). Considered as an unlikely transition by the evaluators as implied Mult=M3 is not allowed by RUL.
4047.9	3/2,5/2	420.9	<4	3627.0	7/2$^+$			
		557.6	<4	3490.29	5/2$^+$			
		771.9	7[@] *3*	3276.0	3/2,5/2			I_γ: other: 17 *9* (1973Po03).
		1509.5[@] *6*	11[@] *4*	2538.15	3/2			Additional information 7. I_γ: others: <15 (1970Ha48), <13 (1973Po03).
		2200.3	<4[@]	1847.53	5/2$^+$			I_γ: others: <9 (1970Ha48, 1973Po03).
		2616.5 *8*	77[@] *4*	1431.35	3/2$^+$	D+Q		A_2=−0.01 *12*; A_4=+0.13 *13* A_2=+0.01 *5*; A_4=−0.03 *5* (1970Ha48) A_2=+0.02 *5*; A_4=+0.03 *5* (1970Ha48) E_γ: weighted average of 2616.6 *8* (1973Wa14) and 2616.1 *12* (1973Po02). I_γ: others: 100 (1970Ha48), 83 *9* (1973Po03). δ: 0.19 *4* for J(4048)=5/2 or −8<δ<8 for J=3/2 (1970Ha48); −0.33<δ<+0.78 for J=5/2, or δ<−1.28 or −0.36<δ<0 or δ>+1.88 for J=3/2 (1973Po03).
		4047.6	5[@] *3*	0.0	1/2$^+$			I_γ: others: <10 (1970Ha48), <5 (1973Po03).
4192.2	5/2$^+$	2344.6	<5[@]	1847.53	5/2$^+$			I_γ: other: <50 (1970Ha48).
		2760.7	<4[@]	1431.35	3/2$^+$			
		4193.5 *25*	100	0.0	1/2$^+$	E2(+M3)		A_2=−0.01 *8*; A_4=+0.04 *8* (1973Po03); A_2=+0.31 *9*; A_4=−0.32 *10* (1970Ha48) E_γ: weighted average of 4193.9 *30* (1973Wa14) and 4193.2 *25* (1973Po02). Mult.,δ: Q+O for J(4194)=5/2 with δ>+0.35 or −3.73<δ<+0.07, or O for J=7/2 in 1970Ha48; M2+E3, M3 and E3 ruled out by RUL. Note that the two $\gamma(\theta)$ results are in severe disagreement.
4224.5	7/2$^-$	2377.0 *7*	100	1847.53	5/2$^+$	D(+Q)	+0.01 *8*	A_2=−0.33 *6*; A_4=+0.06 *6*

$^{33}_{15}P_{18}$-5

^{31}P(t,pγ) 1973Po02,1973Po03,1970Ha48 (continued)

$\gamma(^{33}P)$ (continued)

E_i(level)	J_i^π	E_γ †	I_γ ‡	E_f	J_f^π	Mult.#	δ#	Comments
								A_2=−0.06 *10*; A_4=−0.15 *13* (1970Ha48) A_2=−0.20 *12*; A_4=−0.20 *13* (1970Ha48) E_γ: weighted average of 2377.3 *6* (1973Wa14) and 2375.6 *12* (1973Po02). δ: other: 0.0 *1* (1970Ha48). (1226γ)(2377γ)(θ): A_2=−0.40 *11*, A_4=+0.16 *11* (1973Po03).
4224.5	7/2$^-$	2793.0	<4@	1431.35	3/2$^+$			
		4224.2	<4@	0.0	1/2$^+$	[E3]		I_γ: other: <9 (1970Ha48).
4855.8	3/2,5/2	631.3	<4	4224.5	7/2$^-$			
		663.6	<4	4192.2	5/2$^+$			
		807.9	<4	4047.9	3/2,5/2			
		1228.8	<4	3627.0	7/2$^+$			
		1365.5	<4	3490.29	5/2$^+$			
		1579.8	<3	3276.0	3/2,5/2			
		2317.6	<2	2538.15	3/2			
		3008.3 *12*	80 *4*	1847.53	5/2$^+$	D+Q		A_2=+0.06 *4*; A_4=+0.01 *4* δ: −0.40<δ<0.40 or +2.5<δ<+11.4 for J(4856)=5/2 (1973Po03).
		3424.3	<2	1431.35	3/2$^+$			
		4854.6 *30*	20 *4*	0.0	1/2$^+$			A_2=+0.06 *7*; A_4=+0.02 *7* δ: δ<−8.1 or −1.57<δ<−0.22 or +0.22<δ<+0.35 for J(4856)=5/2 (1973Po03).
5052.3	3/2	827.8	<2	4224.5	7/2$^-$			
		860.1	<2	4192.2	5/2$^+$			
		1004.4	<2	4047.9	3/2,5/2			
		1425.3	<7	3627.0	7/2$^+$			
		1562.0	<7	3490.29	5/2$^+$			
		1776.3	<7	3276.0	3/2,5/2			
		2514.1	5 *2*	2538.15	3/2			
		3205.7 *17*	35 *5*	1847.53	5/2$^+$	D(+Q)	−0.22 *65*	A_2=−0.02 *10*; A_4=+0.10 *10*
		3620.7	12 *4*	1431.35	3/2$^+$			
		5048.3 *30*	49 *4*	0.0	1/2$^+$	D(+Q)		A_2=−0.50 *3*; A_4=+0.01 *3* δ: −1.8<δ<+0.02 (1973Po03).
5190.4	3/2,5/2	965.9	<4	4224.5	7/2$^-$			
		998	<4	4192.2	5/2$^+$			
		1142.5	<7	4047.9	3/2,5/2			
		1563.4	<7	3627.0	7/2$^+$			
		1700.1	<3	3490.29	5/2$^+$			
		1914.3	<7	3276.0	3/2,5/2			
		2652.1	<7	2538.15	3/2			
		3342.7	37 *4*	1847.53	5/2$^+$			A_2=+0.25 *14*; A_4=+0.10 *13*
		3758.8 *29*	63 *4*	1431.35	3/2$^+$	D(+Q)	0.0 *3*	A_2=−0.35 *9*; A_4=+0.21 *9* δ: 0.0 *3* for J(5191)=5/2, δ<−6.31 or δ>+2.36 for J=3/2 (1973Po03) larger values ruled out by RUL.

$^{33}_{15}P_{18}$-6

^{31}P(t,pγ) 1973Po02,1973Po03,1970Ha48 (continued)

$\gamma(^{33}P)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Comments
5190.4	3/2,5/2	5190.0	<5	0.0	1/2$^+$	
5405.1	(3/2,5/2,7/2,9/2)	2866.8	30 *10*	2538.15	3/2	
		3557.4 *28*	70 *10*	1847.53	5/2$^+$	A_2=+0.02 *7*; A_4=+0.05 *7* δ: −1.0<δ<+0.29 or δ>+1.9 for J(5406)=5/2, δ<−4.7 or +0.01<δ<+0.51 or δ>+4.7 for J=7/2, δ<−3.5 or −0.63<δ<0 for J=9/2 (1973Po03).
5450.5		1226.0 *5*	100	4224.5	7/2$^-$	A_2=+0.58 *11*; A_4=+0.18 *11*
5499.0		1274.5 *5*	83[&] *9*	4224.5	7/2$^-$	
		3648.4 *33*	17[&] *9*	1847.53	5/2$^+$	
5547.2		1355.0 *6*	100[&]	4192.2	5/2$^+$	
5557.3	3/2	1365.1		4192.2	5/2$^+$	E_γ: reported in 1973Po03 only.
		3709.2 *30*	50[&] *10*	1847.53	5/2$^+$	
		4125.7		1431.35	3/2$^+$	E_γ: reported in 1973Po03 only.
		5557.3 *40*	50[&] *10*	0.0	1/2$^+$	A_2=−0.35 *6*; A_4=−0.03 *6*
5645.3		1420.8 *30*	100[&]	4224.5	7/2$^-$	
5674.1	1/2,3/2	5673.6 *30*	100[&]	0.0	1/2$^+$	A_2=+0.04 *4*; A_4=−0.05 *4*
5730	3/2	5730	100	0.0	1/2$^+$	A_2=−0.31 *3*; A_4=+0.01 *3* E_γ,I_γ: from 1973Po03.
5785.1		5784.6 *30*	100[&]	0.0	1/2$^+$	
5813.8		2186.8 *14*	30 *10*	3627.0	7/2$^+$	
		3966.0	36 *10*	1847.53	5/2$^+$	
		4381.5 *34*	34 *10*	1431.35	3/2$^+$	
5972.6		4124.8[a]		1847.53	5/2$^+$	E_γ: possible transition reported in 1973Po03 only.
		5972.0 *30*	100[&]	0.0	1/2$^+$	
6114.5		1923.3 *20*	56[&] *10*	4192.2	5/2$^+$	
		2064.8 *26*	44[&] *10*	4047.9	3/2,5/2	
		2624.1		3490.29	5/2$^+$	E_γ: reported in 1973Po03 only.
		6113.9[a]		0.0	1/2$^+$	E_γ: possible transition reported in 1973Po03 only.
6125		6124 *5*	100[&]	0.0	1/2$^+$	
6182.3		2134		4047.9	3/2,5/2	E_γ: reported in 1973Po03 only.
		6181.7 *35*	100[&]	0.0	1/2$^+$	E_γ: γ seems uncertain in 1973Po03.

[†] From 1973Po02, unless otherwise noted. Values without uncertainties are deduced by the evaluators from level-energy differences. Those transitions are reported but their energies are not listed in 1973Po02 and 1973Po03.

[‡] From 1973Po03, unless otherwise noted.

[#] From p$\gamma(\theta)$ and p$\gamma\gamma(\theta)$ in 1973Po03, with electric or magnetic nature determined based on RUL and measured $T_{1/2}$ in 1973Po02 and/or 1973Wa14 and RUL, unless otherwise noted.

$^{33}_{15}P_{18}$-7

^{31}P(t,pγ) 1973Po02,1973Po03,1970Ha48 (continued)

$\gamma(^{33}P)$ (continued)

[@] From 1973Wa14.
[&] From 1973Po02.
[a] Placement of transition in the level scheme is uncertain.

$^{33}_{15}P_{18}$-8

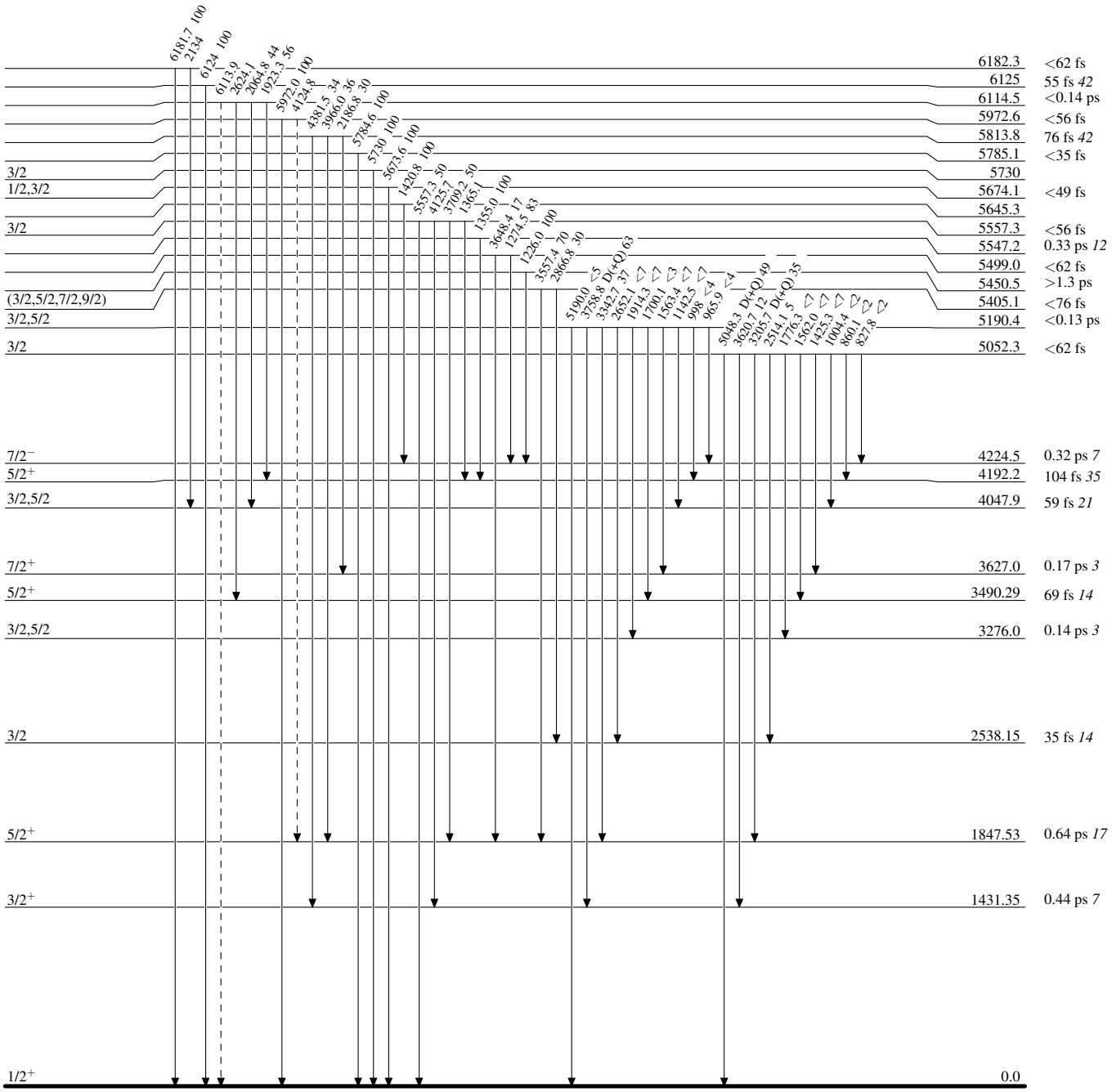
^{31}P(t,pγ) 1973Po02,1973Po03,1970Ha48

Legend

Level Scheme

Intensities: % photon branching from each level

γ Decay (Uncertain)



$^{33}_{15}P_{18}$

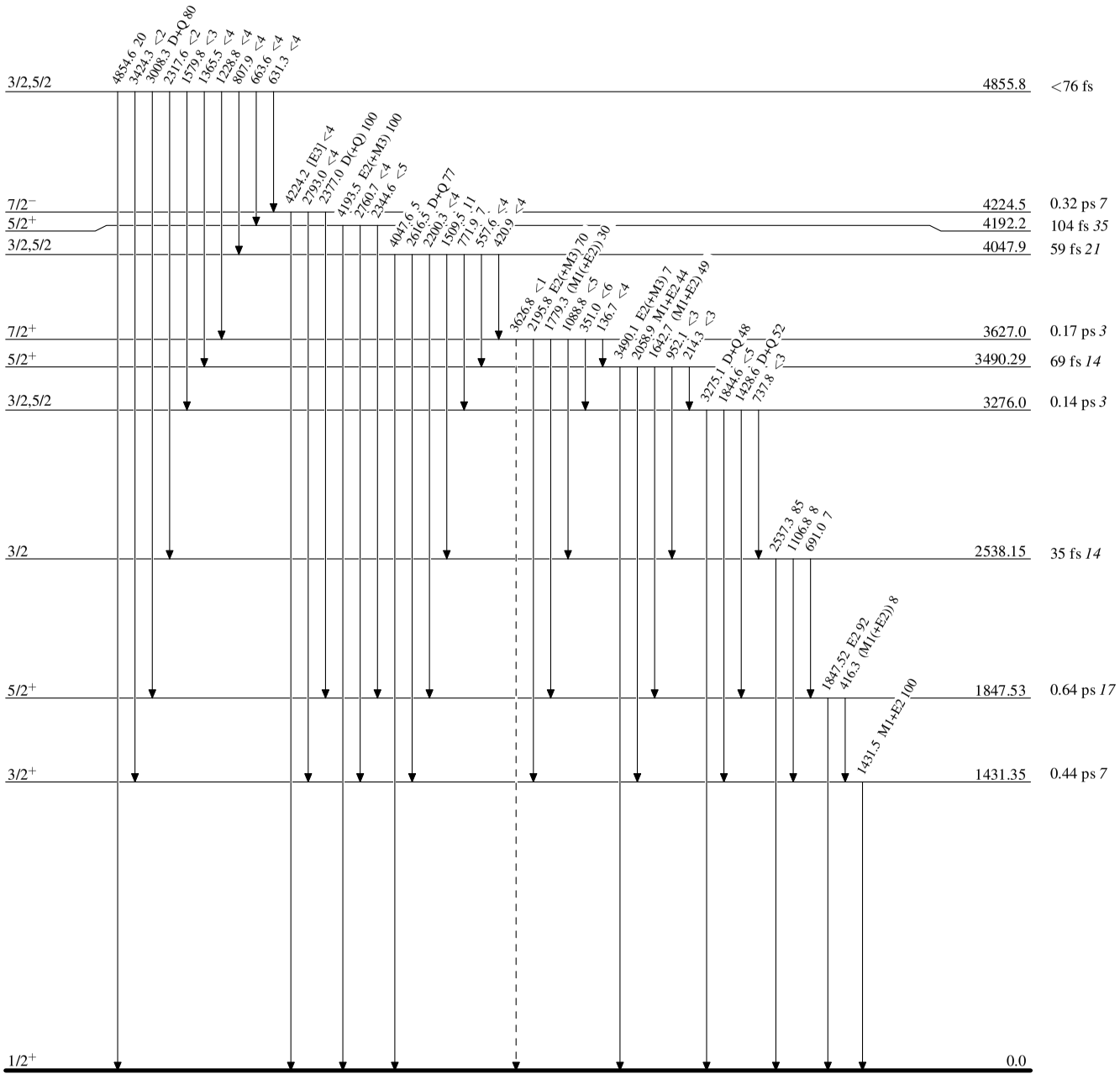
^{31}P(t,pγ) 1973Po02,1973Po03,1970Ha48

Legend

Level Scheme (continued)

Intensities: % photon branching from each level

- - - - - - ► γ Decay (Uncertain)



$^{33}_{15}P_{18}$