^{31}P(γ,γ') 1972Sh07,1969Ra20

History

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

1972Sh07 (also 1970Sh08): 14 MeV endpoint bremsstrahlung from the electron LINAC at the Japan Atomic Energy Research Institute. Thick P target. Ge detectors for γ detection. Data for 12 levels above 3100 keV.

1969Ra20: 3.66 MeV bremsstrahlung beam from the electron beam of the Bartol Van de Graaff impinging on a thin gold foil. NaI(Tl) detectors. Data for 3130 and 3510 levels, estimated their width and measured $\gamma(\theta)$ for 3510γ.

1968Ho06 (also 1966Ho02): photons from ^{30}Si(p,γ) reaction for resonant absorption curve of 7.90 and 8.201 MeV photons at the Southern Universities Nuclear Institute, South Africa. Measured width using the folding technique.

1968Cr01: 3.5 MeV endpoint bremsstrahlung spectrum from 3.5 MeV electrons incident on a thick gold foil at Natuurkundig Laboratorium, Ghent. NaI(Tl) detectors. Measured scattered photon spectra and estimated width of 3130 level based on self absorption.

1966Sk01: bremsstrahlung beam from inelastic proton scattering on ^{31}P used for resonance fluorescence at the Universitat Hamburg. NaI(Tl) detectors. Measured level width of 1266 level but report only the lifetime.

1964Bo22 (also 1962Bo17,1960Bo23,1960Bo02): measured lifetime of first excited state.

1963Le16: measured lifetimes of 1266 and 2230 levels from self absorption at the Bartol Research Foundation of the Franklin Institute Pennsylvania.

Others: 1991Li12, 1972ArZD, 1968Ro14, 1965Hi09.

^{31}P Levels

E(level)[†]	J$^\pi$[‡]	Γ	(2J+1)Γ$_{\gamma0}$[eV][#]	Comments
0	1/2$^+$			
1266	3/2$^+$	0.00092 eV *13*		Γ: from 1963Le16. Others: 0.0009 eV *2* (1966Ho02); mean lifetime τ=0.74 ps *10* (1966Sk01), 0.96 ps *+50−21* (1964Bo22), 0.46 ps *23* (1960Bo23), 0.22 ps *8* (1962Bo17), from nuclear resonance fluorescence.
2234	5/2$^+$	0.00147 eV *15*		J$^\pi$: $\gamma(\theta)$ in 1963Le16 consistent with 5/2 assignment; Γ: weighted average of 0.00157 eV *40* (1963Le16) and 0.00145 eV *15* (1972ArZD). Other: mean lifetime τ=0.45 ps *16* (1962Bo17).
3133 *5*	1/2$^+$	0.0645 eV *39*	0.06 *4*	Γ: weighted average of 0.0696 eV *39* (1972ArZD), 0.061 eV *4* (1969Ra20), 0.066 eV *7* (1968Ro14), and 0.049 eV *10* (1968Cr01). Other: mean lifetime τ=0.020 ps *7* (1962Bo17).
3510	3/2$^+$	0.052 eV *8*		Γ: from 1969Ra20. Other: mean lifetime=2.0 fs *7* if Γ$_{\gamma0}$/Γ=1 (1962Bo17).
5255 *4*	1/2$^+$		0.68 *10*	
5559 *4*	3/2$^+$		0.37 *8*	
6381? *5*	(3/2)$^+$	≤0.11 eV		E(level): no evidence of excitation of this T=3/2 level (1970Sh08), only an upper limit of intensity and level width is obtained. Γ: from 1970Sh08 assuming Γ$_{\gamma0}$/Γ=0.18.
6909 *7*	(3/2)$^-$		0.43 *9*	
7140 *4*	1/2$^+$		3.2 *4*	T=3/2 (2J+1)Γ$_{\gamma0}$[eV]: deduced by 1972Sh07 from their measured branching and Γ$_{\gamma0}$=1.36 16 from 1965Hi09; used for normalization (1972Sh07).
7214 *5*	1/2$^-$,3/2$^-$		0.57 *11*	
7316 *4*	(1/2,3/2)$^+$		2.2 *3*	(2J+1)Γ$_{\gamma0}$[eV]: from 1972Sh07 assuming Γ roughly equal Γ$_\gamma$.
7850 *4*			1.05 *17*	(2J+1)Γ$_{\gamma0}$[eV]: from 1972Sh07 assuming Γ roughly equal Γ$_\gamma$.
7896 *6*	1/2$^-$	68 eV *9*	3.2[@] *7*	Γ$_{\gamma0}$=1.6 eV *2* (1968Ho06) (2J+1)Γ$_{\gamma0}$[eV]: estimated from resonance strength in (p,γ) (1972Sh07). Γ from 1968Ho06. resonance strength=1.7 eV *4* (1968Ho06).
8209 *4*	3/2$^+$	2.6 eV *2*	3.7 *8*	Γ$_{\gamma0}$=1.4 eV *1* (1968Ho06)

Continued on next page (footnotes at end of table)

^{31}P(γ,γ') 1972Sh07,1969Ra20 (continued)

^{31}P Levels (continued)

E(level)[†]	Jπ[‡]	(2J+1)Γγ0[eV][#]	Comments
			(2J+1)Γγ0[eV]: estimated from resonance strength in (p,γ) (1972Sh07). Γ from 1968Ho06.
8728 *4*	3/2+	7.2[@] *11*	
9565 *7*	3/2	4.0[@] *12*	

[†] From 1972Sh07 for E>2230 keV. First two levels are rounded values from Adopted Levels.
[‡] From Adopted Levels. Supporting arguments from this dataset are given under comments.
[#] Data from 1972Sh07, except as noted. Uncertainty is statistical only.
[@] Estimated by 1972Sh07 from (2J+1)ΓγΓp/Γ in 1967En05 evaluation.

γ(^{31}P)

Eγ[†]	Iγ[‡]	Ei(level)	J_i^π	E_f	J_f^π	Mult.	δ	Comments
1266		1266	3/2+	0	1/2+	D+Q	+0.20 *3*	δ: +0.20 *3*, +1.12 *8*, −0.90 *6* or −5.0 *8* from γ(θ) (1963Le16), but only −0.20 is consistent with other measurements. A2=0.638 (1963Le16).
2234		2234	5/2+	0	1/2+			
3133 *5*	9 *6*	3133	1/2+	0	1/2+			Γγ0/Γγ=1 (1972Sh07).
3510		3510	3/2+	0	1/2+			A2=+0.057 *7* (1969Ra20); δ(E2+M1) is found to be in agreement with 0.41 *3* from 1967Wi10 in (p,γ). γ(θ) consistent with ΔJ=2 (1963Le16); identically zero for this sequence.
5255 *4*	22.0 *17*	5255	1/2+	0	1/2+			Γγ0/Γγ=1 (1972Sh07).
5559 *4*	8.1 *14*	5559	3/2+	0	1/2+			Γγ0/Γγ=0.82 assumed by 1972Sh07 from earlier (p,γ) study.
5874	4.2 *12*	7140	1/2+	1266	3/2+			
6381[#]		6381?	(3/2)+	0	1/2+			
6909 *4*	5.0 *8*	6909	(3/2)−	0	1/2+			Γγ0/Γγ=1 (1972Sh07).
6943	3.2 *7*	8209	3/2+	1266	3/2+			
7140 *4*	21.8 *9*	7140	1/2+	0	1/2+			Γγ0/Γγ=0.84 *4* (1972Sh07). Mult.,δ: γ(θ) is isotropic; +0.15<δ<0.40, −2.5>δ>−6.5 (1965Hi09).
7214 *4*	5.4 *8*	7214	1/2−,3/2−	0	1/2+			Γγ0/Γγ=1 (1972Sh07).
7316 *4*	17.0 *8*	7316	(1/2,3/2)+	0	1/2+			Γγ0/Γγ=1 (1972Sh07).
7462	1.9 *9*	8728	3/2+	1266	3/2+			
7850 *4*	6.7 *6*	7850		0	1/2+			Γγ0/Γγ=1 (1972Sh07).
7896 *6*	3.6 *7*	7896	1/2−	0	1/2+			
8209 *4*	8.3 *7*	8209	3/2+	0	1/2+			Γγ0/Γ=0.54 *8* (1968Ho06).
8728 *4*	13.6 *8*	8728	3/2+	0	1/2+			Γγ0/Γγ=0.88 *5* (1972Sh07).
9565 *7*	4.9 *13*	9565	3/2	0	1/2+			Γγ0/Γγ=1 (1972Sh07).

[†] 1972Sh07 do not report precision γ energies. These energies are from level energy differences.
[‡] From 1972Sh07. Branching ratios under comments are obtained from scattering angle of 87°, with angular distribution effects not considered, except as noted.
[#] Placement of transition in the level scheme is uncertain.

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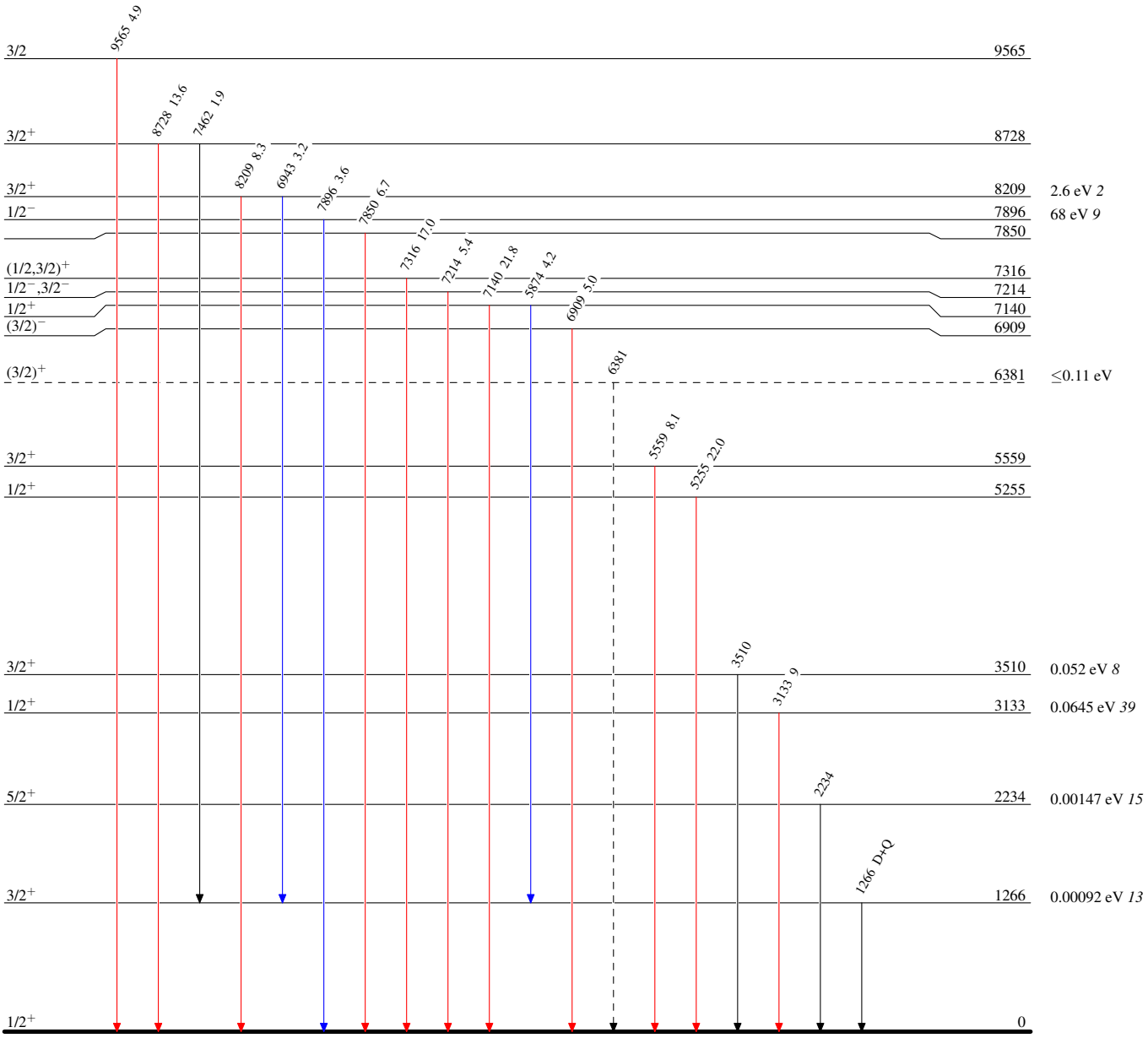
Level Scheme

Intensities: Relative I_γ

Legend
- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$
- γ Decay (Uncertain)



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