

Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 179, 1 (2022)	30-Nov-2021

$Q(\beta^-)=279.5$; $S(n)=9951.5$ 22; $S(p)=15801.9$ 14; $Q(\alpha)=-13976.5$ 16 [2021Wa16](#)

$S(2n)=17227.9$ 22, $S(2p)=29031.6$ 23 ([2021Wa16](#)).

Mass measurements: [2016Ko45](#), [2014Kw04](#), [2013Bu12](#), [2012Re17](#), [2006Fr27](#).

Measurements of hyperfine structure and isotope shift: [2019Kn01](#), [2017Ga02](#), [2015Go24](#).

See $^{48}\text{Ca}(\text{pol } p, p')$:GDR,GQR for information on the giant dipole, giant quadrupole, spin dipole, and spin quadrupole resonances.

See $^{48}\text{Ca}(e, e'n)$:GMR,GDR,GQR,IAR for information on the giant monopole, giant dipole, and giant quadrupole resonances.

 ^{48}Ca Levels

$B(M1)\uparrow$ given under comments are from (p, p') , unless otherwise noted.

$\% \beta^-, \% 2\beta^-$ of g.s.: the small β^- decay probability together with the rather large phase space available for the $2\beta^-$ process have made ^{48}Ca a favorite for the study of the process. See the Nuclear Science References File for theoretical studies, compilations, and reviews. See [1990Al19](#) for a measurement of $\sigma(\theta)$ from the $^{48}\text{Ti}(n, p)$ reaction at $E=198$ MeV and its possible implications for $^{48}\text{Ca } 2\beta^-$ decay.

Cross Reference (XREF) Flags

A	$^{48}\text{K } \beta^-$ decay	H	$^{48}\text{Ca}(n, n' \gamma)$	O	$^{48}\text{Ca}(\alpha, \alpha')$:giant resonance
B	$^{49}\text{K } \beta^- n$ decay	I	$^{48}\text{Ca}(p, p'), (\text{pol } p, p')$	P	$^{48}\text{Ca}(\alpha, \alpha' \gamma)$
C	$^{46}\text{Ca}(t, p)$	J	$^{48}\text{Ca}(\text{pol } p, p')$:GDR,GQR	Q	$^{48}\text{Ca}(^6\text{Li}, ^6\text{Li}')$
D	$^{48}\text{Ca}(\gamma, \gamma'), (\text{pol } \gamma, \gamma')$	K	$^{48}\text{Ca}(p, p' \gamma)$	R	$^{48}\text{Ca}(^{16}\text{O}, ^{16}\text{O}')$
E	$^{48}\text{Ca}(e, e')$	L	$^{48}\text{Ca}(d, d'), (\text{pol } d, d')$	S	$^{48}\text{Ca}(^{48}\text{Ca}, ^{48}\text{Ca}' \gamma)$
F	$^{48}\text{Ca}(e, e'n)$:GMR,GDR,GQR,IAR	M	$^{48}\text{Ca}(^3\text{He}, ^3\text{He}'), (\text{pol } ^3\text{He}, ^3\text{He}')$		
G	$^{48}\text{Ca}(\pi^-, \pi^{-'}), (\pi^+, \pi^{+'})$	N	$^{48}\text{Ca}(\alpha, \alpha')$		

E(level) [†]	J ^π	T _{1/2} ^d	XREF	Comments
0.0	0 ⁺	$2.9 \times 10^{19.8}$ y +42-11	ABCDE GHI KLMN PQRS	$\% \beta^- = 22 +30-22$; $\% 2\beta^- = 78 +22-30$ $\% \beta^-, \% 2\beta^-$: From $T_{1/2}(2\beta^-) = 3.7 \times 10^{19}$ y +33-12 and $T_{1/2} = 2.9 \times 10^{19}$ y +42-11. See footnote comments for $T_{1/2}$. Nuclear rms charge radius=3.4771 fm 20 (2013An02). J ^π : 3831.4γ E2 to 0 ⁺ . T _{1/2} : weighted average of 35 fs 3 from $\Gamma_{\gamma 0}$ in (γ, γ') (2002Ha13), 42 fs 9 from DSAM in $(n, n' \gamma)$ (1992Va06), and 37 fs 17 from DSAM in $(p, p' \gamma)$ (1970Be39). B(E2)↑=0.0082 5 from (e, e') (1985Wi06), but it is discrepant with 0.0140 15 from (α, α') :giant res (2011Lu07) and 0.0131 12 from $(^6\text{Li}, ^6\text{Li}')$ (2010Kr06). XREF: A(?). J ^π : from observation of E0 e+/e- pair emission to g.s. in $(p, p' \gamma)$; L(t,p)=0 from 0 ⁺ . T _{1/2} : from $p\gamma(t)$ in $(p, p' \gamma)$ (1970Be39). XREF: M(?). J ^π : 671.8γ E2 to 2 ⁺ ; 1226γ from 5 ⁻ . T _{1/2} : from $p\gamma(t)$ in $(p, p' \gamma)$ (1972Ta23). J ^π : 4507.3γ E3 to 0 ⁺ . T _{1/2} : from DSAM in $(p, p' \gamma)$ (1970Be39). Other: 7.2 ps +26-20 from adopted B(E3)↑=0.0069 10. B(E3)↑=0.0069 10, unweighted average of 0.0065 10 from (e, e') , 0.0054 8 from (α, α') :giant res, 0.0087 8 from $(^6\text{Li}, ^6\text{Li}')$.
3831.96 22	2 ⁺	36 fs 3	ABCDE GHI KLMNOPQRS	
4283.56 24	0 ⁺	223 ps 11	ABC E HI K N S	
4503.74 24	4 ⁺	1.53 ns 3	A c H K M S	
4507.05 23	3 ⁻	6.1 ps +38-20	A c E GHI KLMNOPQRS	

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Adopted Levels, Gammas (continued)

^{48}Ca Levels (continued)									
E(level) [†]	J ^π	T _{1/2} ^d	XREF						Comments
4612.24 23	3 ⁽⁺⁾	2.5 ps 14	A	E	HI	K	N	S	XREF: N(?). J ^π : spin=3 from $\gamma\gamma(\theta)$ in (p,p' γ) and $\gamma(\theta)$ in (n,n' γ); L(p,p')=(4) from 0 ⁺ . T _{1/2} : unweighted average of 3.7 ps +9–4 from (n,n' γ) (1992Va06) and 1.2 ps 4 from (p,p' γ) (1972Ta23). J ^π : from $\gamma(\theta)$ in (γ,γ') .
4695.4 3	1	32.6 ^e fs +25–22	D						J ^π : D γ to 4 ⁺ . Results are discrepant in the various experiments: 3,5 from $\gamma(\theta)$ in (n,n' γ); 5 ⁺ from DWBA fit to Coulomb form factors and RPA calculation (unnatural π state from absence of longitudinal form factor) in (e,e'); 5 ⁻ from L(p,p')=5 and observance of peak in (α,α') (natural π state) (1988Fu01); (4) from comparison of $\sigma(\theta)$ and analyzing powers to those of known states in (p,p') (1984Se10),(pol p,p'); 3 ⁻ from L(α,α')=3.
5146.42 25	3,4,5	<0.69 ns	E	HI	K	N	RS		T _{1/2} : from direct timing in (p,p' γ) (1977Lo06). XREF: A(?). J ^π : spin=4 from $\gamma(\theta)$ in (n,n' γ); 4 ⁻ from DWBA fit to the Coul. form factors and RPA calc. in (e,e') (unnatural parity state from absence of longitudinal form factor). Other: (5 ⁺) from (p,p') for a group at 5257 5 is discrepant.
5260.81 23	4 ⁽⁻⁾	5.1 ps +14–8	A	E	HI	K		S	XREF: K(5322). Additional information 1. E(level): from (p,p'). J ^π : L(p,p')=1 from 0 ⁺ . J ^π : 5312.2 γ Q to 0 ⁺ . J ^π : L(α,α')=3 from 0 ⁺ . XREF: N(?). E(level): weighted average of 5459 10 from (t,p) and 5462 7 from (p,p'). J ^π : L(t,p)=L(p,p')=0 from 0 ⁺ . J ^π : L(α,α')=L(p,p')=5 from 0 ⁺ . J ^π : L(α,α')=(2) from 0 ⁺ ; 2273.1 γ to 2 ⁺ , 1597.8 γ to 3 ⁻ . Other: 4 ⁻ from DWBA fit to Coulomb form in (e,e') (unnatural π state from absence of longitudinal form factor) and (4 ⁻) from DWBA analysis in (p,p') (unnatural π state since peak not observed in (α,α')) are discrepant.
5311 6	(1) ^{-a}				I	K	n		J ^π : 6336.4 γ E2 to 0 ⁺ . XREF: K(6351). J ^π : L(α,α')=L(p,p')=4 from 0 ⁺ .
5312.2 3	2	232 fs +28–13			H		n		J ^π : 6611.7 γ E1 to 0 ⁺ . XREF: N(?). J ^π : L(α,α')=L(p,p')=4 from 0 ⁺ .
5369.90 23	3 ⁻	1.80 ps 14	A	E	HI	K	N		J ^π : L(α,α')=2 from 0 ⁺ . XREF: e(6796). J ^π : 6791.0 γ D to 0 ⁺ . XREF: C(6793)e(6796)I(6794)n(6820)P(6800). J ^π : L(α,α')=L(p,p')=2 from 0 ⁺ . XREF: n(6820). J ^π : (3) from $\gamma(\theta)$ in (n,n' γ); L(p,p')=(3) from 0 ⁺ .
5461 7	0 ⁺		C		I		N		
5729.64 24	5 ⁻	0.90 ps +49–21		E	GHI	K	N	S	
6105.00 23	(2 ⁺)	139 fs +17–28		E	HI	K	N		
6336.8 20	2 ⁺	191 fs 29	C		H				
6345.72 24	4 ⁺	180 fs +35–13		E	HI	K	N		
6.48×10 ³ ?							N		
6612.19 10	1 ⁻	1.87 ^e fs 14	A	D		I	K	P	
6648.99 24	4 ⁺	114 fs +42–28		C	E	HI	K	N	
6685.64 23	2 ⁽⁻⁾ [‡]	69 fs +56–52	A	E	HI	K			
6755	2 ⁺				I		N		
6791.5 20	1	<6.9 fs		e	H				
6805.7 3	2 ⁺	83 fs +44–38	C	e	HI		n	P	
6830.8 6	(3 ⁻)				HI	K	n		

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Adopted Levels, Gammas (continued) ^{48}Ca Levels (continued)

E(level) [†]	J ^π	T _{1/2} ^d	XREF				Comments
6895.87 24	(2 ⁻)	55 fs +83-55	A	e	H	k	J ^π : 2,3,4 from γ(θ) in (n,n'γ); (2-&5 ⁺) doublet from DWBA analysis in (p,p') with unnatural π state since peak not observed in (α,α') (1988Fu01).
6896 7	(5 ⁺)			E	I		E(level): weighted average of 6893 9 from (e,e') and 6898 7 from (p,p'). J ^π : the 5 ⁺ member of (2-&5 ⁺) doublet (see comment on J ^π (6895.87)); J≥3 1 from comparison of σ(θ) and analyzing power to those of known states in (p,p') (1984Se10); .
7007.6 6	3 ^{-b}	69 fs +18-14		E	HI		J ^π : L(p,p')=3 and L(α,α')=(3) from 0 ⁺ ; natural parity.
7019 7				e	I		
7032.0 6	(3) ^{-b}			e	HI	K N	XREF: N(7050). J ^π : L(p,p')=3+6 from 0 ⁺ ; L(α,α')=(3) from 0 ⁺ ; (3,5) from γ(θ) in (n,n'γ); natural parity.
7.16×10 ³ ?						N	
7296.1 5	(2 ⁺)	<6.9 fs			H		J ^π : 7298γ (E2) to 0 ⁺ .
7298.50 20	1 ⁻	0.201 ^e fs 14	A	DE	I	K P	J ^π : 7297.9γ E1 to 0 ⁺ . Other: L(p,p')=3 is discrepant.
7370.6 20	(1,2)				H		J ^π : 7370γ to 0 ⁺ .
7385 10	3 ⁻ , (1 ⁻)				I		E(level), J ^π : from (p,p'), with J ^π from analysis of σ(θ).
7401.22 23	(2 ⁻) ^{‡#}		A	E	I	K S	XREF: E(7397). J ^π : (4 ⁻) from DWBA fit to the Coulomb form factors and RPA calculations in (e,e') (unnatural π state from absence of longitudinal form factor) discrepant. But L(p,p')=(3) favors (3 ⁻).
7407.3? 5	(0,1,2,3 ⁻)		A				Additional information 2. J ^π : 793.11γ to 1 ⁻ .
7440.6 20	2,3 ⁻	177.4 fs 70			HI	K	J ^π : 7440γ Q,E3 to 0 ⁺ .
7471 5	4 ⁺			E	I		E(level): weighted average of 7476 7 from (e,e') and 7468 5 from (p,p'). J ^π : L(p,p')=4 from 0 ⁺ and natural parity due to presence in (α,α') measured by 1988Fu01 in (p,p').
7497.5 3	(3 ⁻)				HI		J ^π : (3) from analysis of σ(θ) in (p,p') (1984Se10); 1767.8γ to 5 ⁻ .
7536.4 4	3 ^{-#b}				I	N S	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
7568.7 6					H		
7580 7					I		
7652 10	3 ^{-&}		A	c	E	G i K	Additional information 3. E(level): from (p,p'). Other: 7658 from ^{48}K β ⁻ decay, 7657 10 from (e,e'). J ^π : also from analysis of σ(θ) in (p,p').
7655.66 20	1 ⁻	1.87 ^e fs 7		cD		P	B(M1)↑=0.008 5 XREF: P(7651). J ^π : 7655.0γ E1 to 0 ⁺ .
7659 3	3 ^{-b}			c	e	g I	E(level): from (p,p'). Others: 7650 20 from (t,p) and 7657 10 from (e,e'). J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
7696	(1 ⁺ ,2 ⁺) [@]			E			B(E3)↑≈0.0014 from (e,e'). B(M1)↑<0.05 from (e,e'). 15 additional states reported in (p,p') by 1983Cr01 between 7.7 MeV and 12.7 MeV, seven of which appear to correspond to states observed in (e,e').
7789 7	3 ⁻			E		K N	XREF: N(7760). Additional information 4.

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Adopted Levels, Gammas (continued) ^{48}Ca Levels (continued)

E(level) [†]	J^π	$T_{1/2}$ ^d	XREF		Comments
					E(level): weighted average of 7791 7 from (e,e') and 7784 10 from (p,p'). J^π : L(α,α')=3 from 0 ⁺ . J^π : L(p,p')=4 from 0 ⁺ and natural parity. J^π : L(p,p')=3 from 0 ⁺ and natural parity. J^π : 7914.7 γ E2 to 0 ⁺ .
7797 8	4 ⁺ ^b		I		
7911 7	3 ⁻ ^b		I		
7915.4 9	2 ⁺	22 ^e fs +4-3	D		
7953? 15	(2 ⁻ ,6 ⁻)&		E		
7957 10	(4) ⁺ ^a		I K		Additional information 5. E(level): from (p,p'). J^π : L(p,p')=4 from 0 ⁺ and not clearly seen in α spectrum (1988Fu01).
8001 8			c I		J^π : natural parity state from presence in α spectra by 1988Fu01 in (p,p').
8027.6 4	2 ⁺	11.4 ^e fs 12	cDe I		J^π : 8026.9 γ E2 to 0 ⁺ .
8045 8	(1)		c e I K		Additional information 6. E(level): from (p,p'). J^π : from analysis of $\sigma(\theta)$ in (p,p'); γ to 0 ⁺ . Other: (1 ⁻ ,2 ⁺) from (e,e') for a group at 8038 15.
8050	2		e P		Additional information 7. E(level): from ($\alpha,\alpha'\gamma$). J^π : from $\alpha\gamma(\theta)$ in ($\alpha,\alpha'\gamma$). J^π : L(p,p')=5 from 0 ⁺ and natural parity.
8065 8	5 ⁻ ^b		I		
8082 10			I		
8116 8	1 ⁺ ,2 ⁺ ,3 ⁺		E I		E(level): weighted average of 8113 9 from (e,e') and 8119 8 from (p,p'). J^π : L(p,p')=2 from 0 ⁺ . B(M1) \uparrow <0.05 from (e,e').
8150	(1 ⁺ ,2 ⁺)@		E		
8178 8	4 ⁺ ^b		I		J^π : L(p,p')=4 from 0 ⁺ and natural parity.
8236 8	4 ⁻ ,5 ⁻ ,6 ⁻		c I		XREF: c(8237). E(level): from (p,p'). Other: 8237 20 from (t,p). J^π : L(p,p')=5 from 0 ⁺ .
8248 8	4 ⁺ ^b		c I K		XREF: c(8237). Additional information 8. E(level): from (p,p'). J^π : L(p,p')=4 from 0 ⁺ and natural parity.
8276?	(1 ⁻ ,2,3)		c K		XREF: c(8268). Additional information 9. E(level): reported by 1969Te03 as the same level at 8276 10 seen in their (p,p') measurement, however, while the level seen in their (p,p') could correspond to the 8283 8 level with J^π =4 ⁺ from 1988Fu01 in (p,p') and the level seen in (p,p') γ by 1969Te03 with a different J^π could be a separate level. J^π : 8275 γ to 0 ⁺ , 1456 γ to (3 ⁻).
8279.1 9	4 ⁺ ^{#b}		c E I n S		XREF: c(8268)n(8330). J^π : L(p,p')=4 from 0 ⁺ and natural parity.
8356 8	5 ⁻ ^b		I n		XREF: n(8330). J^π : L(p,p')=5 from 0 ⁺ and natural parity.
8385? 18	(3 ⁻)		E		J^π : first maxima for Coul. Form factor at ≈ 1.0 fm ⁻¹ . in (e,e').
8386 8	(6) ⁺		i P		E(level): from (p,p'). J^π : see comment on J^π (8386.1).
8386.1 5	1 ⁻ ^a	0.159 ^f fs 21	A D i K P		XREF: P(8400). J^π : 1-&(6) ⁺ doublet from L(p,p')=1+6 and natural π state from presence of peak in (α,α') spectra; 8385.3 γ E1 to 0 ⁺ .
8437 5	3 ⁻ ^b		E I		E(level): weighted average of 8435 5 from (e,e'), and 8441 8

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Adopted Levels, Gammas (continued) ^{48}Ca Levels (continued)

E(level) [†]	J ^π	T _{1/2} ^d	XREF		Comments
8467?	(1,2)		A	c	from (p,p'). J ^π : L(p,p')=3 from 0 ⁺ and natural parity (1988Fu01). Additional information 10.
8478 8	3 ⁺ ,4 ⁺ ,5 ⁺		c	E I K	E(level): from ^{48}K β ⁻ decay. J ^π : 4635γ to 2 ⁺ , 8466γ to 0 ⁺ . Additional information 11.
8517.9 8	(1 ⁻ ,2 ⁺)		c	D	E(level): from (p,p'). Other: 8477 15 from (e,e'). J ^π : L(p,p')=4 from 0 ⁺ . J ^π : 8517.1γ to 0 ⁺ ; (1 ⁻ ,2 ⁺) is most likely from γ excitation.
8523 5	3 ^{-b}		c	E I K	T _{1/2} : 4.6 fs 8 if J ^π =1 ⁻ or 11.4 fs 28 if J ^π =2 ⁺ from Γ _{γ0} in (γ,γ') assuming Γ _{γ0} /Γ=1. Additional information 12.
8531?	(1,2 ⁺)		A	c	E(level): from (p,p'). Other: 8518 8 from (e,e'). J ^π : L(p,p')=3 from 0 ⁺ and natural parity. Additional information 13.
8563 7	(6 ⁻) ^{&}		E	I	E(level): from ^{48}K β ⁻ decay. J ^π : possible 4247γ to 0 ⁺ . E(level): weighted average of 8557 14 from (e,e'), and 8565 7 from (p,p').
8586? 10				I K	J ^π : other: (6) assigned by 1988Fu01 based on L(p,p')=(6) from 0 ⁺ and uncertain existence of this state in the (α,α') spectra in 1988Fu01. Additional information 14.
8607 6	3 ^{-b}		C	E I	E(level): from (p,p'). E(level): weighted average of 8605 6 from (e,e') and 8609 6 from (p,p').
8664.6 11	(3,4,5) [#]				J ^π : L(p,p')=3 from 0 ⁺ and natural parity. S J ^π : 386γ to 4 ⁺ is most likely dipole.
8680 7	(3 ⁺) [‡]		c	I K	Additional information 15. E(level): from (p,p').
8698 8			c	I	
8788 8			C	I K	Additional information 16.
8797 8	4 ⁺ & (6 ⁺) ^b			I	E(level): from (p,p').
8805 5	5 ⁻		E	I	E(level): L(p,p')=4+6 from 0 ⁺ , with L=4 more likely. E(level): weighted average of 8804 9 from (e,e') and 8806 5 from (p,p').
8831 8	2 ⁻ ,3 ⁻ ,4 ⁻			I	J ^π : L(p,p')=5 from 0 ⁺ ; 5 ⁻ from DWBA analysis in (e,e').
8866 8	4 ⁻ ,5 ⁻ ,6 ⁻			I	J ^π : L(p,p')=3 from 0 ⁺ . J ^π : L(p,p')=5 from 0 ⁺ .
8883.3 5	1 ⁻	0.42 ^f fs 14	De	P	XREF: P(8900). J ^π : 8882.6γ E1 to 0 ⁺ .
8886 6	2 ⁺ ^b		e	I	E(level): from (p,p'). J ^π : L(p,p')=2 from 0 ⁺ and natural parity.
8890.7 6	>5 [#]				S J ^π : 3160.8γ to 5 ⁻ .
8920 8				I	
8947 8				I	
8967?	(1,2,3)		A	I	Additional information 17. E(level): from ^{48}K β ⁻ decay. Other: 8964 10 from (p,p'). J ^π : 8966γ to 0 ⁺ .
8982 8	3 ^{-b}			I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
9033.9 4	1 ⁻	0.242 ^f fs 14	De	I	J ^π : 9033γ E1 to 0 ⁺ .
9047 9	2 ⁺ ^b		e	I	J ^π : L(p,p')=2 from 0 ⁺ and natural parity.
9050	1		e	P	Additional information 18.

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Adopted Levels, Gammas (continued) ^{48}Ca Levels (continued)

E(level) [†]	J ^π	T _{1/2} ^d	XREF				Comments
							E(level): from (α,α'γ). J ^π : 9050γ D to 0 ⁺ .
9079 9			I				
9094.6 15	#				S		
9123.1 10	(1 ⁺ ,2 ⁺ ,3 ⁺) [#]		I		S		J ^π : L(p,p')=2+(8) for the 9123 doublet. 9138 state appears to be the high-spin member.
9138 22			E				J ^π : (8 ⁻) from DWBA fit to the Coulomb form factors and RPA calculations in (e,e'); unnatural parity state from absence of longitudinal form factor; L(p,p')=(8), J ^π =(7 ⁻) from comparison to DWBA in (p,p'). See also J ^π comment for 9123 level.
9158 9	(4) ⁺ ^a		I				J ^π : L(p,p')=4 from 0 ⁺ but not clearly seen in (α,α').
9176 9	2 ⁺ ^b		I				J ^π : L(p,p')=2 ⁺ from 0 ⁺ and natural parity.
9211 9	3 ⁻ ^b		I				J ^π : L(p,p')=3+(7) from 0 ⁺ (natural π from presence of peak in (α,α')) in (p,p') for the doublet. 9229 state appears to be the high-spin member.
9229	(7 ⁻)		I				J ^π : (7,8,9) from comparison of σ(θ) and analyzing power to those of known states in (p,p'),(pol p,p'); (6 ⁻ ,7 ⁻) from comparison to DWBA in (p,p'),(α,α'). See comment on J ^π (9211).
9232 9	(0 ⁻ ,1 ⁻ ,2 ⁻)		I				J ^π : L(p,p')=(1) from 0 ⁺ .
9288 9	(2 ⁺) ^{&}		E	I			E(level): weighted average of 9290 9 from (e,e') and 9285 10 from (p,p').
9295.3 5	1 ⁻ ^b	0.236 ^e fs 14	A	D	i	P	XREF: P(9300). J ^π : 9294.3γ E1 to 0 ⁺ . L(p,p')=1+(8) (natural π state from presence of peak in (α,α')) in (p,p') for the doublet. 9296 state appears to be the L=8 member.
9295.7 11	(8 ⁻) [#]		E	i		S	XREF: E(9276). J ^π : (8 ⁻) from DWBA fit to the Coulomb form factors and RPA calculations in (e,e') unnatural π state from absence of longitudinal form factor; (7,8,9) from comparison of σ(θ) and analyzing power to those of known states and (8 ⁻) from comparison to DWBA in (p,p'). See comment for J ^π (9295.3).
9307	8		I				
9334 9			I				
9366 9	5 ⁺ ,6 ⁺ ,7 ⁺		I				J ^π : L(p,p')=6 from 0 ⁺ .
9383 10	(1 ⁺ ,2 ⁺) [@]		E	I			B(M1)↑=0.020 2 E(level): from (p,p'). J ^π : 1 ⁺ ,2 ⁺ also from analysis of σ(θ) in (p,p'). B(M1)↑<0.07 from (e,e').
9430 9	2 ⁻ ,3 ⁻ ,4 ⁻		I				J ^π : L(p,p')=3 from 0 ⁺ .
9472.8 8	1 ⁻ ^b	0.250 ^e fs 21	D	I		P	J ^π : 9471.8γ E1 to 0 ⁺ ; L(p,p')=1 from 0 ⁺ and natural parity.
9496 9			I				
9545.72 20	1 ⁻	0.139 ^e fs 7	D	I		P	J ^π : 9544.7γ E1 to 0 ⁺ .
9550? 20	(3 ⁻) ^{&}		E				
9568 9	(5 ⁺ ,6 ⁺ ,7 ⁺)		I				J ^π : L(p,p')=(6) from 0 ⁺ .
9621 9	4 ⁺ ^b		I				J ^π : L(p,p')=4 from 0 ⁺ and natural parity.
9645 9	2 ⁻ ,3 ⁻ ,4 ⁻		I				J ^π : L(p,p')=3 from 0 ⁺ .
9691 9	(0 ⁻ ,1 ⁻ ,2 ⁻)		I				J ^π : L(p,p')=(1) from 0 ⁺ .
9728 9	2 ⁻ ,3 ⁻ ,4 ⁻		I				J ^π : L(p,p')=3 from 0 ⁺ .
9765 9	3 ⁻ ^b		I				J ^π : L(p,p')=3 from 0 ⁺ and natural parity.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{48}Ca Levels (continued)

E(level) [†]	J ^π	XREF		Comments
9784 9	(3 ⁺ ,4 ⁺ ,5 ⁺)		I	J ^π : L(p,p')=4 from 0 ⁺ .
9816 9	(1) ^{-a}		I	J ^π : L(p,p')=1 from 0 ⁺ but not clearly seen in (α,α').
9862 9	3 ^{-b}		I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
9885	(1 ⁺ ,2 ⁺) [@]	E		B(M1)↑<0.09 from (e,e').
9894 7			I	J ^π : L(p,p')=3+(6) from 0 ⁺ .
9921 9	3 ^{-b}		I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
9942 9	2 ⁻ ,3 ⁻ ,4 ⁻	e	I	J ^π : L(p,p')=3 from 0 ⁺ .
9.95×10 ³ 3	(8 ⁻) ^{&}	E		
9954	(1 ⁺ ,2 ⁺) [@]	E		B(M1)↑<0.10 from (e,e').
				J ^π : from analysis of σ(θ) in (p,p').
9973 10	1 ⁺		I	B(M1)↑=0.037 3
9993 9	4 ⁺ ^b	A	I	XREF: A(9985).
				J ^π : L(p,p')=4 from 0 ⁺ and natural parity.
10065 10	(4) ^{+a}	a	I	J ^π : L(p,p')=4 from 0 ⁺ but not clearly seen in (α,α').
10081 10	(3) ^{-a}	a	I	J ^π : L(p,p')=3 from 0 ⁺ but not clearly seen in (α,α').
10108 10	4 ⁺ ^b		I	J ^π : L(p,p')=4 from 0 ⁺ and natural parity.
10126 10	1 ^{-b}	A	I	J ^π : L(p,p')=1 from 0 ⁺ and natural parity.
10138 10	(1 ⁺ ,2 ⁺) [@]	E	I	B(M1)↑=0.148 13
				E(level): from (p,p').
				B(M1)↑=0.12 3 from (e,e').
10151 10	3 ^{-b}	e	I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
10178 10	3 ^{-b}	A	I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
10191 10	3 ^{-b}		I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
10224 7	1 ⁺	E G	I	B(M1)↑=3.9 3 from (e,e').
				E(level): weighted average of 10227 5 from (e,e') and 10211 10 from (p,p').
				J ^π : L(p,p')=0 from 0 ⁺ ; unnatural parity state from absence of peak in (α,α').
10240?		A		
10265 10	(⁻)	A	I	E(level): from (p,p').
				J ^π : suggested in ^{48}K β ⁻ decay.
10288 10			I	B(M1)↑=0.080 8
10319 10	3 ^{-b}		I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
10330? 10	(1 ⁺ ,2 ⁺) [@]	E		B(M1)↑=0.09 4 from (e,e').
10345 10	3 ^{-b}		I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
10350 10	(1 ⁺ ,2 ⁺) [@]	A E	I	B(M1)↑=0.040 13
				E(level): from (p,p').
				B(M1)↑=0.08 4 from (e,e').
10370 10	(2) ^{+a}	A	I	J ^π : L(p,p')=2 from 0 ⁺ but not clearly seen in (α,α').
10390 10			I	B(M1)↑=0.023 2
10399 10	3 ⁺ ,4 ⁺ ,5 ⁺		I	J ^π : L(p,p')=4 from 0 ⁺ .
10433 10	1 ⁺ ,2 ⁺ ,3 ⁺		I	J ^π : L(p,p')=2 from 0 ⁺ .
10483 10	3 ^{-b}		I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
10521 10	(2) ^{+a}		I	J ^π : L(p,p')=2 from 0 ⁺ but not clearly seen in (α,α').
10535 10	(0 ⁻ ,1 ⁻ ,2 ⁻)		I	B(M1)↑=0.010 3
				J ^π : L(p,p')=(1) from 0 ⁺ .
10571 10			I	B(M1)↑=0.060 8
				J ^π : L(p,p')=1,2.
10586 10	(4) ^{+a}		I	J ^π : L(p,p')=4 from 0 ⁺ but not clearly seen in (α,α') (1988Fu01).
10610 10			I	B(M1)↑=0.031 4
10611 10	3 ^{-b}	A	I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
10623 10			I	
10645 10			I	B(M1)↑=0.020 4
10648 10	(3) ^{-a}	a	I	J ^π : L(p,p')=3 from 0 ⁺ but not clearly seen in (α,α').

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{48}Ca Levels (continued)

E(level) [†]	J ^π	XREF		Comments
10686 10	3 ^{-b}	a	I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
10708 10			I	
10731 10	2 ^{+b}		I	J ^π : L(p,p')=2 from 0 ⁺ and natural parity.
10764 10			I	B(M1)↑=0.059 29
10782 10	(1 ⁺ ,2 ⁺)@	E	I	E(level): from (p,p'). B(M1)↑=0.12 4 from (e,e').
10803 10	(3 ⁻) ^b		I	J ^π : L(p,p')=(3) from 0 ⁺ and natural parity.
10822 10	3 ^{-b}	A	I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
10857 10	2 ^{+b}		I	J ^π : L(p,p')=2 from 0 ⁺ and natural parity.
10872 10	5 ⁺ ,6 ⁺ ,7 ⁺		I	J ^π : L(p,p')=6 from 0 ⁺ .
10883 10	(2 ⁺) ^b		I	J ^π : L(p,p')=(2) from 0 ⁺ and natural parity.
10916 10	(3 ⁻) ^a	A	I	E(level): from (p,p'). J ^π : L(p,p')=3 from 0 ⁺ but not clearly seen in (α,α').
10935 10	(1 ⁺ ,2 ⁺)@	e	I	B(M1)↑=0.011 8 E(level): from (p,p'). B(M1)↑=0.05 2 from (e,e').
10955 10	4 ^{+b}		I	J ^π : L(p,p')=4 from 0 ⁺ and natural parity.
11013 11		a	i	
11032?	(⁻)	A		J ^π : suggested in ^{48}K β ⁻ decay.
11037 11	(2 ⁺) ^b		I	J ^π : L(p,p')=(2) from 0 ⁺ and natural parity.
11050 11	(3 ⁺ ,4 ⁺ ,5 ⁺)		I	J ^π : L(p,p')=(4) from 0 ⁺ .
11098 11	2 ⁺ &4 ^{+b}		I	J ^π : L(p,p')=2+4 from 0 ⁺ and natural parity.
11125 11	3 ⁺ ,4 ⁺ ,5 ⁺		I	J ^π : L(p,p')=4 from 0 ⁺ .
11153 11			I	
11183 11	(5 ⁻) ^b		I	J ^π : L(p,p')=(5) from 0 ⁺ and natural parity.
11219 11			I	
11227 10			I	B(M1)↑=0.012 3
11248 11	(4 ⁺) ^a		I	J ^π : L(p,p')=4 from 0 ⁺ but not clearly seen in (α,α').
11281 11	2 ^{+b}		I	J ^π : L(p,p')=2 from 0 ⁺ and natural parity.
11329 11	3 ^{-b}		I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
11376 11	3 ^{-b}		I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
11383 10			I	B(M1)↑=0.003 2
11421 11	(1 ⁺ ,2 ⁺)@	E	I	XREF: E(11410). B(M1)↑<0.09 from (e,e').
11433 11	1 ⁺ ,2 ⁺ ,3 ⁺		I	J ^π : L(p,p')=2 from 0 ⁺ .
11447 11	2 ⁻ ,3 ⁻ ,4 ⁻		I	J ^π : L(p,p')=3 from 0 ⁺ .
11466 11			I	
11485 11	(2 ⁻ ,3 ⁻ ,4 ⁻)		I	J ^π : L(p,p')=(3) from 0 ⁺ .
11490	(1 ⁺ ,2 ⁺)@	E		B(M1)↑=0.15 3 from (e,e').
11508 11	2 ^{+b}		I	J ^π : L(p,p')=2 from 0 ⁺ and natural parity.
11513 10			I	B(M1)↑=0.021 15
11530 11	3 ^{-b}		I	J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
11550 11			I	
11563 10			I	B(M1)↑=0.039 5
11589 11	0 ⁻ ,1 ⁻ ,2 ⁻		I	J ^π : L(p,p')=1 from 0 ⁺ .
11622 11	(4 ⁺) ^b		I	J ^π : L(p,p')=(4) from 0 ⁺ and natural parity.
11639 11	(1 ⁺ ,2 ⁺ ,3 ⁺)		I	J ^π : L(p,p')=2 from 0 ⁺ .
11671 11	(4 ⁻ ,5 ⁻ ,6 ⁻)&(8 ⁻)		I	J ^π : L(p,p')=(5)+(8,9) from 0 ⁺ .
11693 11	5 ^{-b}		I	J ^π : L(p,p')=5 from 0 ⁺ and natural parity.
11695 10			I	B(M1)↑=0.025 9
11715 11	(1 ⁺ ,2 ⁺ ,3 ⁺)		I	J ^π : L(p,p')=(2) from 0 ⁺ .

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Adopted Levels, Gammas (continued) ^{48}Ca Levels (continued)

E(level) [†]	J ^π	XREF		Comments
11725 10	(1 ⁺ ,2 ⁺) [@]	E	I	B(M1)↑=0.014 9 B(M1)↑=0.12 4 from (e,e').
11752 11	(2) ^{+a}	I		J ^π : L(p,p')=2 from 0 ⁺ but not clearly seen in (α,α').
11773 11		I		
11816 11	2 ⁻ ,3 ⁻ ,4 ⁻	I		J ^π : L(p,p')=3 from 0 ⁺ .
11828 11		I		
11843 10		I		B(M1)↑=0.030 4
11848 11		I		
11913 11	3 ^{-b}	I		J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
11945 11	(0) ^{+c}	I		J ^π : L(p,p')=0 from 0 ⁺ and σ(θ) fitted well assuming J ^π =0 ⁺ .
11967 11	(0) ^{+c}	I		J ^π : L(p,p')=0 from 0 ⁺ and σ(θ) fitted well assuming J ^π =0 ⁺ .
11990 10		I		B(M1)↑=0.047 5
12009 12	(3 ⁻) ^b	I		J ^π : L(p,p')=(3) from 0 ⁺ and natural parity.
12029 12	3 ^{-b}	I		J ^π : L(p,p')=3 from 0 ⁺ and natural parity.
12051 12	(0 ⁻ ,1 ⁻ ,2 ⁻)	I		J ^π : L(p,p')=(1) from 0 ⁺ .
12055	(1 ⁺ ,2 ⁺) [@]	E		B(M1)↑=0.08 3 from (e,e').
12090 12	(2 ⁻ ,3 ⁻ ,4 ⁻)	I		J ^π : L(p,p')=(3) from 0 ⁺ .
12107 12	4 ⁻ ,5 ⁻ ,6 ⁻	I		J ^π : L(p,p')=4 from 0 ⁺ .
12121 10	0 ⁻ ,1 ⁻ ,2 ⁻	I		B(M1)↑=0.048 6 J ^π : L(p,p')=1 from 0 ⁺ .
12162 12	3 ⁺ ,4 ⁺ ,5 ⁺	I		J ^π : L(p,p')=4 from 0 ⁺ .
12176 12		I		
12216 12	4 ⁻ ,5 ⁻ ,6 ⁻	I		J ^π : L(p,p')=5 from 0 ⁺ .
12271 12	(3 ⁺ ,4 ⁺ ,5 ⁺)	e	I	J ^π : L(p,p')=(4) from 0 ⁺ .
12275 10	(1 ⁺ ,2 ⁺) [@]	E	I	B(M1)↑=0.035 19 XREF: E(12270). B(M1)↑=0.10 5 from (e,e').
12318 12	(0) ^{+c}	E	I	XREF: E(12310). J ^π : (M1) transition in (e,e') is inconsistent. B(M1)↑=0.11 3 from (e,e').
12338 10	(1,2) ⁺	I		B(M1)↑=0.070 9 J ^π : L(p,p')=2 from 0 ⁺ ; (M1) transition with E2 not excluded due to weakness of this transition.
12369 12	(3 ⁺ ,4 ⁺ ,5 ⁺)	I		J ^π : L(p,p')=(4) from 0 ⁺ .
12422 12	1 ⁺ ,2 ⁺ ,3 ⁺	I		J ^π : L(p,p')=2 from 0 ⁺ .
12441 12	2 ⁻ ,3 ⁻ ,4 ⁻	I		J ^π : L(p,p')=3 from 0 ⁺ .
12478 10		I		B(M1)↑=0.025 13
12499 12	(1 ⁺ ,2 ⁺) [@]	E	I	B(M1)↑=0.09 4 from (e,e').
12540 12	1 ⁺ ,2 ⁺ ,3 ⁺	I		J ^π : L(p,p')=2 from 0 ⁺ .
12565 12	(0) ^{+c}	I		J ^π : L(p,p')=0 from 0 ⁺ .
12620 12	1 ⁺ ,2 ⁺ ,3 ⁺	I		J ^π : L(p,p')=2 from 0 ⁺ .
12623 10		I		B(M1)↑=0.054 20
12659 10		I		B(M1)↑=0.077 6
12667 12		I		
12693 10	(1 ⁺ ,2 ⁺) [@]	E	I	B(M1)↑=0.035 5 B(M1)↑=0.10 5 from (e,e').
12704 12		I		
12757 12	1 ⁺ ,2 ⁺ ,3 ⁺	I		J ^π : L(p,p')=2 from 0 ⁺ .
12798 12	1 ⁺ ,2 ⁺ ,3 ⁺	I		J ^π : L(p,p')=2 from 0 ⁺ .
12846 12		I		
12869 12	(0 ⁺) ^c	I		J ^π : L(p,p')=(0) from 0 ⁺ .
12918 10		I		B(M1)↑=0.048 40
12925 12	1 ⁺ ,2 ⁺ ,3 ⁺	I		J ^π : L(p,p')=2 from 0 ⁺ .
12968 12	(2 ⁻ ,3 ⁻ ,4 ⁻)	I		J ^π : L(p,p')=(3) from 0 ⁺ .

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Adopted Levels, Gammas (continued) ^{48}Ca Levels (continued)

E(level) [†]	J ^π	T _{1/2} ^d	XREF	Comments
13030 13	4 ⁻ ,5 ⁻ ,6 ⁻		I	J ^π : L(p,p')=5 from 0 ⁺ .
13065 13	(1 ⁺ ,2 ⁺ ,3 ⁺)		I	J ^π : L(p,p')=(2) from 0 ⁺ .
13098 13	1 ⁺ ,2 ⁺ ,3 ⁺		I	J ^π : L(p,p')=2 from 0 ⁺ .
13169 13	0 ⁻ ,1 ⁻ ,2 ⁻		I	J ^π : L(p,p')=1 from 0 ⁺ .
13223 13			I	
13256 13	2 ⁻ ,3 ⁻ ,4 ⁻		I	J ^π : L(p,p')=3 from 0 ⁺ .
13290 13			I	
13360 13	1 ⁺ ,2 ⁺ ,3 ⁺		I	J ^π : L(p,p')=2 from 0 ⁺ .
13403 13	1 ⁺ ,2 ⁺ ,3 ⁺		I	J ^π : L(p,p')=2 from 0 ⁺ .
13439 13			I	
13475 13	1 ⁺ ,2 ⁺ ,3 ⁺		I	J ^π : L(p,p')=2 from 0 ⁺ .
13493 13			I	
16.69×10 ³ 19		6.2 MeV +15-1	0	E1 resonance.
16.79×10 ³ 14		6.95 MeV +11-35	0	E2 resonance.
19.88×10 ³ 18		6.68 MeV +31-36	0	E0 (ISGMR) resonance.
20.90×10 ³ 14		9.34 MeV 16	0	E3+E4 resonance.
24.2×10 ³	(1 ⁻)		F	%n=100 T=(5) J ^π ,T: momentum transfer dependence favors an E1 excitation and small Γ implies an isobaric analog resonance in (e,e'n).
37.3×10 ³ 20		14.9 MeV +35-1	0	E1 resonance.

[†] From a least-squares fit to γ -ray energies for levels connected with γ transitions except for those from (p,p' γ), and from (p,p') for other levels where available, unless otherwise noted. In the least-squares fit, where $\Delta E\gamma$ is not available, the following assumptions have been made: 0.05 keV for $E\gamma$ quoted to 100th keV, 0.5 keV for $E\gamma$ quoted to 10th keV and 1.0 keV for quoted to keV. The reduced χ^2 of the fitting is 2.65, compared to the critical $\chi^2=1.83$, after adjustments of $\Delta E\gamma$ for some poor-fit $E\gamma$ values, as noted.

[‡] From DWBA analysis in (p,p') with unnatural parity due to peak not observed in (α,α') spectra (1988Fu01). Natural parity is distinguished from unnatural parity based on observation of one-to-one correspondences of levels in (p,p') and (α,α') spectra (1988Fu01).

In ($^{48}\text{Ca},^{48}\text{Ca}'\gamma$), 2001Br35 suggest that these states are near yrast states with J>5 and must involve two-particle two-hole core excitations, which is manifested by their large energy separation from lower lying states.

@ (M1) transition in (e,e') gives (1⁺); E2 giving 2⁺ may not be excluded due to the weakness of the transition.

& From DWBA fit to the Coulomb form factors and RPA calculations in (e,e'); unnatural parity state from absence of longitudinal form factor.

^a Likely spin but not clearly observed in (α,α') spectra measured by 1988Fu01 in (p,p').

^b Natural parity state due to presence in the (α,α') spectra measured by 1988Fu01 in (p,p').

^c $\sigma(\theta)$ in (p,p') show oscillatory patterns and are well fitted by DWBA assuming 0⁺.

^d From DSAM in (n,n' γ) (1992Va06), unless otherwise noted.

^e From $\Gamma_{\gamma 0}$ in (γ,γ') assuming $\Gamma_{\gamma 0}/\Gamma=1$ (2002Ha13).

^f From $\Gamma_{\gamma 0}$ in (γ,γ') (2002Ha13) and adopted $\Gamma_{\gamma 0}/\Gamma$.

^g Estimated by the evaluator from the following partial T_{1/2} and limits: T_{1/2}(β^-)>1.6×10²⁰ y, >2.5×10²⁰ y, >1.9×10²⁰ y for single β^- decay to g.s., 131 and 252 levels in ^{48}Sc , respectively (2002Bb03, 90% C.L.), T_{1/2}(2 $\nu 2\beta^-$)=5.6×10¹⁹ y +14-11 (2016Ar19,2000Br63,1996Ba80) and T_{1/2}(0 $\nu 2\beta^-$)>5.8×10²² y (2008Um05, 90% C.L.), for 2 β^- to g.s. in ^{48}Ti , and T_{1/2}(2 β^-)>1.8×10²⁰ y, >1.5×10²⁰ y, and >1.5×10²⁰ y (2002Bb03, 90% C.L.), for (0 ν +2 ν)2 β^- to 984, 2421, and 2997 levels in ^{48}Ti , respectively. Estimate was obtained by taking decay constant $\lambda=\lambda_{\text{upper}}/2$ with $\Delta\lambda=\lambda$ for partial T_{1/2} given as lower limit (for λ_{upper}). See the ^{48}Ca β^- and ^{48}Ca 2 β^- decay datasets for experimental details.

Adopted Levels, Gammas (continued)

$\gamma(^{48}\text{Ca})$										Comments
$E_i(\text{level})$	J_i^π	E_γ^{\ddagger}	$I_\gamma^\#$	E_f	J_f^π	Mult. ^e	δ^e	α^\dagger	$I_{(\gamma+ce)}^b$	
3831.96	2 ⁺	3831.4 3	100	0.0	0 ⁺	E2		1.12×10^{-3} 2		B(E2)(W.u.)=1.84 +17-14 $\alpha(\text{K})=6.68 \times 10^{-6}$ 9; $\alpha(\text{L})=5.71 \times 10^{-7}$ 8; $\alpha(\text{M})=6.78 \times 10^{-8}$ 9 $\alpha(\text{N})=3.86 \times 10^{-9}$ 5; $\alpha(\text{IPF})=0.001111$ 16 E_γ : weighted average of 3831.3 2 from (γ, γ') and 3832.2 5 from (n,n' γ). Mult.: Q from $\text{py}(\theta)$ in (p,p' γ) and M2 ruled out by RUL.
4283.56	0 ⁺	451.6 1	100.0 ^b 10	3831.96	2 ⁺	[E2]		0.000934 13		B(E2)(W.u.)=10.1 5 $\alpha=0.000934$ 13; $\alpha(\text{K})=0.000851$ 12; $\alpha(\text{L})=7.37 \times 10^{-5}$ 10; $\alpha(\text{M})=8.73 \times 10^{-6}$ 12 $\alpha(\text{N})=4.89 \times 10^{-7}$ 7 E_γ : from (n,n' γ). Other: 451.9 5 from (p,p' γ). I_γ : from (p,p' γ). Other: 100 13 from ⁴⁹ K β^- n decay. Mult.: from observation of E0 e+/e- pair emission to g.s. $q_K^2(\text{E0/E2})=0.95$ 4; $X(\text{E0/E2})=0.0503$ 19; $\rho^2(\text{E0})=0.0145$ 9 (2005Ki02,1970Be39). $\omega(\text{E0})=4.817 \times 10^{10}$; $\omega(\text{E0})(\text{K})=1.342 \times 10^8$; $\omega(\text{E0})(\text{ipf})=4.817 \times 10^{10}$. B(E2)(W.u.)=0.261 5 $\alpha=0.000268$ 4; $\alpha(\text{K})=0.0002441$ 34; $\alpha(\text{L})=2.106 \times 10^{-5}$ 30; $\alpha(\text{M})=2.498 \times 10^{-6}$ 35 $\alpha(\text{N})=1.408 \times 10^{-7}$ 20 E_γ : unweighted average of 671.4 1 from (n,n' γ) and 672.1 2 from (p,p' γ). Mult.: Q from $\gamma(\theta)$ in (n,n' γ); M2 ruled out by RUL.
		(4283)		0.0	0 ⁺	E0			29.0 11	
4503.74	4 ⁺	671.8 4	100	3831.96	2 ⁺	E2		0.000268 4		B(E1)(W.u.)=0.00021 +10-8 $\alpha=9.18 \times 10^{-5}$ 13; $\alpha(\text{K})=8.37 \times 10^{-5}$ 12; $\alpha(\text{L})=7.19 \times 10^{-6}$ 10; $\alpha(\text{M})=8.53 \times 10^{-7}$ 12 $\alpha(\text{N})=4.83 \times 10^{-8}$ 7 E_γ : from (n,n' γ). Other: 675.0 1 from (p,p' γ). I_γ : from (p,p' γ). Others: 100 4 from ⁴⁸ K β^- decay and 100 8 from (n,n' γ). Mult., δ : D(+Q) and δ from $\text{py}(\theta)$ in (p,p' γ); $\Delta\pi$ =yes from level scheme.
4507.05	3 ⁻	675.1 1	100.0 28	3831.96	2 ⁺	(E1(+M2))	0.00 3	9.18×10^{-5} 13		B(E3)(W.u.)=8.4 +43-35 $\alpha(\text{K})=6.86 \times 10^{-6}$ 10; $\alpha(\text{L})=5.87 \times 10^{-7}$ 8; $\alpha(\text{M})=6.97 \times 10^{-8}$ 10
		4507.3 5	28 5	0.0	0 ⁺	E3		1.05×10^{-3} 2		

Adopted Levels, Gammas (continued)

$\gamma(^{48}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^{\ddagger}	$I_\gamma^\#$	E_f	J_f^π	Mult. ^e	δ^e	α^\dagger	Comments
4612.24	3 ⁽⁺⁾	780.2 1	100	3831.96	2 ⁺	(M1)		0.0001108 16	$\alpha(\text{N})=3.97\times 10^{-9}$ 6; $\alpha(\text{IPF})=0.001042$ 15 I_γ : unweighted average of 22 6 from ⁴⁸ K β^- decay, 25.0 28 from (n,n' γ), and 37.0 28 from (p,p' γ). I_γ : $I_\gamma(4507\gamma)/I_\gamma(675\gamma)=0.37$ 3 from (p,p' γ) discrepant, 0.22 6 from β^- decay consistent. Mult.: O from $\gamma\gamma(\theta)$ in (p,p' γ); M3 ruled out by RUL. B(M1)(W.u.)=0.019 +17-7 $\alpha=0.0001108$ 16; $\alpha(\text{K})=0.0001010$ 14; $\alpha(\text{L})=8.68\times 10^{-6}$ 12; $\alpha(\text{M})=1.031\times 10^{-6}$ 14 $\alpha(\text{N})=5.85\times 10^{-8}$ 8 E_γ : weighted average of 780.1 1 from (n,n' γ) and 780.4 2 from (p,p' γ). Mult.: D from $\gamma\gamma(\theta)$ in (p,p' γ) and $\gamma(\theta)$ in (n,n' γ); $\Delta\pi=(\text{no})$ from level scheme.
4695.4	1	4695.2 @ 3	100	0.0	0 ⁺	D			E_γ , Mult.: from (γ, γ'), with Mult from $\gamma(\theta)$.
5146.42	3,4,5	642.7 1	100	4503.74	4 ⁺	D			E_γ : other: 642.9 2 from (p,p' γ).
5260.81	4 ⁽⁻⁾	648.4 1	16.8 17	4612.24	3 ⁽⁺⁾	(E1)		0.0001008 14	B(E1)(W.u.)= 5.3×10^{-5} +10-12 $\alpha=0.0001008$ 14; $\alpha(\text{K})=9.19\times 10^{-5}$ 13; $\alpha(\text{L})=7.89\times 10^{-6}$ 11; $\alpha(\text{M})=9.37\times 10^{-7}$ 13 $\alpha(\text{N})=5.30\times 10^{-8}$ 7 I_γ : other: $I(648\gamma)/I(754\gamma)=100$ 20/41 20 from (p,p' γ) is discrepant. Mult.: D from $\gamma(\theta)$ in (n,n' γ); $\Delta\pi=(\text{yes})$ from level scheme.
		753.8 1	100 9	4507.05	3 ⁻	(M1)		0.0001188 17	B(M1)(W.u.)=0.0086 +16-19 $\alpha=0.0001188$ 17; $\alpha(\text{K})=0.0001083$ 15; $\alpha(\text{L})=9.31\times 10^{-6}$ 13; $\alpha(\text{M})=1.106\times 10^{-6}$ 15 $\alpha(\text{N})=6.28\times 10^{-8}$ 9 E_γ : other: 753.9 from (⁴⁸ Ca, ⁴⁸ Ca' γ). Mult.: D from $\gamma(\theta)$ in (n,n' γ); $\Delta\pi=(\text{no})$ from level scheme.
5311	(1) ⁻	757.7 ^{ag}		4503.74	4 ⁺				E_γ : from (⁴⁸ Ca, ⁴⁸ Ca' γ).
		804	25 ^b 13	4507.05	3 ⁻				E_γ : original 810 from (p,p' γ).
		1479	100 ^b 13	3831.96	2 ⁺				E_γ : original 1490 from (p,p' γ).
5312.2	2	803.9 ^c 1	5.7 10	4507.05	3 ⁻	D			E_γ : level-energy difference=805.17.
		1480.2 ^d 1	100 8	3831.96	2 ⁺	D+Q	+0.7 6		
		5312.2 5	15.4 18	0.0	0 ⁺	Q			
5369.90	3 ⁻	757.5 1	29 4	4612.24	3 ⁽⁺⁾	(E1)		7.10 $\times 10^{-5}$ 10	Mult.: M2 or E2 both allowed by RUL. B(E1)(W.u.)=0.000102 15 $\alpha=7.10\times 10^{-5}$ 10; $\alpha(\text{K})=6.47\times 10^{-5}$ 9; $\alpha(\text{L})=5.56\times 10^{-6}$ 8; $\alpha(\text{M})=6.59\times 10^{-7}$ 9 $\alpha(\text{N})=3.74\times 10^{-8}$ 5 I_γ : other: 6.3 4 from ⁴⁸ K β^- decay is discrepant. Mult.: D from $\gamma(\theta)$ in (n,n' γ); $\Delta\pi=\text{yes}$ from level scheme.

Adopted Levels, Gammas (continued)

$\gamma(^{48}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^{\ddagger}	$I_\gamma^\#$	E_f	J_f^π	Mult. ^e	α^\dagger	Comments
5369.90	3 ⁻	862.7 1	30 4	4507.05	3 ⁻	[M1,E2]	0.000112 22	B(M1)(W.u.)=0.00308 +46-43 (if pure M1); B(E2)(W.u.)=10.3 +15-14 (if pure E2) $\alpha=0.000112$ 22; $\alpha(K)=0.000102$ 20; $\alpha(L)=8.8\times 10^{-6}$ 17; $\alpha(M)=1.04\times 10^{-6}$ 20 $\alpha(N)=5.9\times 10^{-8}$ 11 I_γ : weighted average of 29 4 from ⁴⁸ K β^- decay and 30 4 from (n,n' γ). Other: 67 17 from (p,p' γ) is discrepant.
		866.9 ^d 1	26.4 32	4503.74	4 ⁺	(E1)	5.33×10^{-5} 7	B(E1)(W.u.)=6.2 $\times 10^{-5}$ +9-8 $\alpha=5.33\times 10^{-5}$ 7; $\alpha(K)=4.86\times 10^{-5}$ 7; $\alpha(L)=4.17\times 10^{-6}$ 6; $\alpha(M)=4.95\times 10^{-7}$ 7 $\alpha(N)=2.81\times 10^{-8}$ 4 E_γ : level-energy difference=866.16. I_γ : weighted average of 23 4 from ⁴⁸ K β^- decay and 28.6 32 from (n,n' γ). Mult.: D from $\gamma(\theta)$ in (n,n' γ); $\Delta\pi$ =yes from level scheme.
		1537.8 1	100 6	3831.96	2 ⁺	(E1)	0.000312 4	B(E1)(W.u.)=4.2 $\times 10^{-5}$ 4 $\alpha=0.000312$ 4; $\alpha(K)=1.715\times 10^{-5}$ 24; $\alpha(L)=1.468\times 10^{-6}$ 21; $\alpha(M)=1.743\times 10^{-7}$ 24 $\alpha(N)=9.91\times 10^{-9}$ 14; $\alpha(\text{IPF})=0.000293$ 4 I_γ : from ⁴⁸ K β^- decay. Others: 100 9 from (n,n' γ) and 100 17 from (p,p' γ). Mult.: D from $\gamma(\theta)$ in (n,n' γ); $\Delta\pi$ =yes from level scheme.
5729.64	5 ⁻	468.7 1	100 9	5260.81	4 ⁽⁻⁾	[M1]	0.000324 5	B(M1)(W.u.)=0.14 5 $\alpha=0.000324$ 5; $\alpha(K)=0.000295$ 4; $\alpha(L)=2.55\times 10^{-5}$ 4; $\alpha(M)=3.03\times 10^{-6}$ 4 $\alpha(N)=1.713\times 10^{-7}$ 24 I_γ : from (n,n' γ). Other: 100 17 from (p,p' γ). Mult.: assumed based on comparions with RUL.
		1226.0 1	65 14	4503.74	4 ⁺	[E1]	0.0001000 14	B(E1)(W.u.)=0.00012 +4-5 $\alpha=0.0001000$ 14; $\alpha(K)=2.511\times 10^{-5}$ 35; $\alpha(L)=2.151\times 10^{-6}$ 30; $\alpha(M)=2.55\times 10^{-7}$ 4 $\alpha(N)=1.451\times 10^{-8}$ 20; $\alpha(\text{IPF})=7.25\times 10^{-5}$ 10 I_γ : weighted average of 63 14 from (n,n' γ) and 67 17 from (p,p' γ).
6105.00	(2 ⁺)	1597.8 1	100 10	4507.05	3 ⁻	[E1]	0.000359 5	B(E1)(W.u.)=0.00079 +19-9 $\alpha=0.000359$ 5; $\alpha(K)=1.613\times 10^{-5}$ 23; $\alpha(L)=1.381\times 10^{-6}$ 19; $\alpha(M)=1.640\times 10^{-7}$ 23 $\alpha(N)=9.32\times 10^{-9}$ 13; $\alpha(\text{IPF})=0.000341$ 5
		2273.1 1	13.7 20	3831.96	2 ⁺	[M1,E2]	0.00042 4	B(M1)(W.u.)=0.0016 +5-3 (if pure M1); B(E2)(W.u.)=0.78 +24-14 (if pure E2) $\alpha=0.00042$ 4; $\alpha(K)=1.49\times 10^{-5}$ 6; $\alpha(L)=1.28\times 10^{-6}$ 5; $\alpha(M)=1.52\times 10^{-7}$ 6 $\alpha(N)=8.63\times 10^{-9}$ 32; $\alpha(\text{IPF})=0.00041$ 4

Adopted Levels, Gammas (continued)

$\gamma(^{48}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^{\ddagger}	$I_\gamma^\#$	E_f	J_f^π	Mult. ^e	α^\dagger	Comments
6336.8	2 ⁺	6336.4 20	100	0.0	0 ⁺	E2		B(E2)(W.u.)=0.028 +5-4
6345.72	4 ⁺	1199.3 1	17 8	5146.42	3,4,5			
		1733.5 1	20 5	4612.24	3 ⁽⁺⁾			
		1841.2 ^d 1	100 11	4503.74	4 ⁺			E_γ : level-energy difference=1841.94.
6612.19	1 ⁻	6611.7 [@] 1	100	0.0	0 ⁺	E1		B(E1)(W.u.)=0.00095 +8-7 Mult.: $\gamma(\theta)$ and γ asymmetry in (γ, γ') .
6648.99	4 ⁺	1278 ^g		5369.90	3 ⁻			E_γ : level-energy difference=1502.54.
		1504.0 ^c 1	68 8	5146.42	3,4,5	D		B(M1)(W.u.)=0.0053 +19-15
		2036.8 1	51 5	4612.24	3 ⁽⁺⁾	(M1)	0.000283 4	$\alpha=0.000283$ 4; $\alpha(K)=1.724\times 10^{-5}$ 24; $\alpha(L)=1.476\times 10^{-6}$ 21; $\alpha(M)=1.753\times 10^{-7}$ 25
		2145.1 1	100 16	4503.74	4 ⁺	(M1)	0.000327 5	$\alpha(N)=9.98\times 10^{-9}$ 14; $\alpha(IPF)=0.000264$ 4 Mult.: D from $\gamma(\theta)$ in $(n, n'\gamma)$; $\Delta\pi$ =no from level scheme. B(M1)(W.u.)=0.009 3 $\alpha=0.000327$ 5; $\alpha(K)=1.583\times 10^{-5}$ 22; $\alpha(L)=1.354\times 10^{-6}$ 19; $\alpha(M)=1.609\times 10^{-7}$ 23
6685.64	2 ⁽⁻⁾	1315.8 1	100 8	5369.90	3 ⁻	[M1,E2]	7.3 $\times 10^{-5}$ 9	$\alpha(N)=9.16\times 10^{-9}$ 13; $\alpha(IPF)=0.000310$ 4 Mult.: D from $\gamma(\theta)$ in $(n, n'\gamma)$; $\Delta\pi$ =no from level scheme. B(M1)(W.u.)=0.10 +13-5 (if pure M1); B(E2)(W.u.)=1.5 $\times 10^2$ +19-7 (if pure E2) $\alpha=7.3\times 10^{-5}$ 9; $\alpha(K)=4.1\times 10^{-5}$ 4; $\alpha(L)=3.49\times 10^{-6}$ 33; $\alpha(M)=4.2\times 10^{-7}$ 4 $\alpha(N)=2.36\times 10^{-8}$ 22; $\alpha(IPF)=2.8\times 10^{-5}$ 5
		2073.9 ^d 1	17 4	4612.24	3 ⁽⁺⁾	(E1)	0.000705 10	I_γ : from ⁴⁸ K β^- decay. Other: 100 10 from $(n, n'\gamma)$. B(E1)(W.u.)=1.0 $\times 10^{-4}$ +13-5 $\alpha=0.000705$ 10; $\alpha(K)=1.089\times 10^{-5}$ 15; $\alpha(L)=9.31\times 10^{-7}$ 13; $\alpha(M)=1.106\times 10^{-7}$ 15
		2178.30 ^{&g}	18 ^{&} 4	4507.05	3 ⁻	[M1,E2]	0.00038 4	$\alpha(N)=6.29\times 10^{-9}$ 9; $\alpha(IPF)=0.000693$ 10 E_γ : level-energy difference=2073.35. I_γ : weighted average of 15 4 from ⁴⁸ K β^- decay and 26 9 from $(n, n'\gamma)$. Mult.: D from comparison to RUL; $\Delta\pi$ =yes from level scheme. B(M1)(W.u.)=0.0041 +52-21 (if pure M1); B(E2)(W.u.)=2.2 +28-11 (if pure E2) $\alpha=0.00038$ 4; $\alpha(K)=1.60\times 10^{-5}$ 6; $\alpha(L)=1.37\times 10^{-6}$ 5; $\alpha(M)=1.63\times 10^{-7}$ 7 $\alpha(N)=9.3\times 10^{-9}$ 4; $\alpha(IPF)=0.00036$ 4
6791.5	1	6791.0 20	100	0.0	0 ⁺	D		E_γ, I_γ : from ⁴⁸ K β^- decay. γ reported in $(p, p'\gamma)$ but not seen in $(n, n'\gamma)$.
6805.7	2 ⁺	2301.9 1	100 14	4503.74	4 ⁺	[E2]	0.000478 7	B(E2)(W.u.)=5.9 +48-22 $\alpha=0.000478$ 7; $\alpha(K)=1.510\times 10^{-5}$ 21; $\alpha(L)=1.292\times 10^{-6}$ 18; $\alpha(M)=1.535\times 10^{-7}$ 21
		2974.8 5	72 24	3831.96	2 ⁺	[M1,E2]	0.00073 6	$\alpha(N)=8.73\times 10^{-9}$ 12; $\alpha(IPF)=0.000462$ 6 B(M1)(W.u.)=0.0042 +36-17 (if pure M1); B(E2)(W.u.)=1.2 +10-5 (if

Adopted Levels, Gammas (continued)

$\gamma(^{48}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^{\ddagger}	$I_\gamma^\#$	E_f	J_f^π	Mult. ^e	α^\dagger	Comments
								pure E2) $\alpha=0.00073$ 6; $\alpha(K)=9.64\times10^{-6}$ 26; $\alpha(L)=8.24\times10^{-7}$ 22; $\alpha(M)=9.79\times10^{-8}$ 26 $\alpha(N)=5.58\times10^{-9}$ 15; $\alpha(\text{IPF})=0.00072$ 6
6830.8	(3 ⁻)	2998.7 5	100	3831.96	2 ⁺	D		
6895.87	(2 ⁻)	1525.7 1	36 6	5369.90	3 ⁻	(M1)	0.0001032 14	B(M1)(W.u.)>0.0065 $\alpha=0.0001032$ 14; $\alpha(K)=2.83\times10^{-5}$ 4; $\alpha(L)=2.426\times10^{-6}$ 34; $\alpha(M)=2.88\times10^{-7}$ 4 $\alpha(N)=1.640\times10^{-8}$ 23; $\alpha(\text{IPF})=7.21\times10^{-5}$ 10 I_γ : from ⁴⁸ K β^- decay. Other: 35 8 from (n,n' γ). Mult.: D from $\gamma(\theta)$ in (n,n' γ); $\Delta\pi=(\text{no})$ from level scheme.
		2283.15&g	23& 4	4612.24	3 ⁽⁺⁾	[E1]	0.000843 12	B(E1)(W.u.)>2.8 $\times10^{-5}$ $\alpha=0.000843$ 12; $\alpha(K)=9.50\times10^{-6}$ 13; $\alpha(L)=8.12\times10^{-7}$ 11; $\alpha(M)=9.65\times10^{-8}$ 14 $\alpha(N)=5.49\times10^{-9}$ 8; $\alpha(\text{IPF})=0.000833$ 12
		2389.0 1	100 7	4507.05	3 ⁻	(M1)	0.000428 6	B(M1)(W.u.)>0.0053 $\alpha=0.000428$ 6; $\alpha(K)=1.329\times10^{-5}$ 19; $\alpha(L)=1.137\times10^{-6}$ 16; $\alpha(M)=1.350\times10^{-7}$ 19 $\alpha(N)=7.69\times10^{-9}$ 11; $\alpha(\text{IPF})=0.000413$ 6 I_γ : from ⁴⁸ K β^- decay. Other: 100 14 from (n,n' γ). Mult.: D from $\gamma(\theta)$ in (n,n' γ); $\Delta\pi=(\text{no})$ from level scheme.
7007.6	3 ⁻	3063.27&g 3175.5 5	35& 7 100	3831.96 2 ⁺ 3831.96 2 ⁺		[E1]	1.33 $\times10^{-3}$ 2	E_γ, I_γ : from ⁴⁸ K β^- decay only. B(E1)(W.u.)=0.00023 +6-5 $\alpha(K)=6.12\times10^{-6}$ 9; $\alpha(L)=5.23\times10^{-7}$ 7; $\alpha(M)=6.21\times10^{-8}$ 9 $\alpha(N)=3.54\times10^{-9}$ 5; $\alpha(\text{IPF})=0.001328$ 19
7032.0	(3 ⁻)	1771 g 2524.9 5		5260.81 4 ⁽⁻⁾ 4507.05 3 ⁻		D+Q		E_γ : level-energy difference=1763 from (p,p' γ). δ : large.
7296.1	(2 ⁺)	3463.9 5 7298 2	100 11 21 4	3831.96 2 ⁺ 0.0 0 ⁺		(E2)		B(E2)(W.u.)>0.051 Mult.: (Q) from $\gamma(\theta)$ in (n,n' γ); M2 ruled out by RUL.
7298.50	1 ⁻	1929& 2686& 7297.9 2	0.52& 0.52& 100 26	5369.90 3 ⁻ 4612.24 3 ⁽⁺⁾ 0.0 0 ⁺		E1		E_γ : 1932 from level-energy difference in ⁴⁸ K β^- decay. E_γ : 2689 from level-energy difference in ⁴⁸ K β^- decay. B(E1)(W.u.)=0.0065 5 E_γ : from (γ, γ'). Other: 7300.9 from ⁴⁸ K β^- decay. I_γ : from ⁴⁸ K β^- decay. Mult.: from $\gamma(\theta)$ and γ asymmetry in (γ, γ').
7370.6	(1,2)	7370 2	100	0.0 0 ⁺				
7401.22	(2 ⁻)	715.61& 2031.23& 2788.90&	8.2& 24 17.9& 24 100& 6	6685.64 2 ⁽⁻⁾ 5369.90 3 ⁻ 4612.24 3 ⁽⁺⁾				

Adopted Levels, Gammas (continued)

$\gamma(^{48}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ [†]	I_γ [#]	E_f	J_f^π	Mult. ^e	α [†]	Comments
7401.22	(2 ⁻)	2894 ^{&} 3569 ^{&} 7400 ^{&}	5.3 ^{&} 6.6 ^{&} 1.30 ^{&}	4507.05 3831.96 0.0	3 ⁻ 2 ⁺ 0 ⁺			
7407.3?	(0,1,2,3 ⁻)	793.11 ^{&g} 6	100	6612.19	1 ⁻			
7440.6	2,3 ⁻	7440 2	100	0.0	0 ⁺	Q,E3		B(E3)(W.u.)=39.7 +17-15 (if pure E3)
7497.5	(3 ⁻)	1767.8 1	100	5729.64	5 ⁻			
7536.4	3 ⁻	2389.8 ^a 3032.7 ^a		5146.42 4503.74	3,4,5 4 ⁺			
7568.7		3736.6 5	100	3831.96	2 ⁺			
7652	3 ⁻	3146 ^{fg} 3146 ^{fg} 7651		4503.74 4507.05 0.0	4 ⁺ 3 ⁻ 0 ⁺			E_γ : level-energy difference=3140 from (p,p' γ). E_γ : level-energy difference=3140 from (p,p' γ).
7655.66	1 ⁻	7655.0 [@] 2	100	0.0	0 ⁺	E1		B(E1)(W.u.)=6.11 $\times 10^{-4}$ +24-23 Mult.: from $\gamma(\theta)$ and α asymmetry in (γ,γ').
7789	3 ⁻	958		6830.8	(3 ⁻)			E_γ : level-energy difference=964 from (p,p' γ).
7915.4	2 ⁺	7914.7 [@] 9	100	0.0	0 ⁺	E2		B(E2)(W.u.)=0.080 +13-12
7957	(4 ⁺)	1126		6830.8	(3 ⁻)			E_γ : level-energy difference=1137 from (p,p' γ).
8027.6	2 ⁺	8026.9 [@] 4	100	0.0	0 ⁺	E2		B(E2)(W.u.)=0.144 +17-14 Mult.: Q from $\gamma(\theta)$ in (γ,γ'); M2 ruled out by RUL.
8045	(1)	3544 ^{fg} 3544 ^{fg} 8044 ^g		4503.74 4507.05 0.0	4 ⁺ 3 ⁻ 0 ⁺			E_γ : level-energy difference=3529 from (p,p' γ). E_γ : level-energy difference=3529 from (p,p' γ). E_γ : level-energy difference=8040 from (p,p' γ).
8050	2	8050		0.0	0 ⁺			
8248	4 ⁺	3740 ^{fg} 3740 ^{fg}		4503.74 4507.05	4 ⁺ 3 ⁻			E_γ : level-energy difference=3735 from (p,p' γ). E_γ : level-energy difference=3735 from (p,p' γ).
8276?	(1 ⁻ ,2,3)	1445		6830.8	(3 ⁻)			E_γ : level-energy difference=1456 from (p,p' γ).
		3770 ^{fg} 3770 ^{fg} 8275		4507.05 4503.74 0.0	3 ⁻ 4 ⁺ 0 ⁺			E_γ : level-energy difference=3764 from (p,p' γ). E_γ : level-energy difference=3764 from (p,p' γ).
8279.1	4 ⁺	3133 ^a		5146.42	3,4,5			
8386.1	1 ⁻	1555 ^g 4554.2 [@] 12		6830.8	(3 ⁻)			E_γ : level-energy difference=1564 from (p,p' γ).
			9.9 [@] 3	3831.96	2 ⁺	(E1)	1.88 $\times 10^{-3}$ 3	B(E1)(W.u.)=0.0031 +6-4 $\alpha(K)$ =3.93 $\times 10^{-6}$ 5; $\alpha(L)$ =3.35 $\times 10^{-7}$ 5; $\alpha(M)$ =3.98 $\times 10^{-8}$ 6 $\alpha(N)$ =2.269 $\times 10^{-9}$ 32; $\alpha(\text{IPF})$ =0.001876 26 Mult.: D from $\gamma(\theta)$ in (γ,γ'); $\Delta\pi$ =yes from level scheme.
		8385.3 [@] 5	100 [@] 9	0.0	0 ⁺	E1		B(E1)(W.u.)=0.0050 +8-6 Mult.: from $\gamma(\theta)$ and γ asymmetry in (γ,γ').
8467?	(1,2)	4635 ^{&g} 8466 ^{&g}	100 ^{&} 15.7 ^{&}	3831.96 0.0	2 ⁺ 0 ⁺			

Adopted Levels, Gammas (continued)

$\gamma(^{48}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^{\ddagger}	$I_\gamma^\#$	E_f	J_f^π	Mult. ^e	α^\dagger	Comments
8478	3 ⁺ ,4 ⁺ ,5 ⁺	3972 ^f _g		4503.74	4 ⁺			E_γ : level-energy difference=3976 from (p,p' γ).
		3972 ^f _g		4507.05	3 ⁻			E_γ : level-energy difference=3976 from (p,p' γ).
8517.9	(1 ⁻ ,2 ⁺)	8517.1@ 8	100	0.0	0 ⁺			
8523	3 ⁻	4017 ^f _g		4503.74	4 ⁺			E_γ : level-energy difference=4015 from (p,p' γ).
		4017 ^f _g		4507.05	3 ⁻			E_γ : level-energy difference=4015 from (p,p' γ).
8531?	(1,2 ⁺)	4247& ^g	39&	4283.56	0 ⁺			
		4699& ^g	100&	3831.96	2 ⁺			
		8530& ^g	61&	0.0	0 ⁺			
8586?		4080 ^f _g		4503.74	4 ⁺			E_γ : level-energy difference=4073 from (p,p' γ).
		4080 ^f _g		4507.05	3 ⁻			E_γ : level-energy difference=4073 from (p,p' γ).
8664.6	(3,4,5)	386 ^a		8279.1	4 ⁺			
8680	(3 ⁺)	4174 ^f _g		4503.74	4 ⁺			E_γ : level-energy difference=4159 from (p,p' γ).
		4174 ^f _g		4507.05	3 ⁻			E_γ : level-energy difference=4159 from (p,p' γ).
8788		4282 ^f _g		4503.74	4 ⁺			E_γ : level-energy difference=4277 from (p,p' γ).
		4282 ^f _g		4507.05	3 ⁻			E_γ : level-energy difference=4277 from (p,p' γ).
8883.3	1 ⁻	5050.6 9	4.0 10	3831.96	2 ⁺	(E1)	2.04×10 ⁻³ 3	B(E1)(W.u.)=0.00036 +30-14 $\alpha(\text{K})=3.48\times 10^{-6}$ 5; $\alpha(\text{L})=2.97\times 10^{-7}$ 4; $\alpha(\text{M})=3.52\times 10^{-8}$ 5 $\alpha(\text{N})=2.008\times 10^{-9}$ 28; $\alpha(\text{IPF})=0.002035$ 28 E_γ, I_γ : from (γ, γ'). Mult.: D from $\gamma(\theta)$ in (γ, γ'); $\Delta\pi$ =yes from level scheme. B(E1)(W.u.)=0.0017 +9-4 $E_\gamma, I_\gamma, \text{Mult.}$: from (γ, γ') with Mult from $\gamma(\theta)$ and γ asymmetry.
		8882.6 5	100 30	0.0	0 ⁺	E1		
8890.7	>5	3160.8 ^a		5729.64	5 ⁻			
8967?	(1,2,3)	8966& ^g	100	0.0	0 ⁺			
9033.9	1 ⁻	5200.9@ 15	2.2@ 9	3831.96	2 ⁺	(E1)	2.08×10 ⁻³ 3	B(E1)(W.u.)=0.00033 13 $\alpha(\text{K})=3.36\times 10^{-6}$ 5; $\alpha(\text{L})=2.87\times 10^{-7}$ 4; $\alpha(\text{M})=3.41\times 10^{-8}$ 5 $\alpha(\text{N})=1.940\times 10^{-9}$ 27; $\alpha(\text{IPF})=0.002080$ 29 Mult.: D from $\gamma(\theta)$ in (γ, γ'); $\Delta\pi$ =yes from level scheme. B(E1)(W.u.)=0.0028 2 Mult.: from $\gamma(\theta)$ and γ asymmetry in (γ, γ'). $E_\gamma, \text{Mult.}$: from ($\alpha, \alpha'\gamma$), with Mult from $\alpha\gamma(\theta)$.
		9033.0@ 4	100@ 4	0.0	0 ⁺	E1		
9050	1	9050		0.0	0 ⁺	D		
9094.6		430 ^a		8664.6	(3,4,5)			
9123.1	(1 ⁺ ,2 ⁺ ,3 ⁺)	232 ^a		8890.7	>5			
		459 ^a		8664.6	(3,4,5)			
9295.3	1 ⁻	9294.3	100	0.0	0 ⁺	E1		B(E1)(W.u.)=0.00270 +17-15 E_γ : other: 9300 from ($\alpha, \alpha'\gamma$) and ⁴⁸ K β^- decay. Mult.: from $\gamma(\theta)$ and γ asymmetry in (γ, γ') and $\alpha\gamma(\theta)$ in ($\alpha, \alpha'\gamma$).
9295.7	(8 ⁻)	405 ^a		8890.7	>5			
9472.8	1 ⁻	9471.8@ 8	100	0.0	0 ⁺	E1		B(E1)(W.u.)=0.00241 +22-19 Mult.: from $\gamma(\theta)$ and γ asymmetry in (γ, γ').

Adopted Levels, Gammas (continued)

$\gamma(^{48}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^{\ddagger}	$I_\gamma^\#$	E_f	J_f^π	Mult. ^e	Comments
9545.72	1 ⁻	9544.7 [@]	2	100	0.0	0 ⁺	E1 B(E1)(W.u.)=0.00424 +23-21 Mult.: from $\gamma(\theta)$ and γ asymmetry in (γ,γ') .

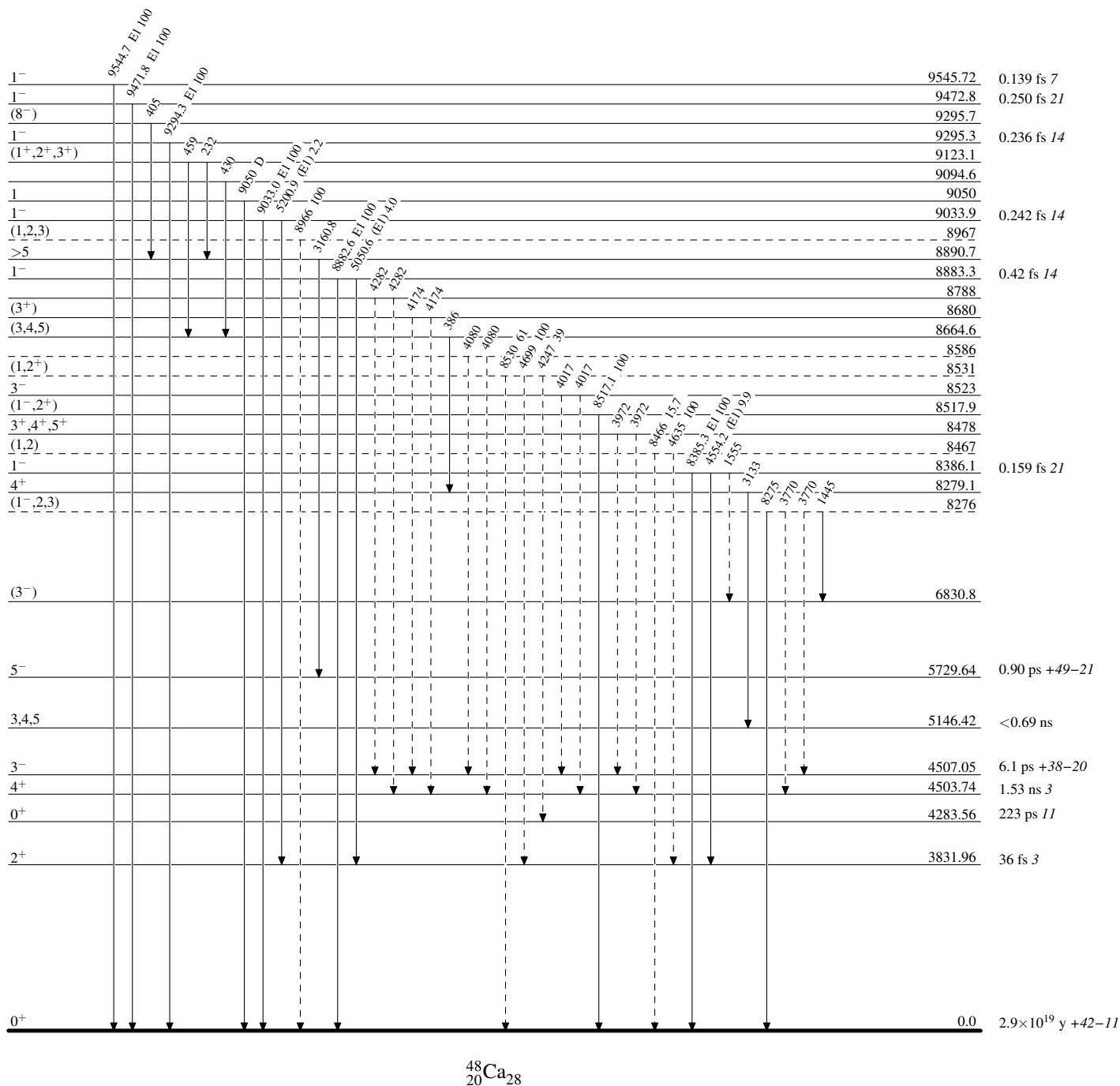
[†] Additional information 19.
[‡] Values with uncertainties are from (n,n'γ) and those without uncertainties are from level-energy differences for transitions reported in (p,p'γ) , unless otherwise noted. Note that values without uncertainties from (p,p'γ) are deduced from E(level) values reported in 1969Te03 only, while adopted E(level) values from (p,p') are mostly from 1988Fu01 or average of all available measurements. Therefore, for those transitions, Eγ values quoted here have been re-deduced by the evaluator from the adopted level energies.
[#] From (n,n'γ), unless otherwise noted.
[@] From (γ,γ').
[&] From β⁻ decay.
^a From (⁴⁸Ca,⁴⁸Ca'γ).
^b From (p,p'γ), except as noted.
^c Very poor-fit and omitted in the fitting.
^d Poor-fit and uncertainty multiplied by a factor of 3 in the fitting.
^e D,Q or D+Q with δ are from γ(θ) in (n,n'γ) and electric or magnetic nature is from comparison to RUL where T_{1/2} is available, unless otherwise noted.
^f Multiply placed.
^g Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

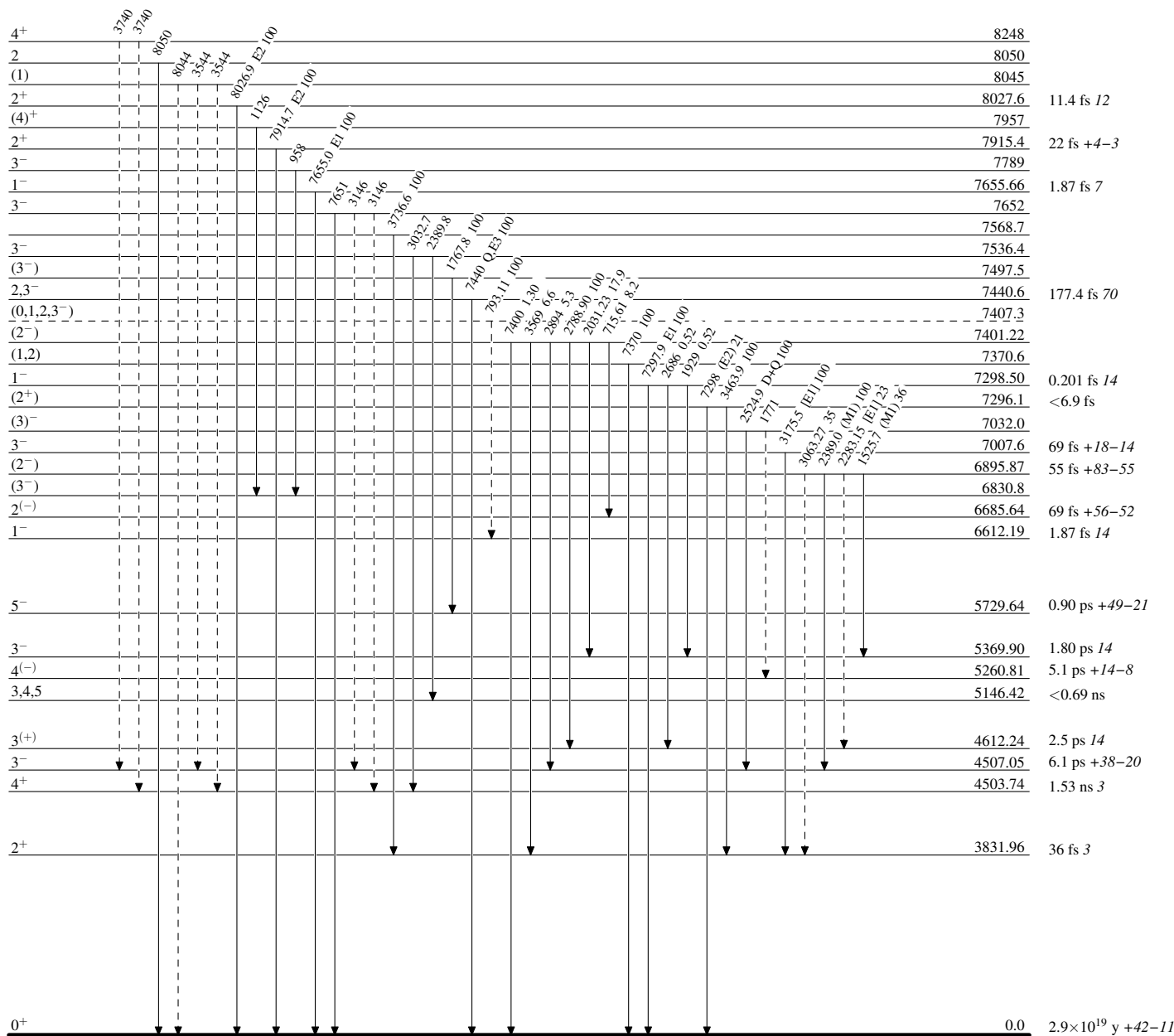
-----► γ Decay (Uncertain) $^{48}_{20}\text{Ca}_{28}$

Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

-----► γ Decay (Uncertain) $^{48}_{20}\text{Ca}_{28}$

Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

-----► γ Decay (Uncertain)