

Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 196,17 (2024)	30-Sep-2023

Q(β^-)=-9630 40; S(n)=12631.4 15; S(p)=2668.0 14; Q(α)=-2613.6 14 2021Wa16
 S(2n)=25560 40, S(2p)=9141.0 16, Q(ϵ)=5666.3 20 (2021Wa16).

Mass measurements: 2021Pa44, 2007Gu09, 2007Sc24, 1989Sh10.

Other measurements:

See ⁶³Ge ϵ decay dataset for a preliminary decay scheme proposed by 2019Ru07, which is not adopted here due to very limited information available in this conference proceeding about the decay scheme.

2012Pr11: U(p,X) E=1.4 GeV at ISOLDE-CERN facility. Measured hyperfine structure and isotope shift. Deduced spin, moments, rms charge radius.

1975AgZX: ⁶⁴Zn(p,2n γ) E=25, 33, 40 MeV. Measured E γ , I γ , $\gamma\gamma$ -coin. No data are available.

Additional information 1.

The level scheme is as that proposed by 2021Ru07 in (²⁸Si, $\alpha\gamma$).

⁶³Ga Levels

Band assignments are from (²⁸Si, $\alpha\gamma$) (2021Ru07).

Cross Reference (XREF) Flags

A	⁶³ Ge ϵ decay (153.3 ms)	D	⁴⁰ Ca(²⁹ Si, $\alpha\text{pn}\gamma$)
B	⁶⁴ As ep decay (69.0 ms)	E	⁴⁰ Ca(³² S,2 $\alpha\text{p}\gamma$)
C	⁴⁰ Ca(²⁸ Si, $\alpha\text{p}\gamma$)		

E(level) [†]	J $^\pi$	T _{1/2} [‡]	XREF	Comments
0.0	3/2 ⁻	32.1 s 5	ABCDE	<p>$\% \epsilon + \% \beta^+ = 100$ $\mu = +1.469$ 5 (2012Pr11,2019StZV) $Q = +0.212$ 14 (2012Pr11,2021StZZ) $T_z = -1/2$ J^π: spin=3/2 from fitting of hyperfine structure and agreement of measured quadrupole moment with shell-model calculations using jj44b and JUN45 interactions (2012Pr11) and parity=- from allowed $\epsilon + \beta^+$ feeding to 3/2⁻ g.s. in ⁶³Zn. $T_{1/2}$: weighted average of 32.4 s 5 (1971GiZS), 31.4 s 8 (1970Du05), 33 s 4 (1965Nu02). Other: 35 s 1 (1964Fi01) is slightly discrepant. Weighted average of all gives 32.6 s 7 with a reduced $\chi^2 = 2.7$. μ, Q: extracted by 2012Pr11 from previous measurements of hyperfine coefficients by the same group as 2012Pr11 by collinear laser spectroscopy. Known μ and Q for ⁷¹Ga were used for calibration. The 3/2 is correct spin assignment, however 2012Pr11 list $\mu = +1.652$ 6, $Q = +0.424$ 25 for J=5/2 also and compare these with shell-model calculations. See also 2019StZV evaluation and 2021StZZ compilation. 2012Pr11 predict first three levels at 0, 3/2⁻; 118, 1/2⁻ and 165, 5/2⁻ using jj44b interaction. Using jun45 interaction, the first three levels are predicted at 0, 1/2⁻; 88, 3/2⁻ and 237, 5/2⁻. But 1/2 spin for the ground state is not supported in the present experimental hyperfine structure. $\delta \langle r^2 \rangle (^{71}\text{Ga}, ^{63}\text{Ga}) = -0.643$ fm² 15(stat) 135(syst) (2012Pr11). Isotope shift $\delta \nu (^{71}\text{Ga}, ^{63}\text{Ga}) = +121$ MHz 6(stat) 18(syst) (2012Pr11). rms matter radius $\langle r^2 \rangle^{1/2} = 3.91$ fm 26 (2004Li29).</p>
75.10 8	(5/2) ⁻	≈25 ns	ABCDE	<p>J^π: 75.1γ M1+E2, $\Delta J = 1$ to 3/2⁻; 5/2⁻ from systematics of neighboring odd-A Ga isotopes and shell-model predictions (1f_{5/2} single-particle orbit) (1991Ba20). Shell-model calculations (2012Pr11) predict 1/2⁻ with E(level)=118 using jj44b interaction and 3/2⁻ at E(level)=88 using JUN45 interaction for the first excited state, and predict 5/2⁻ for the second excited state using either interaction. In systematics of</p>

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Adopted Levels, Gammas (continued)

⁶³Ga Levels (continued)

E(level) [†]	J ^π	T _{1/2} [‡]	XREF	Comments
				odd Ga isotopes in 1991Ba20 , the 5/2 ⁻ first excited state in ⁶³ Ga corresponds to the 5/2 ⁻ second excited states in ^{65,67,69} Ga isotopes.
442.76 10	(3/2 ⁻) [#]		A C E	XREF: E(?). J ^π : 442.9γ ΔJ=(0) to 3/2 ⁻ .
722.33 8	(5/2 ⁻) [#]		A C E	XREF: A(?)E(?). J ^π : 722.2γ to 3/2 ⁻ ; 699.3γ (D+Q), ΔJ=1 from 7/2 ⁻ .
1152.33 18	(9/2 ⁻) [#]		CDE	J ^π : 1077.2γ Q, ΔJ=2 to (5/2) ⁻ .
1421.58 13	7/2 ⁽⁻⁾		CDE	J ^π : 1422.4γ Q, ΔJ=2 to 3/2 ⁻ is most likely E2, with M2 not completely ruled out.
2046.16& 19	(9/2 ⁺)	<2 ns	CDE	J ^π : 624.6γ D, ΔJ=1 to 7/2 ⁽⁻⁾ ; 9/2 ⁺ proposed by 1991Ba20 based on systematics of neighboring odd-A Ga isotopes and shell-mode predictions; band head.
2940.27& 28	(13/2 ⁺)		CDE	J ^π : 894.1γ Q, ΔJ=2 to (9/2 ⁺); band assignment.
4080.25& 34	(17/2 ⁺)		CDE	J ^π : 1139.8γ Q, ΔJ=2 to (13/2 ⁺); band assignment.
5243.9 5			C E	XREF: E(?).
5715.38& 38	(21/2 ⁺)		C E	J ^π : 1634.9γ Q, ΔJ=2 to (17/2 ⁺); band assignment.
5852.64 ^a 37	(19/2 ⁻)		CDE	J ^π : 1772.4γ (E1), ΔJ=1 to (17/2 ⁺); band head.
6501.25 ^a 39	(23/2 ⁻)		CDE	J ^π : 648.8γ Q, ΔJ=2 to (19/2 ⁻), 785.7γ D, ΔJ=1 to (21/2 ⁺); band assignment.
7334.8 ^c 6	(21/2)		C	J ^π : 3255γ to (17/2 ⁺); band head.
7656.2 ^d 7	(23/2)		C E	J ^π : 1154.4γ ΔJ=(0) to (23/2 ⁻); band head.
7710.15 ^a 43	(27/2 ⁻)		CDE	J ^π : 1208.9γ Q, ΔJ=2 to (23/2 ⁻); band assignment.
7912.3 ^b 10	(25/2 ⁻)		C E	J ^π : 1412.0γ ΔJ=1 to (23/2 ⁻); band assignment.
8213.3 ^c 6	(25/2) [@]		C	
8856.7 ^d 8	(27/2)		C	J ^π : 1200.2γ (Q), ΔJ=(2) to (23/2); 1146.8γ (D+Q), ΔJ=(0) to (27/2 ⁻).
9039.9 ^a 5	(31/2 ⁻)		C E	J ^π : 1329.7γ Q, ΔJ=2 to (27/2 ⁻); band assignment.
9254.8 ^b 6	(29/2 ⁻)		C E	J ^π : 1544.8γ D+Q, ΔJ=1 to (27/2 ⁻); band assignment.
9482.6 ^c 6	(29/2)		C E	J ^π : 1269.2γ Q, ΔJ=2 to (25/2); band assignment.
10161.3? ^d 8	(31/2)		C E	XREF: C(?)E(?). J ^π : 1304.6γ (Q), ΔJ=(2) to (27/2). Reversed ordering of the 1812-1305 γ cascade from 11974 level is possible, which can give level energy as 10670 keV instead of 10161 (2021Ru07).
10868.7 ^a 6	(35/2 ⁻)		C E	J ^π : 1828.7γ Q, ΔJ=2 to (31/2 ⁻); band assignment.
10908.3 ^c 5	(33/2)		C E	J ^π : 1425.8γ Q, ΔJ=2 to (29/2); 1868.3γ ΔJ=1 to (31/2 ⁻).
10980.1 ^b 6	(33/2 ⁻)		C E	J ^π : 1725.6γ Q, ΔJ=2 to (29/2 ⁻); 1939.7γ D+Q, ΔJ=1 to (31/2 ⁻).
11972.9 ^d 9	(35/2)		C E	J ^π : band assignment.
12736.7 ^b 8	(37/2 ⁻)		C E	XREF: E(12743.2). J ^π : 1756.4γ Q, ΔJ=2 to (33/2 ⁻); 1868.2γ D+Q, ΔJ=1 to (35/2 ⁻).
12832.6 ^c 8	(37/2)		C E	E(level): 2001We11 in (³² S,2αpy) report a doublet of 12831+12832 based on placements of 1921.9γ+1924.3γ doublet transitions and different ordering of γ cascades. Both the γ and level doublets are considered as a singlet by 2021Ru07 in (²⁸ Si,αpy) as adopted here. See more detailed comments in (³² S,2αpy). J ^π : 1924.8γ Q, ΔJ=2 to (33/2); band assignment. 2001We11 assigned J ^π =39/2 ⁻ to the 12832 component of the 12831+12832 doublet reported in (³² S,2αpy); J ^π of 12831 component is not assigned but could be (37/2 ⁺) based on their band assignment.
14212.4 18	(39/2)		C	J ^π : 3343.4γ to (35/2 ⁻); 2979.3γ from (43/2).
14463.8 ^c 9	(41/2)		C E	J ^π : 1631.1γ Q, ΔJ=2 to (37/2); band assignment. 43/2 ⁻ assigned by 2001We11 in (³² S,2αpy).
14541.6 22	(39/2) [@]		C	J ^π : 3671.9γ to (35/2 ⁻); 2213.0γ from (41/2 ⁻).
15140? 6	(35/2 ⁻) [@]		C	XREF: C(15141?). J ^π : possible 1555.1γ from (39/2 ⁻); could be the band head of the Q3 band (2021Ru07).

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Adopted Levels, Gammas (continued)

⁶³Ga Levels (continued)

E(level) [†]	J ^π	XREF	Comments
15764.8 ^e 39	(39/2 ⁻)	C	J ^π : 4895.9γ (Q), ΔJ=(2) to (35/2 ⁻).
16297.3 42	(39/2 ⁻) [@]	C	
16427.1? 42	(39/2 ⁻) [@]	C	XREF: C(?).
16634.1 26		C	
16695 ^g 6	(39/2 ⁻)	C	J ^π : 5825.6γ (Q), ΔJ=(2) to (35/2 ⁻).
16754.6 ^f 22	(41/2 ⁻)	C	J ^π : 4018.5γ (Q), ΔJ=(2) to (37/2 ⁻).
17170.8 21		C	
17192.1 17	(43/2)	C	J ^π : 2728.4γ (D), ΔJ=1 to (41/2).
17477.9 20		C	
17573.3 ^h 43	(41/2 ⁻) [@]	C	J ^π : 4836.4γ to (37/2 ⁻); band head.
17641.6 31	(41/2 ⁻)	C	J ^π : 4903.7γ (Q), ΔJ=(2) to (37/2 ⁻).
17660.1 31	(41/2 ⁻)	C	J ^π : 4924.1γ (Q), ΔJ=(2) to (37/2 ⁻).
17705.0 39	(41/2 ⁻)	C	J ^π : 4968.3γ (Q), ΔJ=(2) to (37/2 ⁻).
17754.1 40	(41/2 ⁻)	C	J ^π : 5016.9γ (Q), ΔJ=(2) to (37/2 ⁻).
18089.5 ^e 41	(43/2 ⁻)	C	J ^π : 2324.6γ (Q), ΔJ=(2) to (39/2 ⁻).
18451.8 28		C	
18523 ^g 6	(43/2 ⁻) [@]	C	
18930.8 ^f 25	(45/2 ⁻)	C	J ^π : 2176.1γ (Q), ΔJ=(2) to (41/2 ⁻).
19033.9 32		C	
19536.0 ^h 45	(45/2 ⁻)	C	J ^π : 1962.7γ (Q), ΔJ=(2) to (41/2 ⁻).
19701.1 ⁱ 31	(45/2 ⁻)	C	J ^π : 2059.4γ (Q), ΔJ=(2) to (41/2 ⁻).
19763.4 ^j 39	(45/2 ⁻)	C	J ^π : 2009.3γ (Q), ΔJ=(2) to (41/2 ⁻).
20099.9 ^e 43	(47/2 ⁻)	C	J ^π : 2010.4γ (Q), ΔJ=(2) to (43/2 ⁻).
20625 ^g 6	(47/2 ⁻)	C	J ^π : 2101.6γ (Q), ΔJ=(2) to (43/2 ⁻).
21375.6 ^f 31	(49/2 ⁻)	C	J ^π : 2444.8γ (Q), ΔJ=(2) to (45/2 ⁻).
21806 ^h 5	(49/2 ⁻)	C	J ^π : 2269.6γ (Q), ΔJ=(2) to (45/2 ⁻).
22071.6 ⁱ 34	(49/2 ⁻)	C	J ^π : 2370.4γ (Q), ΔJ=(2) to (45/2 ⁻).
22114.2 ^j 42	(49/2 ⁻) [@]	C	
22612 ^e 5	(51/2 ⁻)	C	J ^π : 2512.0γ (Q), ΔJ=(2) to (47/2 ⁻).
23069 ^g 6	(51/2 ⁻)	C	J ^π : 2444.2γ (Q), ΔJ=(2) to (47/2 ⁻).
24234.3 ^f 36	(53/2 ⁻) [@]	C	
24454 ^h 5	(53/2 ⁻)	C	J ^π : 2648.3γ (Q), ΔJ=(2) to (49/2 ⁻).
24795.5 ^j 45	(53/2 ⁻)	C	J ^π : 2681.3γ (Q), ΔJ=(2) to (49/2 ⁻).
24899.9 ⁱ 38	(53/2 ⁻) [@]	C	
25952 ^g 6	(55/2 ⁻) [@]	C	
25987? ^e 6	(55/2 ⁻) [@]	C	XREF: C(?).
27612 ^h 5	(57/2 ⁻) [@]	C	
27869 ^j 5	(57/2 ⁻) [@]	C	
28122.3 ⁱ 43	(57/2 ⁻) [@]	C	
29439? ^g 7	(59/2 ⁻) [@]	C	XREF: C(?).
31328? ^j 6	(61/2 ⁻) [@]	C	XREF: C(?).
x ^k	J1	C	Additional information 2. E(level): x=19000 (estimated by 2021Ru07).
2191.2+x ^k 13	J1+2	C	
2227.8+x? 24		C	XREF: C(?).
4661.7+x ^k 19	J1+4	C	
7339.2+x ^k 25	J1+6	C	
10254.2+x ^k 30	J1+8	C	

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Adopted Levels, Gammas (continued)

^{63}Ga Levels (continued)

E(level) [†]	J ^π	XREF	Comments
13502.9+x ^k 37	J1+10	C	
y ^l	J2	C	Additional information 3. E(level): y=20300 (estimated by 2021Ru07).
2327.1+y ^l 14	J2+2	C	
4896.3+y ^l 21	J2+4	C	
7673.0+y ^l 26	J2+6	C	
10743.7+y ^l 33	J2+8	C	
14206.8+y ^l 41	J2+10	C	
z? ^m	J3	C	XREF: C(?). Additional information 4. E(level): z=19200 (estimated by 2021Ru07).
2200.0+z ^m 19	J3+2	C	
4645.0+z ^m 25	J3+4	C	
7350.6+z ^m 30	J3+6	C	
10382.4+z ^m 37	J3+8	C	
13792+z ^m 6	J3+10	C	

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

[‡] From particle- γ (t) in ($^{29}\text{Si},\alpha\text{pn}\gamma$) (1991Ba20), unless otherwise noted.

Proposed by 2021Ru07 in ($^{28}\text{Si},\alpha\text{p}\gamma$) based on shell-model predictions and γ -ray decay pattern.

@ Proposed by 2021Ru07 in ($^{28}\text{Si},\alpha\text{p}\gamma$) based on band assignments and/or γ -ray decay pattern.

& Band(A): Band B1 based on (9/2⁺), $\alpha=+1/2$. Configuration=[21₊; 40] (2021Ru07).

^a Band(B): Band B2 based on (19/2⁻), $\alpha=-1/2$. Configuration=[21₊; 3₊1₊] (2021Ru07), bands B2 and B3 considered as signature partners.

^b Band(b): Band B3 based on (25/2⁻), $\alpha=+1/2$. Configuration=[21₊; 3₋1₊] (2021Ru07), bands B2 and B3 considered as signature partners.

^c Band(C): Band B4 based on (21/2), $\alpha=+1/2$. Configuration=[21₊; 22] (2021Ru07).

^d Band(D): Band B5 based on (23/2), $\alpha=-1/2$. Configuration=[21₊; 3₊1₊] (2021Ru07), interpreted as excited band of the same configuration as that for band B2.

^e Band(E): Band Q1 based on (39/2⁻), 15765 keV, $\alpha=-1/2$. Configuration=[(1)22; 22] (2021Ru07), bands Q1 and Q2 considered as signature partners.

^f Band(e): Band Q2 based on (41/2⁻), 16755 keV, $\alpha=+1/2$ Configuration=[(1)22; 22] (2021Ru07), bands Q1 and Q2 considered as signature partners.

^g Band(F): Band Q3 based on (39/2⁻), 16695 keV, $\alpha=-1/2$. Configuration=[(1)22; (1)3₊2] (2021Ru07), bands Q3 and Q4 considered as signature partners.

^h Band(f): Band Q4 based on (41/2⁻), 17573 keV, $\alpha=+1/2$. Configuration=[(1)22; (1)3₊2] (2021Ru07), bands Q3 and Q4 considered as signature partners.

ⁱ Band(G): Band Q5 based on (41/2⁻), $\alpha=+1/2$. The band starts at 17642 keV, (41/2⁻) or 17661 keV, (41/2⁻). Configuration=[(1₊)22; (1₊)3₊2] (2021Ru07), bands Q5 and Q6 considered as signature partners.

^j Band(g): Band Q6 based on (41/2⁻), $\alpha=+1/2$. The band starts at 17705 keV, (41/2⁻) or 17755 keV, (41/2⁻). Configuration=[(1₋)22; (1₋)3₋2] (2021Ru07), bands Q5 and Q6 considered as signature partners.

^k Band(H): $\Delta J=2$ band Q7. Estimated energy of the bandhead=19000 keV (2021Ru07).

^l Band(I): $\Delta J=2$ band Q8. Estimated energy of the bandhead=20300 keV (2021Ru07).

^m Band(J): $\Delta J=2$ band Q9. Estimated energy of the bandhead=19200 keV (2021Ru07).

Adopted Levels, Gammas (continued)

$\gamma(^{63}\text{Ga})$

Additional information 5.

$E_i(\text{level})$	J_i^π	E_γ^\ddagger	I_γ^\ddagger	E_f	J_f^π	Mult.#	δ	α^\dagger	Comments
75.10	$(5/2)^-$	75.1 1	100	0.0	$3/2^-$	M1+E2	+0.25 5	0.26 5	$\alpha(\text{K})=0.23$ 4; $\alpha(\text{L})=0.028$ 5; $\alpha(\text{M})=0.0041$ 8 $\alpha(\text{N})=0.000186$ 30 B(M1)(W.u.) ≈ 0.0016 ; B(E2)(W.u.) ≈ 30 E_γ : weighted average of 75.0 1 from ^{63}Ge ε decay, 75.4 3 from ($^{28}\text{Si},\alpha p\gamma$), 75.4 3 from ($^{29}\text{Si},\alpha p n\gamma$), and 75.2 2 from ($^{32}\text{S},2\alpha p\gamma$). Other: 74.6 1 from ^{64}As εp decay is discrepant. Mult., δ : D+Q from $\gamma(\theta)$ and $\Delta J=1$ from $\gamma\gamma(\text{DCO})$ in ($^{29}\text{Si},\alpha p n\gamma$); E1+M2 ruled out by RUL.
442.76	$(3/2)^-$	367.5 1 442.9 2	19 6 100 11	75.10 0.0	$(5/2)^-$ $3/2^-$	(D+Q)			E_γ : from ^{63}Ge ε decay. Other: 368.0 4 from ($^{28}\text{Si},\alpha p\gamma$). E_γ : weighted average of 442.8 1 from ^{63}Ge ε decay, 443.3 2 from ($^{28}\text{Si},\alpha p\gamma$), and 443.1 2 from ($^{32}\text{S},2\alpha p\gamma$). Mult.: $\Delta J=(0)$ from $\gamma\gamma(\text{DCO})$ in ($^{28}\text{Si},\alpha p\gamma$). I_γ : weighted average of 6.9 35 from ($^{28}\text{Si},\alpha p\gamma$) and 8 4 from ($^{32}\text{S},2\alpha p\gamma$). E_γ : from ^{63}Ge ε decay. Other: 647.1 5 from ($^{28}\text{Si},\alpha p\gamma$). E_γ : from ^{63}Ge ε decay. Others: 722.2 2 from ($^{28}\text{Si},\alpha p\gamma$) and 722.2 2 from ($^{32}\text{S},2\alpha p\gamma$). E_γ : from ($^{32}\text{S},2\alpha p\gamma$). Others: 1077.2 5 from ($^{28}\text{Si},\alpha p\gamma$) and 1077.2 3 from ($^{29}\text{Si},\alpha p n\gamma$). E_γ : from ($^{32}\text{S},2\alpha p\gamma$). Other: 699.3 3 from ($^{28}\text{Si},\alpha p\gamma$). I_γ : unweighted average of 29.8 21 from ($^{28}\text{Si},\alpha p\gamma$) and 19.5 8 from ($^{32}\text{S},2\alpha p\gamma$). E_γ : from ($^{32}\text{S},2\alpha p\gamma$). Other: 978.6 4 from ($^{28}\text{Si},\alpha p\gamma$). I_γ : unweighted average of 27.0 14 from ($^{28}\text{Si},\alpha p\gamma$) and 17.9 8 from ($^{32}\text{S},2\alpha p\gamma$). E_γ : weighted average of 1421.6 6 from ($^{28}\text{Si},\alpha p\gamma$), 1422.0 5 from ($^{29}\text{Si},\alpha p n\gamma$), and 1422.6 2 from ($^{32}\text{S},2\alpha p\gamma$). I_γ : from ($^{28}\text{Si},\alpha p\gamma$). Other: 100 6 from ($^{32}\text{S},2\alpha p\gamma$). $\alpha(\text{K})=0.000339$ 5; $\alpha(\text{L})=3.41\times 10^{-5}$ 5; $\alpha(\text{M})=4.98\times 10^{-6}$ 7 $\alpha(\text{N})=2.68\times 10^{-7}$ 4 E_γ : from ($^{32}\text{S},2\alpha p\gamma$). Others: 624.7 3 from ($^{28}\text{Si},\alpha p\gamma$) and 624.6 5 from ($^{29}\text{Si},\alpha p n\gamma$). I_γ : unweighted average of 25.1 10 from ($^{28}\text{Si},\alpha p\gamma$) and 28.0 9 from ($^{32}\text{S},2\alpha p\gamma$).
722.33	$(5/2)^-$	279.2 4 647.4 1 722.2 1	7.4 35 69 24 100 14	442.76 75.10 0.0	$(3/2)^-$ $(5/2)^-$ $3/2^-$				
1152.33	$(9/2)^-$	1077.2 2	100	75.10	$(5/2)^-$	Q			
1421.58	$7/2^{(-)}$	699.3 2 978.4 2 1422.4 3	25 5 22 5 100 4	722.33 442.76 0.0	$(5/2)^-$ $(3/2)^-$ $3/2^-$	(D+Q) (Q) Q			
2046.16	$(9/2)^+$	624.6 2	26.6 15	1421.58	$7/2^{(-)}$	(E1)		0.000378 5	

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Adopted Levels, Gammas (continued)

 $\gamma(^{63}\text{Ga})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^\ddagger	I_γ^\ddagger	E_f	J_f^π	Mult. #	α^\dagger	Comments
								Others: 624.7 3 from ($^{28}\text{Si},\alpha\gamma$) and 624.6 5 from ($^{29}\text{Si},\alpha\text{pn}\gamma$). I_γ : unweighted average of 25.1 10 from ($^{28}\text{Si},\alpha\gamma$) and 28.0 9 from ($^{32}\text{S},2\alpha\gamma$). Mult.: D, $\Delta J=1$ from $\gamma\gamma(\text{DO})$ in ($^{28}\text{Si},\alpha\gamma$) and ($^{32}\text{S},2\alpha\gamma$); $\Delta\pi=(\text{yes})$ from level scheme.
2046.16	(9/2 ⁺)	893.8 2	100.0 33	1152.33	(9/2 ⁻)	(E1)	0.0001743 24	$\alpha(\text{K})=0.0001562$ 22; $\alpha(\text{L})=1.569\times 10^{-5}$ 22; $\alpha(\text{M})=2.292\times 10^{-6}$ 32 $\alpha(\text{N})=1.236\times 10^{-7}$ 17 E_γ : weighted average of 893.9 5 from ($^{28}\text{Si},\alpha\gamma$), 894.1 3 from ($^{29}\text{Si},\alpha\text{pn}\gamma$), and 893.7 2 from ($^{32}\text{S},2\alpha\gamma$). I_γ : from ($^{28}\text{Si},\alpha\gamma$) and ($^{32}\text{S},2\alpha\gamma$). Mult.: either Q with $\Delta J=2$ or D with $\Delta J=0$ from $\gamma\gamma(\text{DCO})$ in ($^{32}\text{S},2\alpha\gamma$) ($^{29}\text{Si},\alpha\text{pn}\gamma$); $\Delta J=(0)$ and $\Delta\pi=(\text{yes})$ from level scheme.
2940.27	(13/2 ⁺)	894.1 2	100	2046.16	(9/2 ⁺)	Q		E_γ : weighted average of 894.3 4 from ($^{28}\text{Si},\alpha\gamma$), 894.1 3 from ($^{29}\text{Si},\alpha\text{pn}\gamma$), and 894.0 2 from ($^{32}\text{S},2\alpha\gamma$). Mult.: also from $\gamma\gamma(\text{DCO})$ in ($^{32}\text{S},2\alpha\gamma$). E_γ : weighted average of 1139.8 4 from ($^{28}\text{Si},\alpha\gamma$), 1139.4 3 from ($^{29}\text{Si},\alpha\text{pn}\gamma$), and 1139.9 2 from ($^{32}\text{S},2\alpha\gamma$). E_γ : weighted average of 2304.2 16 from ($^{28}\text{Si},\alpha\gamma$) and 2306.0 7 from ($^{32}\text{S},2\alpha\gamma$). E_γ : from ($^{32}\text{S},2\alpha\gamma$). Other: 1635.4 8 from ($^{28}\text{Si},\alpha\gamma$). E_γ : weighted average of 608.6 6 from ($^{28}\text{Si},\alpha\gamma$) and 609.6 3 from ($^{32}\text{S},2\alpha\gamma$). I_γ : weighted average of 1.04 26 from ($^{28}\text{Si},\alpha\gamma$) and 1.25 14 from ($^{32}\text{S},2\alpha\gamma$). E_γ : weighted average of 1772.2 7 from ($^{28}\text{Si},\alpha\gamma$), 1772.8 3 from ($^{29}\text{Si},\alpha\text{pn}\gamma$), and 1772.3 2 from ($^{32}\text{S},2\alpha\gamma$). I_γ : from ($^{32}\text{S},2\alpha\gamma$). Other: 100 4 from ($^{28}\text{Si},\alpha\gamma$). Mult.: D from $\gamma\gamma(\text{DCO})$ in ($^{28}\text{Si},\alpha\gamma$); 2001We11 in ($^{32}\text{S},2\alpha\gamma$) show that their measured $\gamma\gamma(\theta)(\text{DCO})$ is best fitted with a calculation with $\delta=-0.3$ 2 which is compatible with E1.
4080.25	(17/2 ⁺)	1139.8 2	100	2940.27	(13/2 ⁺)	Q		
5243.9		2305.7 7	100	2940.27	(13/2 ⁺)			
5715.38	(21/2 ⁺)	1634.9 2	100	4080.25	(17/2 ⁺)	Q		
5852.64	(19/2 ⁻)	609.4 4	1.20 14	5243.9				
		1772.4 2	100.0 31	4080.25	(17/2 ⁺)	(E1)		
6501.25	(23/2 ⁻)	648.8 2	100.0 31	5852.64	(19/2 ⁻)	Q		
		785.7 2	8.9 9	5715.38	(21/2 ⁺)	D		E_γ : from ($^{32}\text{S},2\alpha\gamma$). Other: 100.0 34 from ($^{28}\text{Si},\alpha\gamma$). E_γ : from ($^{32}\text{S},2\alpha\gamma$). Other: 785.8 3 from ($^{28}\text{Si},\alpha\gamma$). I_γ : unweighted average of 9.8 7 from ($^{28}\text{Si},\alpha\gamma$) and 8.00 25 from ($^{32}\text{S},2\alpha\gamma$).
7334.8	(21/2)	3255.1 22	100	4080.25	(17/2 ⁺)			
7656.2	(23/2)	1154.4 8	100 8	6501.25	(23/2 ⁻)	(D+Q)		E_γ : unweighted average of 1155.2 6 from ($^{28}\text{Si},\alpha\gamma$) and 1153.6 2 from ($^{32}\text{S},2\alpha\gamma$).

Adopted Levels, Gammas (continued) $\gamma(^{63}\text{Ga})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^{\ddagger}	I_γ^{\ddagger}	E_f	J_f^π	Mult.#	δ	Comments
7656.2	(23/2)	1804.0 @ 11	46 8	5852.64	(19/2 ⁻)			
7710.15	(27/2 ⁻)	1208.9 2	100	6501.25	(23/2 ⁻)	Q		E_γ : from (³² S,2 $\alpha\gamma$). Others: 1209.1 4 from (²⁸ Si, $\alpha\gamma$) and 1208.8 5 from (²⁹ Si, $\alpha\text{pn}\gamma$).
7912.3	(25/2 ⁻)	1412.0 14	100	6501.25	(23/2 ⁻)	D+Q		E_γ : unweighted average of 1410.6 6 from (²⁸ Si, $\alpha\gamma$) and 1413.4 3 from (³² S,2 $\alpha\gamma$).
8213.3	(25/2)	878.5 2	65 8	7334.8	(21/2)			E_γ : weighted average of 878.9 6 from (²⁸ Si, $\alpha\gamma$) and 878.4 2 from (³² S,2 $\alpha\gamma$). I_γ : other: $I_\gamma(878.5\gamma)/I_\gamma(2497.5\gamma)=100\ 6/27\ 9$ from (³² S,2 $\alpha\gamma$) is discrepant.
		1712.4 8	31 8	6501.25	(23/2 ⁻)			E_γ : not seen in (³² S,2 $\alpha\gamma$).
		2497.5 6	100 12	5715.38	(21/2 ⁺)			E_γ : weighted average of 2497.9 12 from (²⁸ Si, $\alpha\gamma$) and 2497.4 6 from (³² S,2 $\alpha\gamma$).
8856.7	(27/2)	1146.8 8	100 8	7710.15	(27/2 ⁻)	(D+Q)		
		1200.2 8	74 8	7656.2	(23/2)	(Q)		
9039.9	(31/2 ⁻)	1329.7 2	100	7710.15	(27/2 ⁻)	Q		E_γ : from (³² S,2 $\alpha\gamma$). Other: 1329.6 5 from (²⁸ Si, $\alpha\gamma$).
9254.8	(29/2 ⁻)	1343.0 11	38 4	7912.3	(25/2 ⁻)			E_γ : unweighted average of 1344.0 8 from (²⁸ Si, $\alpha\gamma$) and 1341.9 5 from (³² S,2 $\alpha\gamma$).
		1544.8 4	100.0 35	7710.15	(27/2 ⁻)	Q+D	>1	I_γ : weighted average of 42 4 from (²⁸ Si, $\alpha\gamma$) and 34.5 35 from (³² S,2 $\alpha\gamma$). E_γ : weighted average of 1545.6 7 from (²⁸ Si, $\alpha\gamma$) and 1544.7 3 from (³² S,2 $\alpha\gamma$).
								I_γ : from (³² S,2 $\alpha\gamma$). Other: 100 6 from (²⁸ Si, $\alpha\gamma$).
9482.6	(29/2)	1269.2 2	76 6	8213.3	(25/2)	Q		E_γ : from (³² S,2 $\alpha\gamma$). Other: 1269.2 6 from (²⁸ Si, $\alpha\gamma$).
		1773.0 10	100 13	7710.15	(27/2 ⁻)	(D)		
10161.3?	(31/2)	1304.6 2	100	8856.7	(27/2)	(Q)		E_γ : from (³² S,2 $\alpha\gamma$). Other: 1304.2 10 from (²⁸ Si, $\alpha\gamma$). Ordering of the 1812-1305 γ cascade from 11974 level could be reversed (2021Ru07).
10868.7	(35/2 ⁻)	1828.7 3	100	9039.9	(31/2 ⁻)	Q		E_γ : weighted average of 1829.8 8 from (²⁸ Si, $\alpha\gamma$) and 1828.6 2 from (³² S,2 $\alpha\gamma$).
10908.3	(33/2)	1425.8 9	56 8	9482.6	(29/2)	Q		E_γ : unweighted average of 1424.9 7 from (²⁸ Si, $\alpha\gamma$) and 1426.6 2 from (³² S,2 $\alpha\gamma$).
		1868.3 2	100.0 33	9039.9	(31/2 ⁻)	(D)		I_γ : unweighted average of 63 5 from (²⁸ Si, $\alpha\gamma$) and 48 5 from (³² S,2 $\alpha\gamma$). E_γ : from (³² S,2 $\alpha\gamma$). Other: $E_\gamma=1867.3\ 9$, $I_\gamma=100\ 5$ from (²⁸ Si, $\alpha\gamma$). Mult.: $\Delta J=1$ transition from $\gamma\gamma(\text{DCO})$ in (²⁸ Si, $\alpha\gamma$); α asymmetry from (³² S,2 $\alpha\gamma$) is also consistent with $\Delta J=1$.
10980.1	(33/2 ⁻)	1725.6 4	59 9	9254.8	(29/2 ⁻)	Q		E_γ : weighted average of 1726.3 9 from (²⁸ Si, $\alpha\gamma$) and 1725.4 4 from (³² S,2 $\alpha\gamma$).
		1939.7 5	100 5	9039.9	(31/2 ⁻)	Q+D	>1	I_γ : unweighted average of 68 5 from (²⁸ Si, $\alpha\gamma$) and 50 5 from (³² S,2 $\alpha\gamma$). E_γ : weighted average of 1941.2 9 from (²⁸ Si, $\alpha\gamma$) and 1939.5 3 from (³² S,2 $\alpha\gamma$).
								I_γ : from (³² S,2 $\alpha\gamma$). Other: 100 7 from (²⁸ Si, $\alpha\gamma$).

Adopted Levels, Gammas (continued)

 $\gamma(^{63}\text{Ga})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^\ddagger	I_γ^\ddagger	E_f	J_f^π	Mult. #	δ	Comments
11972.9	(35/2)	1811.6 4	100	10161.3?	(31/2)			E_γ : weighted average of 1812.7 10 from ($^{28}\text{Si},\alpha\gamma$) and 1811.5 3 from ($^{32}\text{S},2\alpha\gamma$).
12736.7	(37/2 ⁻)	1756.4 8	71 5	10980.1	(33/2 ⁻)	Q		E_γ : other: 1763.5 3 from ($^{32}\text{S},2\alpha\gamma$) is discrepant. I_γ : $I_\gamma(1763.5\gamma)/I_\gamma(1864.0\gamma)=100\ 5/93\ 5$ is discrepant.
12832.6	(37/2)	1868.2 9 1924.8 9	100 5 100 5	10868.7 10908.3	(35/2 ⁻) (33/2)	Q+D Q	>1	E_γ : other: 1864.0 3 from ($^{32}\text{S},2\alpha\gamma$) is discrepant. E_γ : correspond to the 1921.9 γ +1924.3 γ doublet for a peak structure at around 1922 reported by 2001We11 in ($^{32}\text{S},2\alpha\gamma$). No doublet around this energy is reported by 2021Ru07 in ($^{28}\text{Si},\alpha\gamma$). See more detailed comments regarding this γ doublet as well as a level doublet of 12831+12832 reported by 2001We11 from placements of the doublet transitions.
		1963.4 10	18.8 21	10868.7	(35/2 ⁻)	(D)		E_γ ,Mult.: 2001We11 in ($^{32}\text{S},2\alpha\gamma$) report a $E_\gamma=1963.6\ 2$ with Mult=Q based on γ asymmetry, which may correspond to the doublet of the 1963.4 γ from 12833 level and the stronger 1962.7 γ with Mult=(Q) from 19538 level reported by 2021Ru07 in ($^{28}\text{Si},\alpha\gamma$). 1963.4 γ here has $\Delta J=(1)$ from level scheme, which is inconsistent with Mult=Q assigned for 1963.6 γ in ($^{32}\text{S},2\alpha\gamma$).
14212.4	(39/2)	3343.4 22	100	10868.7	(35/2 ⁻)			
14463.8	(41/2)	1631.1 2	100	12832.6	(37/2)	Q		E_γ : weighted average of 1631.9 8 from ($^{28}\text{Si},\alpha\gamma$) and 1631.0 2 from ($^{32}\text{S},2\alpha\gamma$).
14541.6	(39/2)	3671.9 31	100	10868.7	(35/2 ⁻)			
15764.8	(39/2 ⁻)	4895.9 38	100	10868.7	(35/2 ⁻)	(Q)		
16634.1		3801.3 25	100	12832.6	(37/2)			
16695	(39/2 ⁻)	1555.1 @ 12	167 33	15140?	(35/2 ⁻)			
		5825.6 56	100 17	10868.7	(35/2 ⁻)	(Q)		
16754.6	(41/2 ⁻)	2213.0 4	24 4	14541.6	(39/2)			E_γ : from ($^{32}\text{S},2\alpha\gamma$), placed by 2001We11 as the only transition from a 13039 level which is not confirmed by 2021Ru07 in ($^{28}\text{Si},\alpha\gamma$). Other: 2214.2 20 from ($^{28}\text{Si},\alpha\gamma$).
		4018.5 28	100 8	12736.7	(37/2 ⁻)	(Q)		This transition is much stronger than 2214.2 γ as reported in 2021Ru07 , but is not seen in 2001We11 , probably due to detector threshold, since no transitions above 2497 keV are reported in 2001We11 .
17170.8		2707.0 19	100	14463.8	(41/2)			
17192.1	(43/2)	2728.4 17	100 11	14463.8	(41/2)	(D)		
		2979.3 22	21 11	14212.4	(39/2)			
17477.9		3014.1 18	100	14463.8	(41/2)			
17573.3	(41/2 ⁻)	4836.4 42	100	12736.7	(37/2 ⁻)			
17641.6	(41/2 ⁻)	4903.7 41	100	12736.7	(37/2 ⁻)	(Q)		
17660.1	(41/2 ⁻)	4924.1 40	100	12736.7	(37/2 ⁻)	(Q)		
17705.0	(41/2 ⁻)	4968.3 51	100	12736.7	(37/2 ⁻)	(Q)		
17754.1	(41/2 ⁻)	5016.9 55	100	12736.7	(37/2 ⁻)	(Q)		
18089.5	(43/2 ⁻)	1662.3 @ 11	30 4	16427.1?	(39/2 ⁻)			
		1792.1 11	74 9	16297.3	(39/2 ⁻)	(Q)		
		2324.6 13	100 9	15764.8	(39/2 ⁻)	(Q)		

Adopted Levels, Gammas (continued)

$\gamma(^{63}\text{Ga})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^\ddagger	I_γ^\ddagger	E_f	J_f^π	Mult. #
18451.8		3987.9 27	100	14463.8	(41/2)	
18523	(43/2 ⁻)	1828.8 12	100	16695	(39/2 ⁻)	
18930.8	(45/2 ⁻)	2176.1 13	100	16754.6	(41/2 ⁻)	(Q)
19033.9		2399.8 18	100	16634.1		
19536.0	(45/2 ⁻)	1962.7 13	100	17573.3	(41/2 ⁻)	(Q)
19701.1	(45/2 ⁻)	2041.1 12	100 15	17660.1	(41/2 ⁻)	
		2059.4 13	85 15	17641.6	(41/2 ⁻)	(Q)
19763.4	(45/2 ⁻)	2009.3 14	100 29	17754.1	(41/2 ⁻)	(Q)
		2058.4 13	71 29	17705.0	(41/2 ⁻)	(Q)
20099.9	(47/2 ⁻)	2010.4 13	100	18089.5	(43/2 ⁻)	(Q)
20625	(47/2 ⁻)	2101.6 13	100	18523	(43/2 ⁻)	(Q)
21375.6	(49/2 ⁻)	2444.8 17	100	18930.8	(45/2 ⁻)	(Q)
21806	(49/2 ⁻)	2269.6 14	100	19536.0	(45/2 ⁻)	(Q)
22071.6	(49/2 ⁻)	2370.4 13	100	19701.1	(45/2 ⁻)	(Q)
22114.2	(49/2 ⁻)	2350.7 13	100	19763.4	(45/2 ⁻)	
22612	(51/2 ⁻)	2512.0 16	100	20099.9	(47/2 ⁻)	(Q)
23069	(51/2 ⁻)	2444.2 15	100	20625	(47/2 ⁻)	(Q)
24234.3	(53/2 ⁻)	2858.6 19	100	21375.6	(49/2 ⁻)	
24454	(53/2 ⁻)	2648.3 15	100	21806	(49/2 ⁻)	(Q)
24795.5	(53/2 ⁻)	2681.3 16	100	22114.2	(49/2 ⁻)	(Q)
24899.9	(53/2 ⁻)	2828.3 17	100	22071.6	(49/2 ⁻)	
25952	(55/2 ⁻)	2882.6 18	100	23069	(51/2 ⁻)	
25987?	(55/2 ⁻)	3374.6 @ 29	100	22612	(51/2 ⁻)	
27612	(57/2 ⁻)	3158.1 19	100	24454	(53/2 ⁻)	
27869	(57/2 ⁻)	3072.9 23	100	24795.5	(53/2 ⁻)	
28122.3	(57/2 ⁻)	3222.3 21	100	24899.9	(53/2 ⁻)	
29439?	(59/2 ⁻)	3486.8 @ 26	100	25952	(55/2 ⁻)	
31328?	(61/2 ⁻)	3459.0 @ 29	100	27869	(57/2 ⁻)	
2191.2+x	J1+2	2191.2 13	100	x	J1	
4661.7+x	J1+4	2433.8 @ 15	39 6	2227.8+x?		
		2470.4 14	100 11	2191.2+x	J1+2	
7339.2+x	J1+6	2677.4 16	100	4661.7+x	J1+4	(Q)
10254.2+x	J1+8	2915.0 17	100	7339.2+x	J1+6	(Q)
13502.9+x	J1+10	3248.6 22	100	10254.2+x	J1+8	
2327.1+y	J2+2	2327.0 14	100	y	J2	
4896.3+y	J2+4	2569.2 15	100	2327.1+y	J2+2	(Q)
7673.0+y	J2+6	2776.6 16	100	4896.3+y	J2+4	(Q)
10743.7+y	J2+8	3070.6 20	100	7673.0+y	J2+6	
14206.8+y	J2+10	3463.0 24	100	10743.7+y	J2+8	
2200.0+z	J3+2	2200.0 @ 19	100	z?	J3	
4645.0+z	J3+4	2444.9 16	100	2200.0+z	J3+2	(Q)

Adopted Levels, Gammas (continued)

$\gamma(^{63}\text{Ga})$ (continued)

<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}[‡]</u>	<u>I_{γ}[‡]</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.[#]</u>
7350.6+z	J3+6	2705.5 17	100	4645.0+z	J3+4	
10382.4+z	J3+8	3031.8 21	100	7350.6+z	J3+6	(Q)
13792+z	J3+10	3409.3 44	100	10382.4+z	J3+8	

[†] [Additional information 6.](#)

[‡] From (²⁸Si, $\alpha\gamma$), unless otherwise noted.

[#] From measured $\gamma\gamma$ (DCO) in (²⁸Si, $\alpha\gamma$), unless otherwise noted.

[@] Placement of transition in the level scheme is uncertain.

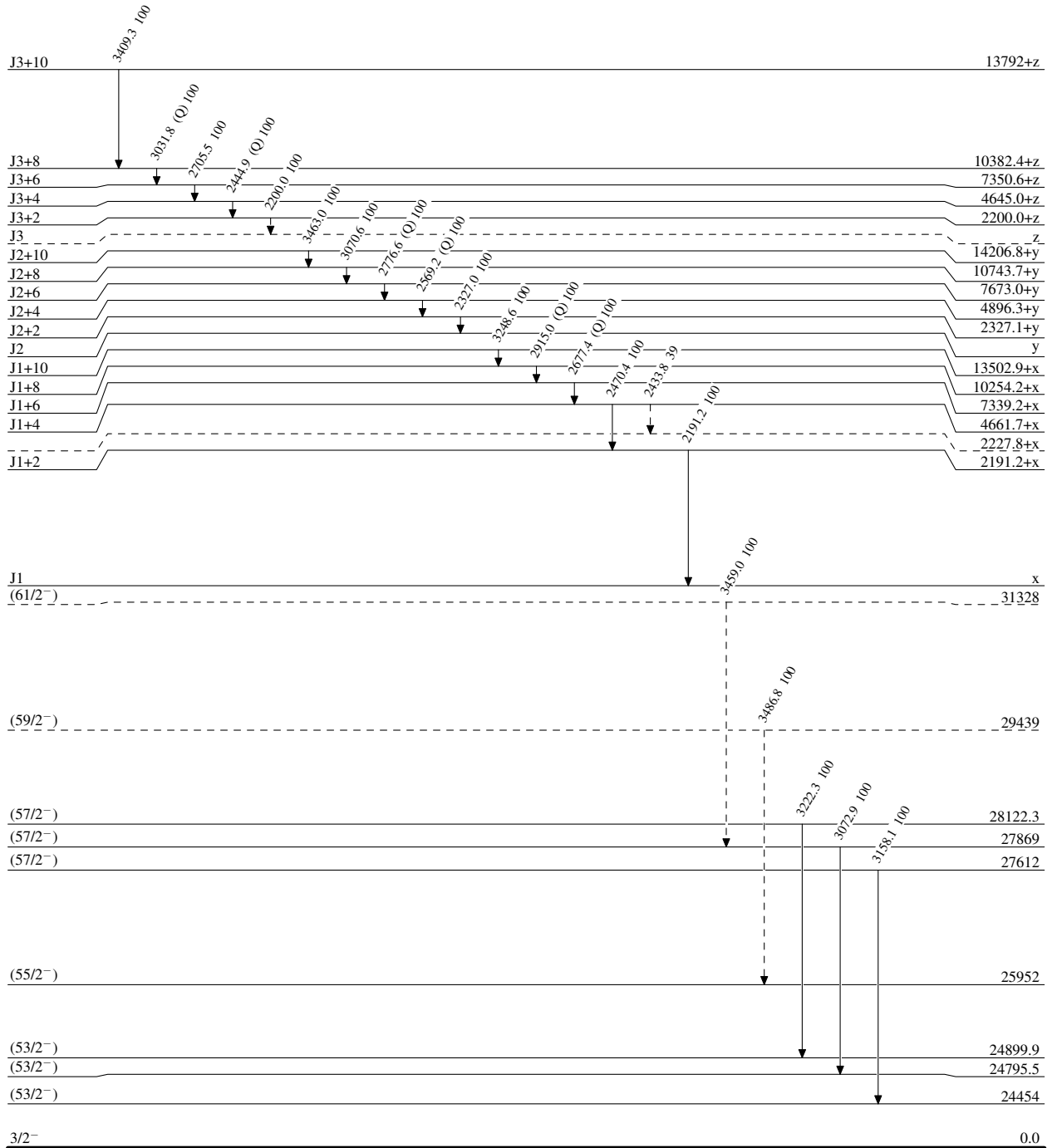
Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

-----▶ γ Decay (Uncertain)



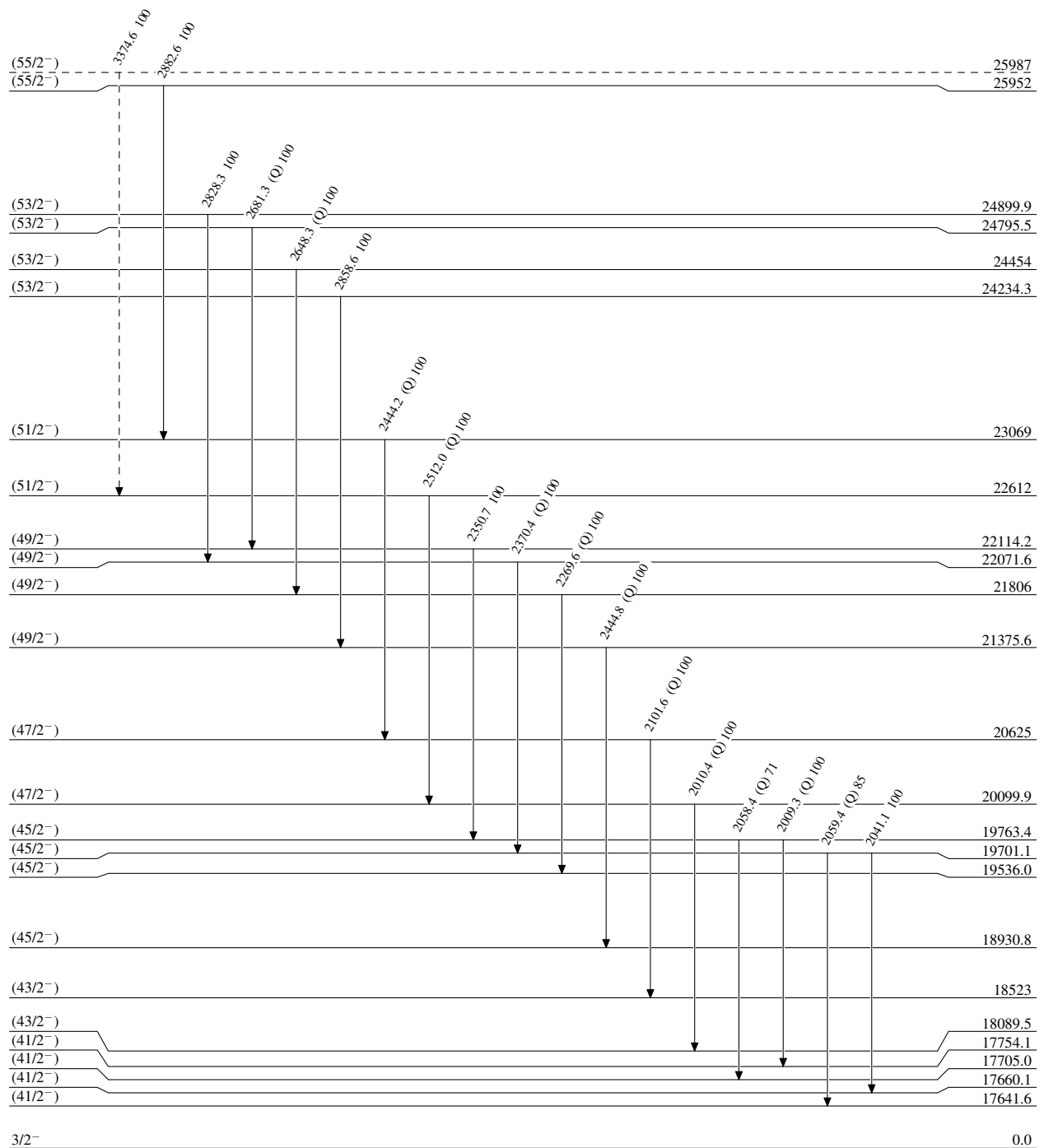
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

-----▶ γ Decay (Uncertain)



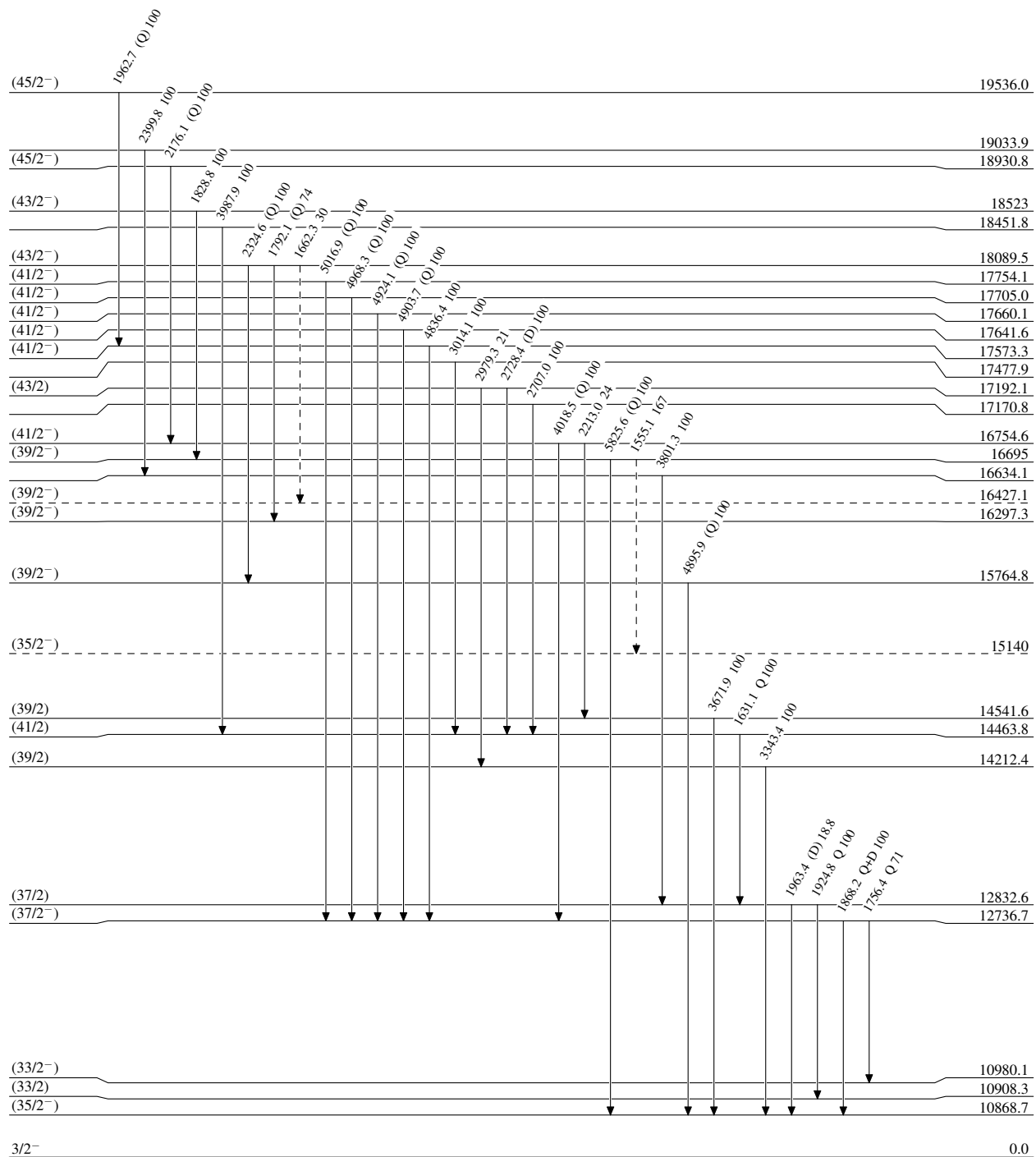
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

-----▶ γ Decay (Uncertain)



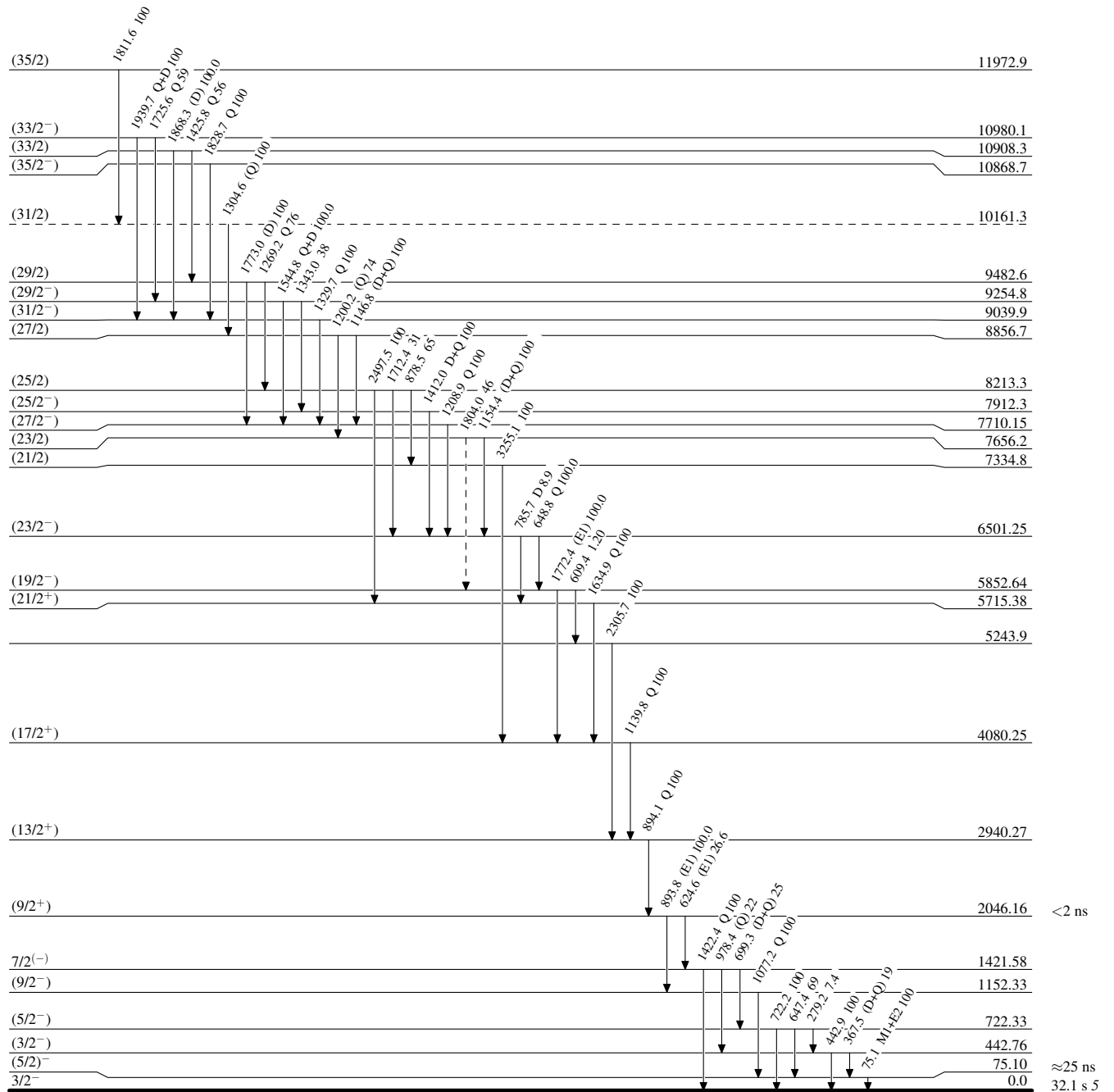
Adopted Levels, Gammas

Legend

Level Scheme (continued)

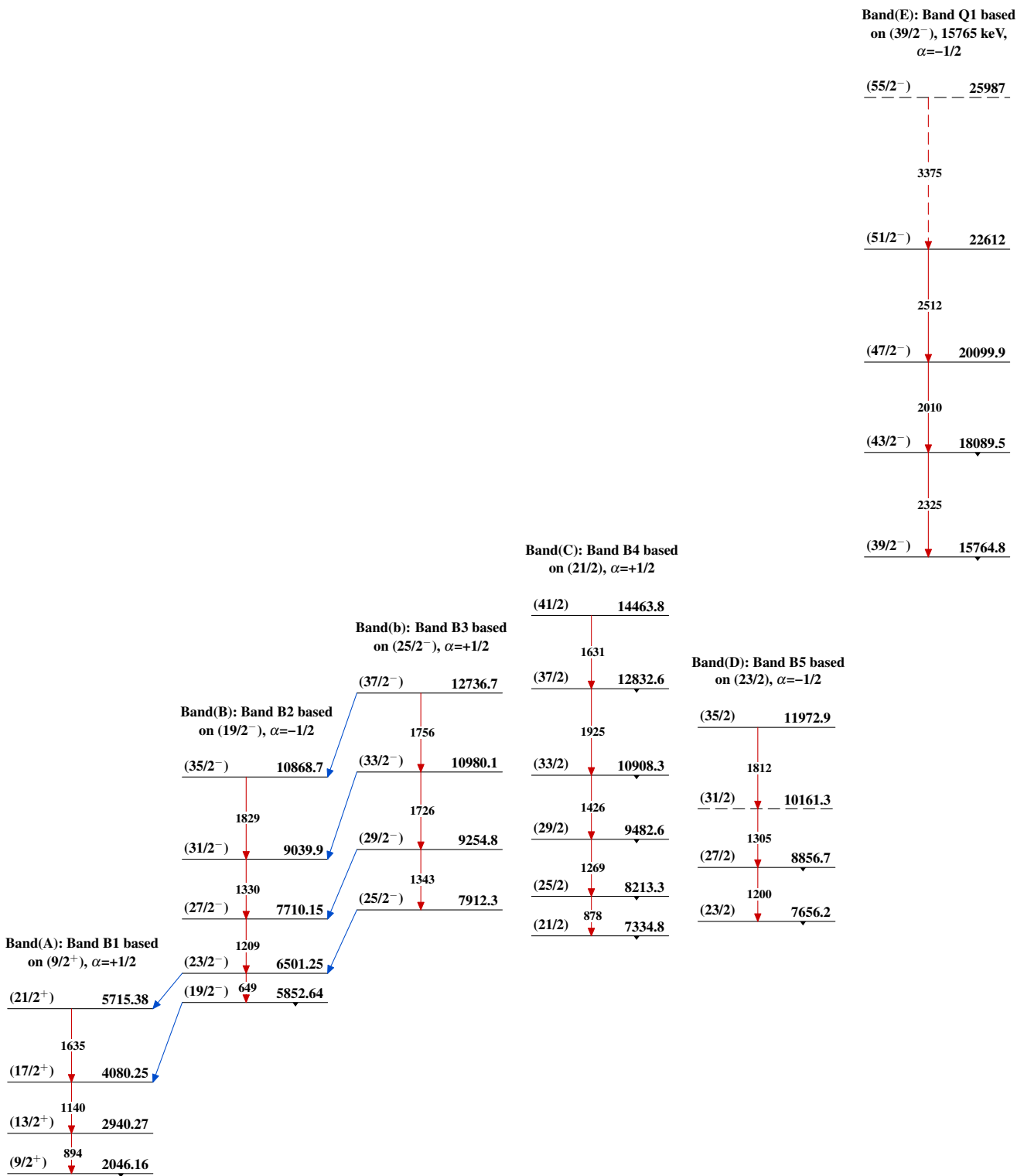
Intensities: Relative photon branching from each level

-----▶ γ Decay (Uncertain)

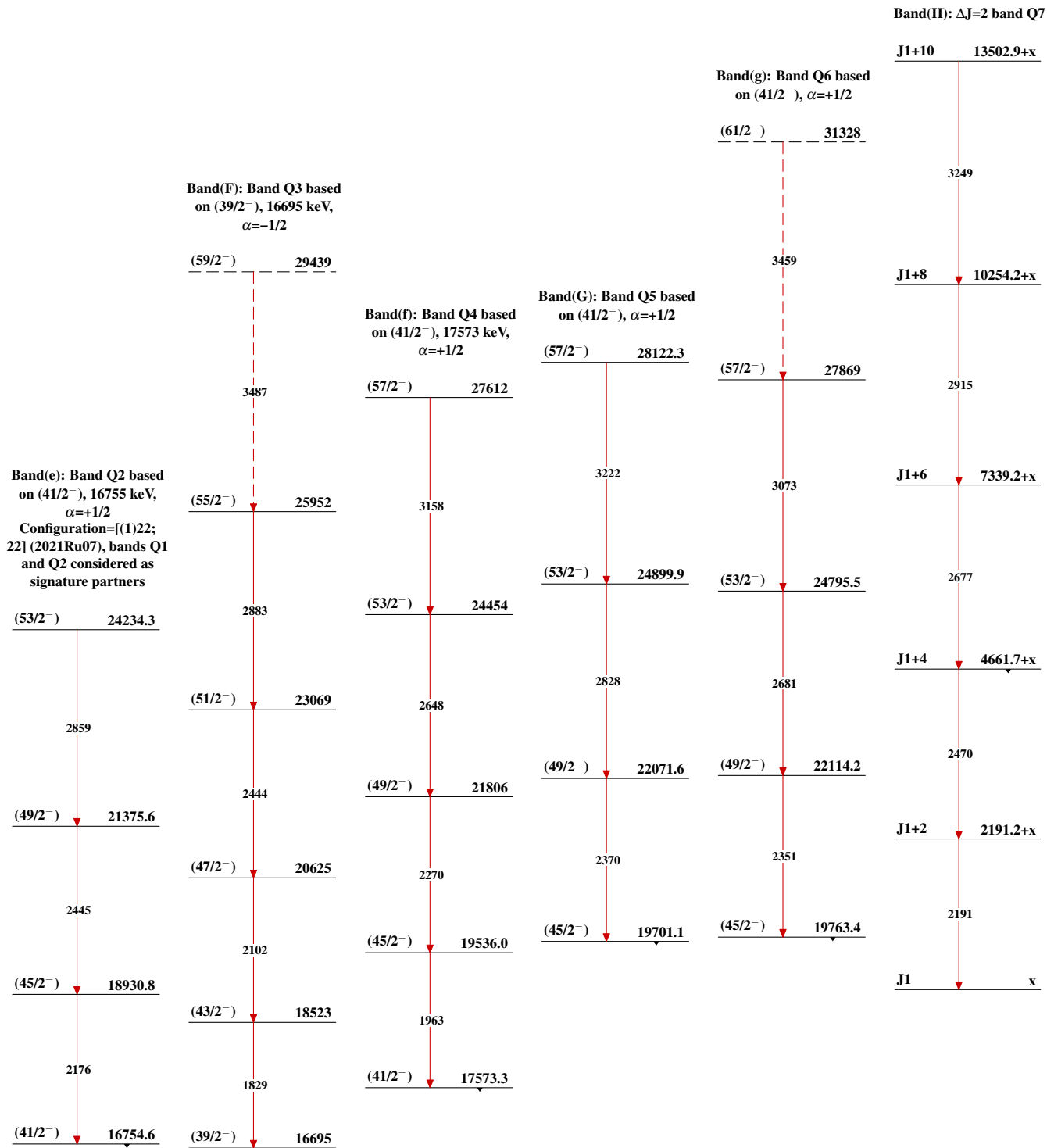


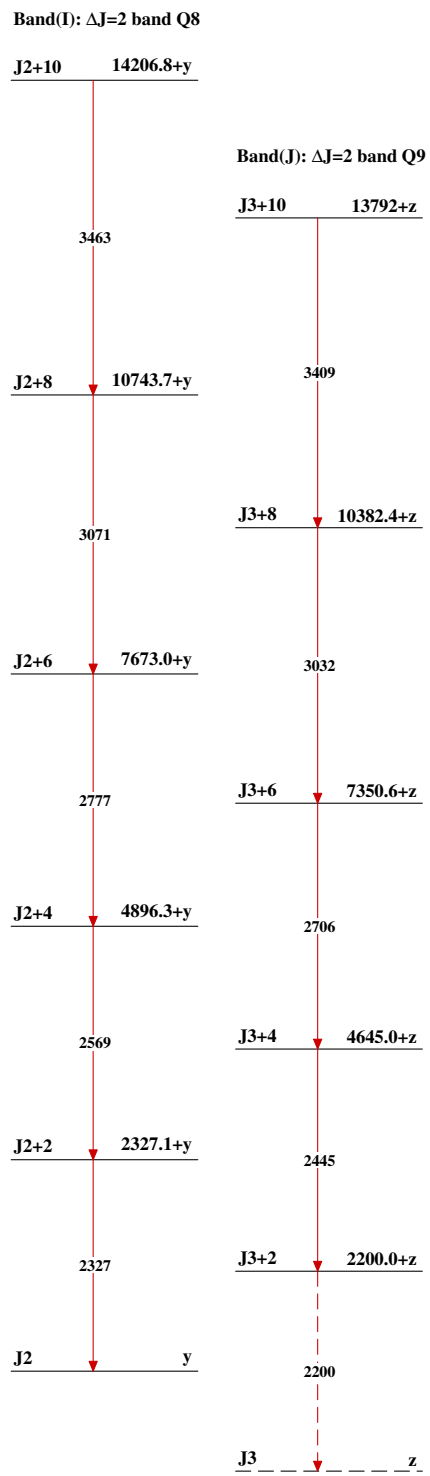
⁶³Ga₃₂

Adopted Levels, Gammas



Adopted Levels, Gammas (continued)



Adopted Levels, Gammas (continued) ${}^{63}_{31}\text{Ga}_{32}$