Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	ENSDF	30-Nov-2021

Q(β^-)=−9025 *25*; S(n)=13796 *6*; S(p)=1997 *5*; Q(α)=−3540 *6* 2021Wa16
Q(ε)=7620 *5*, Q(εp)=1490 *60*, S(2n)=25847 *6*, S(2p)=8098 *8* (2021Wa16).
Two activities in ^{89}Tc isotope produced and identified by 1981OxZZ (also 1983OxZZ) in bombardment of ^{92}Mo by protons; and by 1991He04 in bombardment of Ni by ^{32}S beam.
Measured mass excess of ^{89}Tc: 2008We10 using JYFLTRAP and SHIPTRAP.

^{89}Tc Levels

Detailed particle-hole shell model configurations are given by 1995Ru03 for levels above 1700. For positive-parity states, multi-particle configurations involve $\pi g_{9/2}$ and $\nu g_{9/2}$ and for negative-parity states, $\pi p_{1/2}$, $\pi g_{9/2}$, $\nu g_{9/2}$ and $\nu p_{1/2}$ orbitals. Based on calculations by 1995Ru03, levels above 2300 are interpreted as shell-model states, whereas, those at lower energy are likely to have collective components. See also 1997He24 for structure calculations.

Cross Reference (XREF) Flags

- A ^{89}Ru ε decay (1.32 s)
- B ^{90}Rh εp decay (0.56 s)
- C ^{58}Ni(^{40}Ca,p2$\alpha\gamma$)

E(level)	J$^\pi$[†]	$T_{1/2}$	XREF	Comments
0.0[#]	(9/2$^+$)	12.8 s *9*	ABC	%ε+%β^+=100 $T_{1/2}$: from time decay of 119γ (1991He04). Other: 20 s *4* for a single activity (1983OxZZ,1981OxZZ, average of 17 s *5* for 119γ; 23 s *5* for 269γ). Configuration=$\pi g_{9/2}$ (1995Ru03).
62.6 *5*	(1/2$^-$)	12.9 s *8*	C	%ε+%β^+=100; %IT<0.01 %IT<0.01 from RUL(E4)=100. $T_{1/2}$: from decay curve for 269γ (1991He04). Other: 20 s *4* for a single activity (1983OxZZ,1981OxZZ, average of 17 s *5* for 119γ; 23 s *5* for 269γ). Configuration=$\pi p_{1/2}$ (1995Ru03).
179.2 *1*	(7/2$^+$)		A C	
401.6 *4*	(5/2$^+$)[‡]		A	
790.0? *4*	(5/2$^-$)		C	E(level): energy is uncertain since ordering of 542γ-727γ is not established.
795.9[#] *1*	(13/2$^+$)	<8.3 ps	BC	$T_{1/2}$: from recoil-distance Doppler shift (1995Za11).
998.3 *2*	(7/2$^-$)		C	
1014.6 *4*	(7/2$^+$)[‡]		A	
1101.3 *2*	(11/2$^+$)		C	
1331.9? *3*	(9/2$^-$)		C	E(level): energy is uncertain since ordering of 565γ-542γ is not established.
1518.2 *5*	(5/2$^+$)[‡]		A	
1682.1 *2*	(11/2$^-$)		C	
1731.8[#] *2*	(17/2$^+$)	<9.0 ps	C	$T_{1/2}$: from recoil-distance Doppler shift (1995Za11).
1896.9 *2*	(13/2$^-$)		C	
2031.9 *2*	(17/2$^+$)		C	
2043.6 *3*	(15/2$^+$)		C	
2320.5 *2*	(17/2$^-$)		C	
2427.1[#] *2*	(21/2$^+$)	<26 ps	C	$T_{1/2}$: from recoil-distance Doppler shift (1995Za11).
2530.5 *3*	(17/2$^-$)		C	
2923.8 *3*	(19/2$^-$)		C	
3103.5 *2*	(23/2$^+$)		C	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{89}Tc Levels (continued)

E(level)	Jπ†	XREF	Comments
3112.8 *2*	(21/2⁻)	C	
3217.7# *2*	(25/2⁺)	C	
3311.4 *4*	(21/2⁻)	C	
4065.2 *2*	(25/2⁻)	C	
4224.0? *3*	(25/2⁻)	C	E(level): energy is uncertain since ordering of 490γ-913γ is not established.
4243.2# *2*	(29/2⁺)	C	
4713.6 *3*	(27/2⁻)	C	
4942.3 *3*	(29/2⁻)	C	
5113.8 *3*	(29/2⁻)	C	
5329.2# *2*	(33/2⁺)	C	
5332.1 *3*	(31/2⁻)	C	
5650.9 *3*	(33/2⁻)	C	
6190.5 *3*	(35/2⁺)	C	
6413.7 *3*	(35/2⁻)	C	
6545.9# *3*	(37/2⁺)	C	
6612.0 *4*	(37/2⁻)	C	
7011.3? *3*	(37/2⁺)	C	E(level): energy is uncertain since ordering of 391γ-821γ is not established.
7402.1 *3*	(39/2⁺)	C	
7765.7 *4*	(41/2⁻)	C	
7772.0# *4*	(41/2⁺)	C	
9109.8# *7*	(45/2⁺)	C	
9163.2 *6*	(45/2⁻)	C	
x@	J≈(35/2⁻)	C	
1149.2+x@ *3*	J+2	C	
2408.1+x@ *4*	J+4	C	
3792.4+x@ *4*	J+6	C	
5313.6+x@ *4*	J+8	C	
6981.7+x@ *4*	J+10	C	
8800.6+x@ *4*	J+12	C	
10775.2+x@ *4*	J+14	C	
12911.2+x@ *4*	J+16	C	
15209.6+x@ *4*	J+18	C	
17671.6+x@ *17*	J+20	C	
20291+x?@ *4*	J+22	C	

† From 1995Ru03 unless otherwise stated. These are based on systematics of nuclides in this mass region. The g.s. and 62.6 are identified with $\pi g_{9/2}$ and $\pi p_{1/2}$ configurations. The assignments for higher states are based on $\gamma\gamma(\theta)$(DCO) data with the assumption of mult=E2 for ΔJ=2, mult=M1+E2 for ΔJ=1, admixed transitions, and mult=E1 for ΔJ=1 transitions. It is also assumed that spins ascend with excitation energy in yrast-type pattern of level population in heavy-ion reactions.

‡ Tentative assignments proposed by 2019Pa16 in ^{89}Ru ε decay, based on shell-model calculations.

Band(A): Yrast sequence.

@ Band(B): SD band. Band assignment from 1999Ce09, 2003La24 and 2004La21. Q(intrinsic)=5.9 *+7−5* (2003La24), 6.7 *+30−23* (1999Ce09). Values of β_2≈0.65 and γ≈12° reproduce measured Q(transition) and dynamic moment of inertia plot (2003La24). Percent population=15% of the reaction channel (1999Ce09). Configuration=$\pi 5^1 \nu 5^2$; π=−, α=−1/2 (1999Ce09).

Adopted Levels, Gammas (continued)

γ(^{89}Tc)

Experimental branching ratios are compared with those calculated from shell-model (see Table 4 in 1995Ru03).

E_i(level)	J_i^π	E_γ[†]	I_γ[#]	E_f	J_f^π	Mult.[@]	Comments
179.2	(7/2$^+$)	179.2 *1*	100	0.0	(9/2$^+$)	D+Q	E_γ: same value in ^{89}Ru ε decay and ^{58}Ni(^{40}Ca,p2αγ).
401.6	(5/2$^+$)	401.6[‡] *4*	100	0.0	(9/2$^+$)		
790.0?	(5/2$^-$)	727.4 *3*	100	62.6	(1/2$^-$)		
795.9	(13/2$^+$)	795.9 *1*	100	0.0	(9/2$^+$)	E2	E_γ: from ^{58}Ni(^{40}Ca,p2αγ). Other: 797.7 *17* in ^{90}Rh εp decay. Mult.: ΔJ=2, Q from DCO, RUL(for E2 amd M2) gives E2.
998.3	(7/2$^-$)	819.1 *1*	100	179.2	(7/2$^+$)		
1014.6	(7/2$^+$)	835.4[‡] *4*	100	179.2	(7/2$^+$)		
1101.3	(11/2$^+$)	922.0 *4*	79 *11*	179.2	(7/2$^+$)	Q	
		1101.3 *3*	100 *11*	0.0	(9/2$^+$)	D+Q	
1331.9?	(9/2$^-$)	541.9 *2*	100	790.0?	(5/2$^-$)	Q	
1518.2	(5/2$^+$)	1339.0[‡] *5*	100	179.2	(7/2$^+$)		
1682.1	(11/2$^-$)	683.7 *1*	100	998.3	(7/2$^-$)	Q	
1731.8	(17/2$^+$)	935.9 *1*	100	795.9	(13/2$^+$)	E2	Mult.: ΔJ=2, Q from DCO, RUL(for E2 amd M2) gives E2.
1896.9	(13/2$^-$)	214.8 *1*	100 *5*	1682.1	(11/2$^-$)	D+Q	
		565.0 *2*	23 *5*	1331.9?	(9/2$^-$)	Q	
2031.9	(17/2$^+$)	299.9 *2*	33 *21*	1731.8	(17/2$^+$)		
		1236.3 *3*	100 *21*	795.9	(13/2$^+$)		
2043.6	(15/2$^+$)	942.3 *4*	100 *27*	1101.3	(11/2$^+$)	Q	
		1248.5 *6*	52 *27*	795.9	(13/2$^+$)		
2320.5	(17/2$^-$)	276.9 *2*	21 *2*	2043.6	(15/2$^+$)	D	Mult.: DJ=1, D+Q or D from DCO, assumed (E1) from level scheme.
		423.5 *2*	100 *4*	1896.9	(13/2$^-$)	Q	
2427.1	(21/2$^+$)	395.3 *2*	12 *1*	2031.9	(17/2$^+$)	E2	Mult.: ΔJ=2, Q from DCO, RUL(for E2 amd M2) gives E2.
		695.3 *1*	100 *1*	1731.8	(17/2$^+$)	Q	
2530.5	(17/2$^-$)	210.1 *2*	100	2320.5	(17/2$^-$)		
2923.8	(19/2$^-$)	603.3 *3*	100	2320.5	(17/2$^-$)		
3103.5	(23/2$^+$)	676.4 *1*	100	2427.1	(21/2$^+$)	D+Q	
3112.8	(21/2$^-$)	189.1 *3*	5 *2*	2923.8	(19/2$^-$)		
		792.4 *1*	100 *2*	2320.5	(17/2$^-$)	Q	
3217.7	(25/2$^+$)	114.2 *1*	33 *7*	3103.5	(23/2$^+$)	D+Q	
		790.5 *1*	100 *7*	2427.1	(21/2$^+$)	Q	
3311.4	(21/2$^-$)	198.6 *4*	100 *32*	3112.8	(21/2$^-$)		
		781.0 *4*	89 *32*	2530.5	(17/2$^-$)	Q	
4065.2	(25/2$^-$)	952.3 *1*	100	3112.8	(21/2$^-$)	Q	
4224.0?	(25/2$^-$)	912.8 *4*	100	3311.4	(21/2$^-$)	Q	
4243.2	(29/2$^+$)	1025.5 *1*	100	3217.7	(25/2$^+$)	Q	
4713.6	(27/2$^-$)	489.6 *2*	47 *13*	4224.0?	(25/2$^-$)	D+Q	
		648.6 *2*	100 *13*	4065.2	(25/2$^-$)	D+Q	
4942.3	(29/2$^-$)	228.8 *2*	11 *3*	4713.6	(27/2$^-$)	D+Q	
5113.8	(29/2$^-$)	400.1 *2*	100 *17*	4713.6	(27/2$^-$)	D+Q	
		1048.4 *5*	41 *17*	4065.2	(25/2$^-$)		
5329.2	(33/2$^+$)	1086.0 *1*	100	4243.2	(29/2$^+$)	Q	
5332.1	(31/2$^-$)	218.3 *2*	23 *7*	5113.8	(29/2$^-$)	D+Q	
		389.8 *1*	100 *10*	4942.3	(29/2$^-$)	D+Q	
		618.7 *2*	22 *7*	4713.6	(27/2$^-$)	Q	
		1088.9 *4*	11 *4*	4243.2	(29/2$^+$)	D	Mult.: DJ=1, D+Q or D from DCO, assumed (E1) from level scheme.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

$\gamma(^{89}Tc)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[#]	E_f	J_f^π	Mult.[@]
5650.9	(33/2$^-$)	318.8 *1*	100	5332.1	(31/2$^-$)	D+Q
6190.5	(35/2$^+$)	861.3 *1*	100	5329.2	(33/2$^+$)	D+Q
6413.7	(35/2$^-$)	1081.6 *2*	100	5332.1	(31/2$^-$)	Q
6545.9	(37/2$^+$)	355.5 *2*	100 *10*	6190.5	(35/2$^+$)	D+Q
		1216.5 *5*	49 *10*	5329.2	(33/2$^+$)	
6612.0	(37/2$^-$)	198.3 *4*	28 *8*	6413.7	(35/2$^-$)	
		961.1 *2*	100 *8*	5650.9	(33/2$^-$)	Q
7011.3?	(37/2$^+$)	820.6 *2*	100	6190.5	(35/2$^+$)	D+Q
7402.1	(39/2$^+$)	390.6 *2*	92 *19*	7011.3?	(37/2$^+$)	D+Q
		1211.9 *3*	100 *19*	6190.5	(35/2$^+$)	Q
7765.7	(41/2$^-$)	1153.7 *2*	100	6612.0	(37/2$^-$)	Q
7772.0	(41/2$^+$)	369.8 *2*	100 *10*	7402.1	(39/2$^+$)	D+Q
		1227.0 *6*	41 *10*	6545.9	(37/2$^+$)	
9109.8	(45/2$^+$)	1337.8 *5*	100	7772.0	(41/2$^+$)	
9163.2	(45/2$^-$)	1397.4 *4*	100	7765.7	(41/2$^-$)	Q
1149.2+x	J+2	1149.2 *3*	0.30 *5*	x	J≈(35/2$^-$)	
2408.1+x	J+4	1258.83 *11*	1.00 *5*	1149.2+x	J+2	
3792.4+x	J+6	1384.35 *7*	0.90 *5*	2408.1+x	J+4	
5313.6+x	J+8	1521.18 *8*	0.95 *5*	3792.4+x	J+6	
6981.7+x	J+10	1668.09 *6*	1.00 *5*	5313.6+x	J+8	
8800.6+x	J+12	1818.82 *8*	1.00 *5*	6981.7+x	J+10	
10775.2+x	J+14	1974.57 *9*	0.85 *5*	8800.6+x	J+12	
12911.2+x	J+16	2136.01 *10*	0.60 *3*	10775.2+x	J+14	
15209.6+x	J+18	2298.34 *13*	0.40 *3*	12911.2+x	J+16	
17671.6+x	J+20	2462.0 *16*	0.20 *2*	15209.6+x	J+18	
20291+x?	J+22	2619[&] *3*	0.06 *2*	17671.6+x	J+20	

[†] From ^{58}Ni(^{40}Ca,p2$\alpha\gamma$), unless otherwise stated.

[‡] From ^{89}Ru ε decay.

[#] Branching ratios from Table 4 of 1995Ru03. For SD band, values are relative intensities within the band, normalized to ≈1 for the most intense transition.

[@] Multipolarities of ΔJ=1, M1+E2 and ΔJ=2, E2 are assigned in ^{58}Ni(^{40}Ca,p2$\alpha\gamma$) (1995Ru03). Evaluator assigne ΔJ=1, D+Q for the former and ΔJ=2, Q for the latter, as DCO data are insensitive to parity determination. When level half-life is available, ΔJ=2, Q transitions are assigned DJ=2, E2 from RUL (for E2 and M2).

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

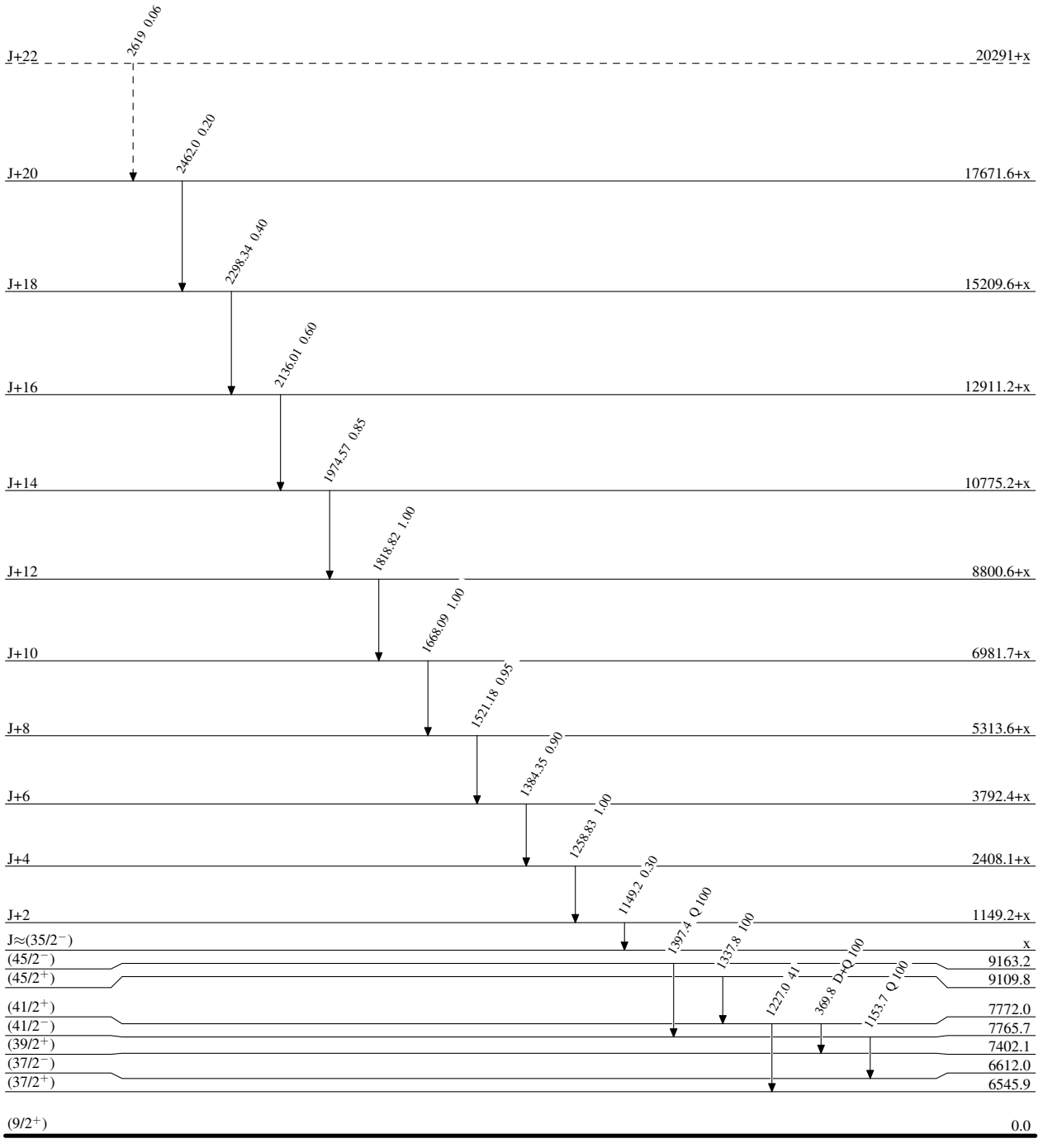
Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

γ Decay (Uncertain)

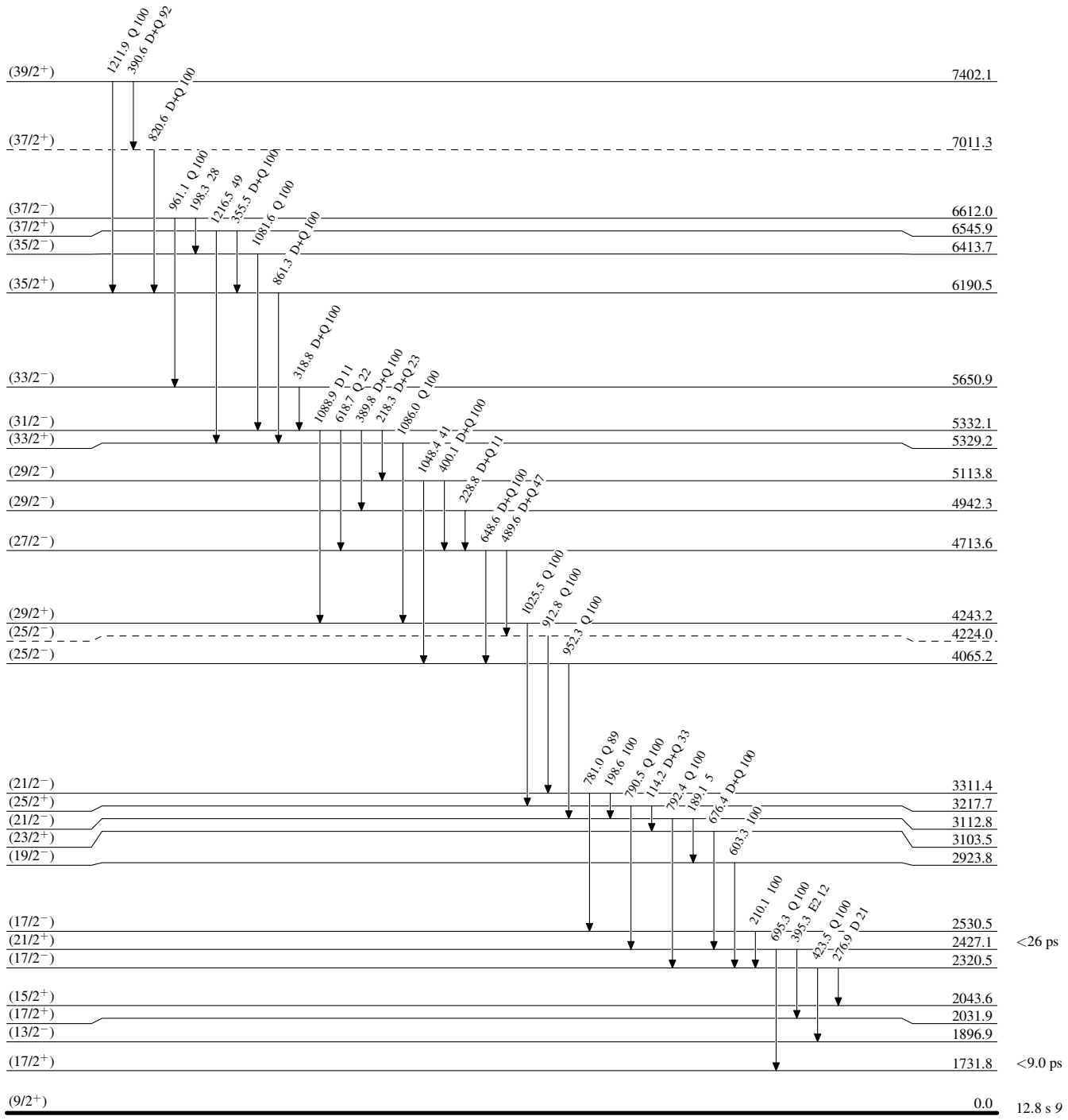


$^{89}_{43}Tc_{46}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

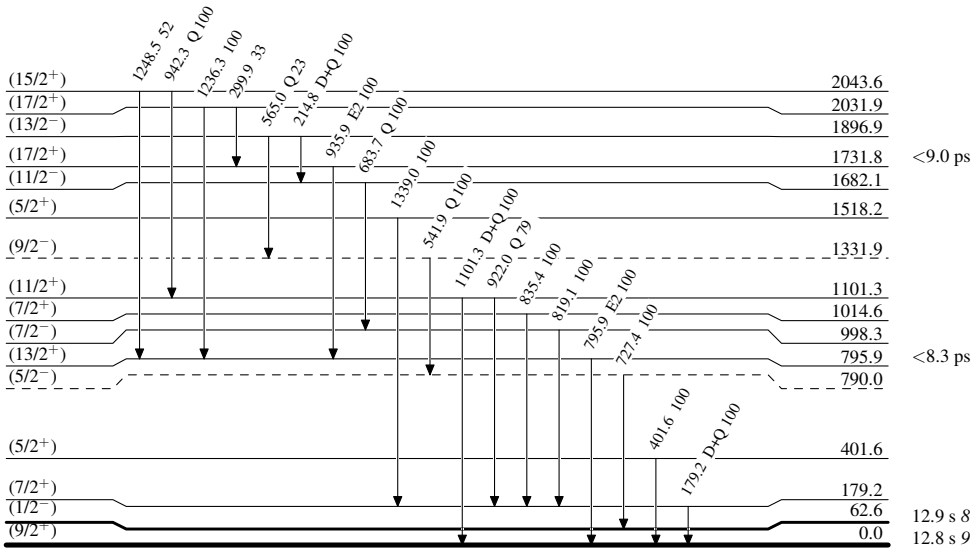


$^{89}_{43}Tc_{46}$

Adopted Levels, Gammas

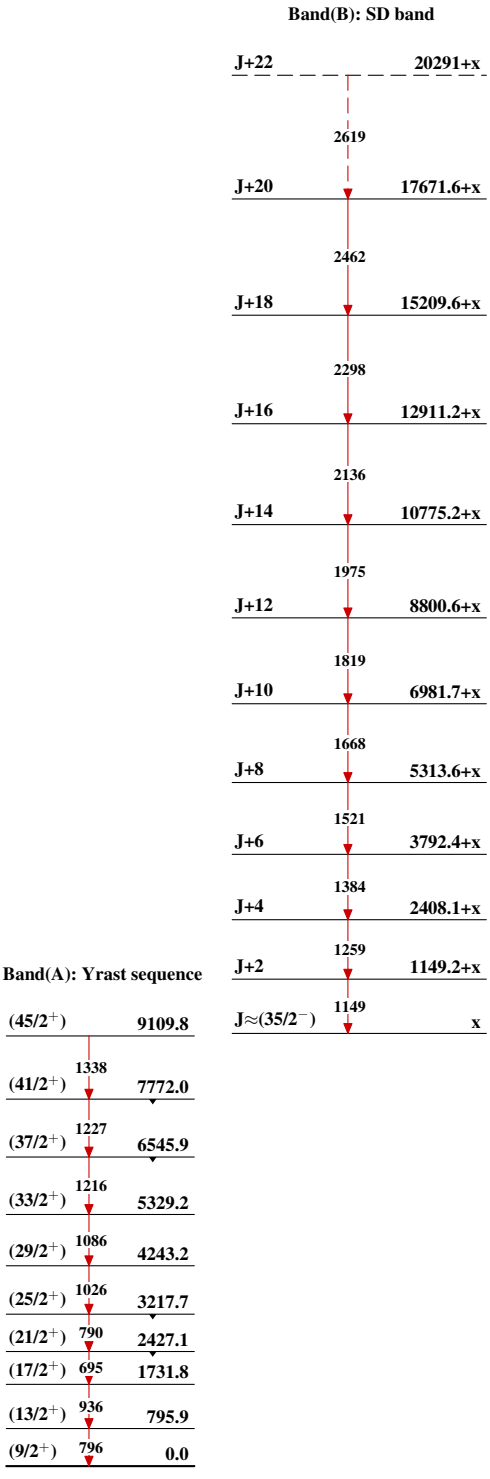
Level Scheme (continued)

Intensities: Relative photon branching from each level



$^{89}_{43}Tc_{46}$

Adopted Levels, Gammas



$^{89}_{43}Tc_{46}$