Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	P. K. Joshi, B. Singh, S. Singh, A. K. Jain	NDS 138, 1 (2016)	15-Oct-2016

Q(β^-)=−9500 *SY*; S(n)=10050 *SY*; S(p)=3170 *SY*; Q(α)=2800 *SY* 2012Wa38

Estimated uncertainties (2012Wa38): ΔQ(β^-)=360, ΔS(n)=280, ΔS(p)=200, ΔQ(α)=250.

Q(εp)=6580 *200*, S(2n)=22560 *360*, S(2p)=4180 *200* (all from syst, 2012Wa38).

1983Ni05: ^{139}Gd identified in ^{50}Cr(^{92}Mo,n2p) reaction at E=385 MeV. OASIS. Measured protons; semi telescope. Identification based on Q(ε)-S(p)=6.5 MeV, σ=70 mb, and agreement between measured $T_{1/2}$ and theoretical $T_{1/2}$=6.4 s from β decay gross theory (1973Ta30) and supported by cross bombardment of ^{54}Fe by ^{92}Mo which produced protons in the same energy range but much lower yield.

1988WiZN: measured beta-delayed E(p), (x ray)p coin, γp coin, $T_{1/2}$.

1999Xi04: ^{106}Cd(^{36}Ar,X). Measured $\gamma\gamma$(t), (x ray)γ(t); He-jet; half-lives, isomers, HPGe detectors. 1999Xi04 claim to have discovered two activities with nearly the same half-lives but with different spins, one a low-spin and the other a high-spin of 9/2$^-$. However, the excitation functions obtained by 1999Xi04 for the two γ rays (115.8 and 121.6) from these two respective activities are nearly the same. Two separate decay schemes are presented but with no γ-ray intensities. In the opinion of the evaluators, sufficient details are absent to justify the existence of the two isomers.

2001BeZY (a report at Int. Conf. St. Marlo (France) in 1988): ^{139}Gd identified in ^{106}Cd(^{36}Ar,2pn) and ^{106}Cd(^{35}Cl,pn) using SARA system and He-jet transport. The following γ rays were listed as emitted by the decay of ^{139}Gd: 27.0, 65.0, 87.5, 116.3, 122.0, 236 and 379. Only the 27.0, 116.3 and 122.0 are present in 1999Xi04, a 26.7 and 121.6 from 4.8-s activity, and 115.8 from 5.8-s activity. The 65.0γ in 2001BeZY could be from ^{138}Gd decay.

2003Xu04: ^{139}Gd produced in ^{106}Cd(^{40}Ca,α2pn),E=232 MeV reaction at Lanzhou-China accelerator facility. The β-delayed proton decay observed through the detection of 347- and 545-keV γ rays in ^{138}Sm.

All data are from ^{92}Mo(^{50}Cr,n2pγ), except for the ground and isomeric properties. The decay scheme of ^{139}Tb ε decay is unknown.

^{139}Gd Levels

Cross Reference (XREF) Flags

A ^{92}Mo(^{50}Cr,n2pγ)
B ^{139}Tb ε decay (1.6 s)

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$	XREF	Comments
0.0[@]	(9/2$^-$)	5.8 s *9*	AB	%ε+%β^+=100; %εp>0 (1983Ni05) $T_{1/2}$: from decay curve for γ rays (1999Xi04), probably the 115.8γ. Full details of this measurement are not available. Others: 4.9 s *10* (from proton decay,1983Ni05), 5.8 s *4* (2001BeZY, from decay curve for γ rays reported in a 1988 conference), 5 s *1* (from proton decay,1988WiZN). %εp: delayed protons observed in 1983Ni05, 1988WiZN and 2003Xu04. J$^\pi$: from systematics of N=75 isotones.
0+x?		4.8 s *9*		%ε+%β^+=100; %εp>0 (1983Ni05) E(level): x=250 *150* (syst,2012Au07). $T_{1/2}$: from decay curve for γ rays (1999Xi04), probably the 121.6γ. Full details of this measurement are not available. 1999Xi04 propose this isomer to be a low-spin without giving any J^π assignment. With (9/2$^-$) for the g.s., this isomer could only have 1/2 or 3/2 to explain the long half-life. 2012Au07 propose 1/2$^+$ from systematics. In view of overlapping half-lives of the two activities and in the absence of detailed data for decay, the evaluators consider the existence of this isomer as uncertain.
211.95[&] *24*	(11/2$^-$)		A	
427.0[a] *7*	(7/2$^-$)		A	
530.06[@] *24*	(13/2$^-$)		A	

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Adopted Levels, Gammas (continued)

^{139}Gd Levels (continued)

E(level)[†]	Jπ[‡]	XREF	Comments
753.0[a] 8	(11/2⁻)	A	
755.2[&] 3	(15/2⁻)	A	
1171.2[@] 3	(17/2⁻)	A	
1255.0[a] 12	(15/2⁻)	A	
1415.7[&] 4	(19/2⁻)	A	
1626.0[b] 12	(13/2⁺)	A	
1871.0[b] 13	(17/2⁺)	A	
1882.0[a] 14	(19/2⁻)	A	
1910.9[@] 4	(21/2⁻)	A	
2174.7[&] 4	(23/2⁻)	A	
2174.7+y[e]		A	Additional information 1.
2238.0[#b] 15	(21/2⁺)	A	
2318.7+y[e] 10		A	
2490.3[c] 8		A	
2576.7[@] 4	(25/2⁻)	A	
2590.0[a] 18	(23/2⁻)	A	
2607.7+y[e] 15		A	
2691.3[c] 13		A	
2697.0[#b] 18	(25/2⁺)	A	
2766.8[&] 5	(27/2⁻)	A	
2919.3[c] 17		A	
2944.7+y[e] 18		A	
3031.4[@] 5	(29/2⁻)	A	
3093.7[d] 11		A	
3235.3[c] 19		A	
3245.0[b] 20	(29/2⁺)	A	
3257.0[a] 20	(27/2⁻)	A	
3288.2[&] 5	(31/2⁻)	A	
3312.7+y[e] 20		A	
3390.7[d] 15		A	
3558.3[c] 22		A	
3627.7[@] 6	(33/2⁻)	A	
3683.8[d] 17		A	
3705.7+y[e] 23		A	
3777.0[a] 23	(31/2⁻)	A	
3880.0[b] 23	(33/2⁺)	A	
3960.0[&] 8	(35/2⁻)	A	
4011.6[d] 17		A	
4108.7+y[e] 25		A	
4370.6[@] 9	(37/2⁻)	A	
4374.2[d] 18		A	
4417.0[a] 25	(35/2⁻)	A	
4600.0[#b] 25	(37/2⁺)	A	
4768.3[&] 11	(39/2⁻)	A	
4788.2[d] 21		A	
5247.3[@] 14	(41/2⁻)	A	
5401[#b] 3	(41/2⁺)	A	

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Adopted Levels, Gammas (continued)

^{139}Gd Levels (continued)

E(level)[†]	J$^\pi$[‡]	XREF
5700.3?[&] *14*	(43/2$^-$)	A
6280[#b] *3*	(45/2$^+$)	A
7231[#b] *3*	(49/2$^+$)	A
8251[#b] *4*	(53/2$^+$)	A
9340[b] *4*	(57/2$^+$)	A
10498?[b] *4*	(61/2$^+$)	A

† From least-squares fit to Eγ data; ΔEγ=1 keV assumed when not given.

‡ From (9/2$^-$) for the g.s.; multipolarities determined from DCO ratios, δ values and RUL; systematics of the lighter N=75 isotones, and γ deexcitation patterns. Ascending order of spins with excitation energy is assumed from yrast type population of states in this reaction.

Lifetime measured in 1992Pa04 (see F(τ) curve in figure 2 of 1992Pa04).

@ Band(A): ν9/2[514] α=−1/2. At low spins, this band is from $\nu h_{11/2}$ 9/2[514] orbital. At $\hbar\omega\approx$0.3 MeV and J^π=23/2$^-$, this band is crossed by a pair of $h_{11/2}$ protons, thus evolves into a 3-qp configuration=ν9/2[514]$\otimes$ $\pi h^2_{11/2}$. This band was first proposed in 1989Ma03, later confirmed in 1990Ma53, 1991Pa04 and 1997Ro13.

& Band(a): ν9/2[514],α=+1/2. See comment for the α=−1/2 partner.

a Band(B): ν1/2[530] band. Band from $\nu h_{9/2}$ orbital (1997Ro13).

b Band(C): ν1/2[660], Highly deformed band. Q(intrinsic)≈7.0 (1992Pa04) from lifetime measurements of seven transitions in the band. Band from $\nu i_{13/2}$ orbital (1997Ro13,1990Ma53).

c Band(D): ΔJ=(1) band. Band from 1990Ma53 only.

d Band(E): ΔJ=1 band. Band from 1990Ma53 only.

e Band(F): ΔJ=(1) band. Band from 1990Ma53 only.

γ(^{139}Gd)

In ^{139}Tb ε decay dataset, no levels are known, only two unplaced gamma rays of 109.0 and 119.7 keV are reported.

E$_i$(level)	J$^\pi_i$	E$_\gamma$	I$_\gamma$	E$_f$	J$^\pi_f$	Mult.[†]	δ[‡]	α[#]	Comments
211.95	(11/2$^-$)	212.0 *3*	100	0.0	(9/2$^-$)	D			
427.0	(7/2$^-$)	215	11.1 *15*	211.95	(11/2$^-$)				
		427	100 *19*	0.0	(9/2$^-$)	D			
530.06	(13/2$^-$)	318.2 *3*	100 *10*	211.95	(11/2$^-$)	D			
		530.0 *3*	46 *5*	0.0	(9/2$^-$)	Q			
753.0	(11/2$^-$)	326	100 *8*	427.0	(7/2$^-$)	(Q)			Mult.: D+Q also possible from DCO ratio.
		753	20 *8*	0.0	(9/2$^-$)	D			
755.2	(15/2$^-$)	225.3 *3*	86 *9*	530.06	(13/2$^-$)	M1+E2	−0.27 *4*	0.203 *4*	α(K)=0.170 *3*; α(L)=0.0254 *4*; α(M)=0.00554 *9* α(N)=0.001274 *21*; α(O)=0.000196 *3*; α(P)=1.252×10^{-5} *23*
		543.2 *3*	100	211.95	(11/2$^-$)	Q			
1171.2	(17/2$^-$)	416.2 *3*	100 *11*	755.2	(15/2$^-$)	M1+E2	−0.48 *4*	0.0372 *7*	α(K)=0.0314 *6*; α(L)=0.00458 *8*; α(M)=0.000996 *16* α(N)=0.000229 *4*; α(O)=3.53×10^{-5} *6*; α(P)=2.28×10^{-6} *5*
		641.0 *3*	83 *9*	530.06	(13/2$^-$)	Q			
1255.0	(15/2$^-$)	502	100	753.0	(11/2$^-$)	Q			

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Adopted Levels, Gammas (continued)

$\gamma(^{139}Gd)$ (continued)

E_i(level)	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult.†	δ‡	α#	Comments
1415.7	(19/2⁻)	244.3 *3*	38 *5*	1171.2	(17/2⁻)	M1+E2	−0.26 *7*	0.163 *3*	α(K)=0.137 *3*; α(L)=0.0202 *4*; α(M)=0.00440 *8* α(N)=0.001011 *17*; α(O)=0.0001558 *24*; α(P)=1.007×10⁻⁵ *24*
		660.4 *3*	100 *11*	755.2	(15/2⁻)	Q			
1626.0	(13/2⁺)	873	100	753.0	(11/2⁻)				
1871.0	(17/2⁺)	245	6.1 *12*	1626.0	(13/2⁺)	Q			
		616	100 *4*	1255.0	(15/2⁻)	D			
1882.0	(19/2⁻)	627	100	1255.0	(15/2⁻)	Q			
1910.9	(21/2⁻)	495.1 *3*	71 *9*	1415.7	(19/2⁻)	M1+E2	−0.34 *6*	0.0247 *6*	α(K)=0.0210 *5*; α(L)=0.00296 *6*; α(M)=0.000642 *12* α(N)=0.000148 *3*; α(O)=2.29×10⁻⁵ *5*; α(P)=1.53×10⁻⁶ *4*
		740.0 *3*	100 *12*	1171.2	(17/2⁻)	Q			
2174.7	(23/2⁻)	264.0 *3*	27 *3*	1910.9	(21/2⁻)	D			
		758.9 *3*	100 *10*	1415.7	(19/2⁻)	Q			
2174.7+y		y		2174.7	(23/2⁻)				
2238.0	(21/2⁺)	356	12.2 *24*	1882.0	(19/2⁻)				
		367	100 *4*	1871.0	(17/2⁺)	E2		0.0329	α(K)=0.0259 *4*; α(L)=0.00545 *8*; α(M)=0.001224 *18* α(N)=0.000278 *4*; α(O)=4.01×10⁻⁵ *6*; α(P)=1.675×10⁻⁶ *24*
2318.7+y		144		2174.7+y					
2490.3		579		1910.9	(21/2⁻)				
		1075		1415.7	(19/2⁻)				
2576.7	(25/2⁻)	402.1 *3*	100 *10*	2174.7	(23/2⁻)	M1+E2	−0.17 *4*	0.0437	α(K)=0.0371 *6*; α(L)=0.00522 *8*; α(M)=0.001132 *17* α(N)=0.000260 *4*; α(O)=4.05×10⁻⁵ *6*; α(P)=2.72×10⁻⁶ *5*
		665.6 *3*	51 *5*	1910.9	(21/2⁻)	(Q)			
2590.0	(23/2⁻)	708	100	1882.0	(19/2⁻)	Q			
2607.7+y		289		2318.7+y					
2691.3		201		2490.3					
2697.0	(25/2⁺)	459	100	2238.0	(21/2⁺)	E2		0.01754	α(K)=0.01415 *20*; α(L)=0.00264 *4*; α(M)=0.000588 *9* α(N)=0.0001337 *19*; α(O)=1.97×10⁻⁵ *3*; α(P)=9.41×10⁻⁷ *14*
2766.8	(27/2⁻)	190.0 *3*	100 *10*	2576.7	(25/2⁻)	M1+E2	−0.17 *6*	0.328	α(K)=0.276 *5*; α(L)=0.0406 *8*; α(M)=0.00883 *19* α(N)=0.00203 *5*; α(O)=0.000313 *6*; α(P)=2.04×10⁻⁵ *4*
		592.2 *3*	34 *4*	2174.7	(23/2⁻)	Q			
2919.3		228		2691.3					
2944.7+y		337		2607.7+y					
3031.4	(29/2⁻)	264.8 *3*	100 *11*	2766.8	(27/2⁻)				
		455 *1*	<17	2576.7	(25/2⁻)	Q			
3093.7		919@		2174.7	(23/2⁻)				
3235.3		316		2919.3					

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Adopted Levels, Gammas (continued)

$\gamma(^{139}Gd)$ (continued)

E_i(level)	J^π_i	E_γ	I_γ	E_f	J^π_f	Mult.†	δ‡	α#	Comments
3245.0	(29/2+)	548	100	2697.0	(25/2+)	Q			
3257.0	(27/2−)	667	100	2590.0	(23/2−)	Q			
3288.2	(31/2−)	256.9 *3*	100 *11*	3031.4	(29/2−)	M1+E2	−0.27 *4*	0.1416 *23*	α(K)=0.1192 *20*; α(L)=0.0175 *3*; α(M)=0.00382 *6* α(N)=0.000878 *13*; α(O)=0.0001354 *20*; α(P)=8.76×10^{-6} *16*
		521.2 *3*	38 *5*	2766.8	(27/2−)	Q			
3312.7+y		368		2944.7+y					
3390.7		297		3093.7					
3558.3		323		3235.3					
3627.7	(33/2−)	339.3 *3*	100 *12*	3288.2	(31/2−)	M1+E2	−0.20 *7*	0.0679 *13*	α(K)=0.0575 *12*; α(L)=0.00819 *12*; α(M)=0.00178 *3* α(N)=0.000409 *6*; α(O)=6.34×10^{-5} *10*; α(P)=4.22×10^{-6} *9*
		596.4 *3*	<40	3031.4	(29/2−)				
3683.8		293		3390.7					
		590@		3093.7					
3705.7+y		393		3312.7+y					
3777.0	(31/2−)	520	100	3257.0	(27/2−)	Q			
3880.0	(33/2+)	635	100	3245.0	(29/2+)	Q			
3960.0	(35/2−)	332 *1*	100	3627.7	(33/2−)	M1+E2	−0.34 *8*	0.0701 *18*	α(K)=0.0591 *16*; α(L)=0.00861 *15*; α(M)=0.00187 *4* α(N)=0.000431 *8*; α(O)=6.65×10^{-5} *12*; α(P)=4.32×10^{-6} *13*
		672		3288.2	(31/2−)				
4011.6		328		3683.8					
		621		3390.7					
4108.7+y		403		3705.7+y					
4370.6	(37/2−)	411		3960.0	(35/2−)				
		743		3627.7	(33/2−)				
4374.2		363		4011.6					
		690		3683.8					
4417.0	(35/2−)	640	100	3777.0	(31/2−)				
4600.0	(37/2+)	720		3880.0	(33/2+)				
4768.3	(39/2−)	398		4370.6	(37/2−)				
		808		3960.0	(35/2−)				
4788.2		414		4374.2					
5247.3	(41/2−)	479		4768.3	(39/2−)				
		877@		4370.6	(37/2−)				
5401	(41/2+)	801		4600.0	(37/2+)				
5700.3?	(43/2−)	453@		5247.3	(41/2−)				
		932@		4768.3	(39/2−)				
6280	(45/2+)	879		5401	(41/2+)				
7231	(49/2+)	951		6280	(45/2+)				
8251	(53/2+)	1020		7231	(49/2+)				
9340	(57/2+)	1089		8251	(53/2+)				
10498?	(61/2+)	1158@		9340	(57/2+)				

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Adopted Levels, Gammas (continued)

$\gamma(^{139}Gd)$ (continued)

† Mult=Q indicates stretched quadrupole (most likely E2), mult=D indicates stretched dipole (most likely M1 or M1+E2, except E1 for 616γ from 17/2^{+} level) from DCO ratios. Mult=M1+E2 is from measured DCO ratio, significantly large δ value and implied RUL. Mult=E2 is from DCO ratio and RUL; level lifetimes are not listed but are implied as short (in ps region) from transition quadrupole moment deduced from these measurements in 1992Pa04.

‡ Read by the evaluators from figure 1 of 1991Pa04.

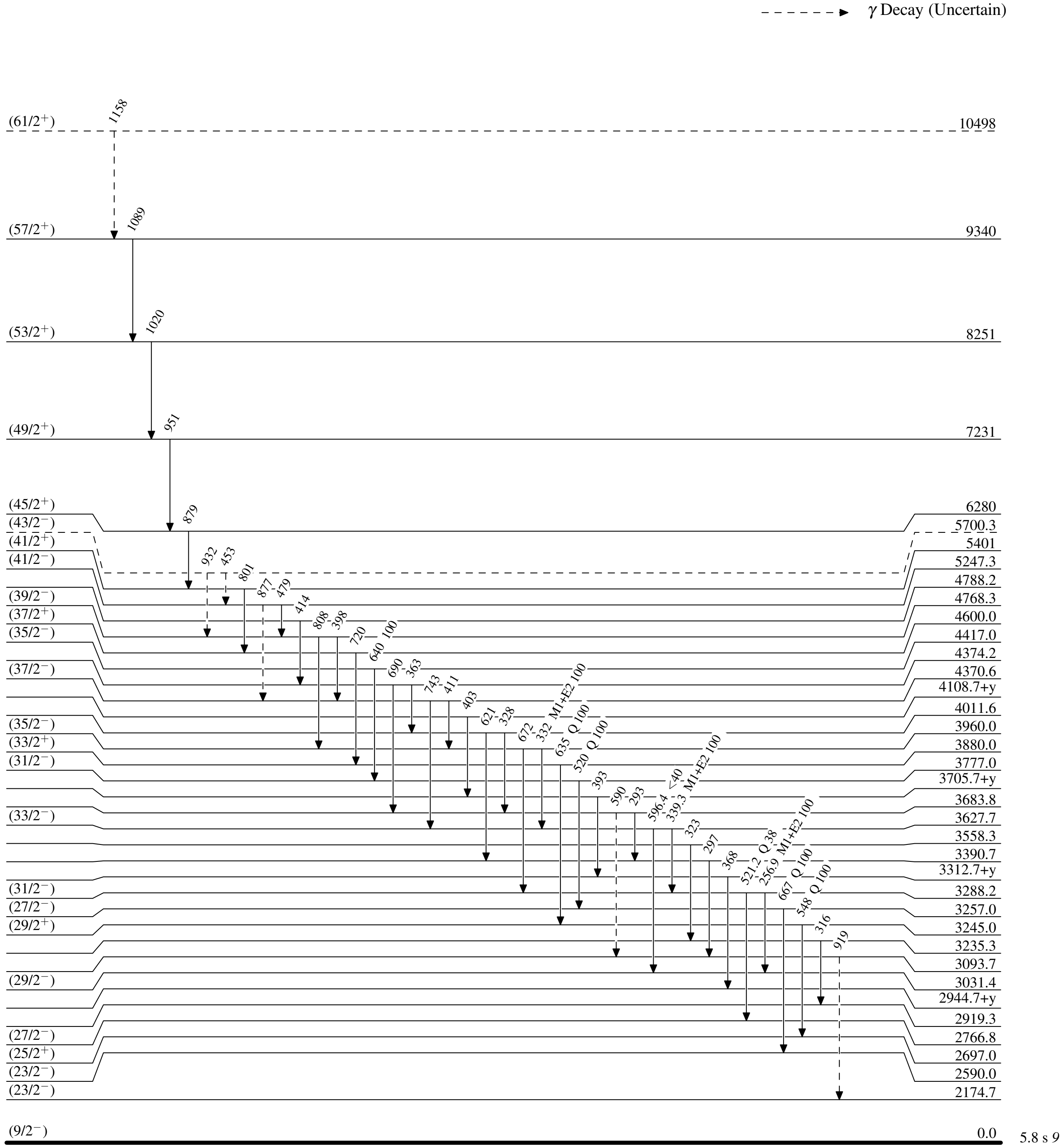
Theoretical values from BrIcc v2.3b (16-Dec-2014) 2008Ki07, "Frozen Orbitals" approximation.

@ Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level

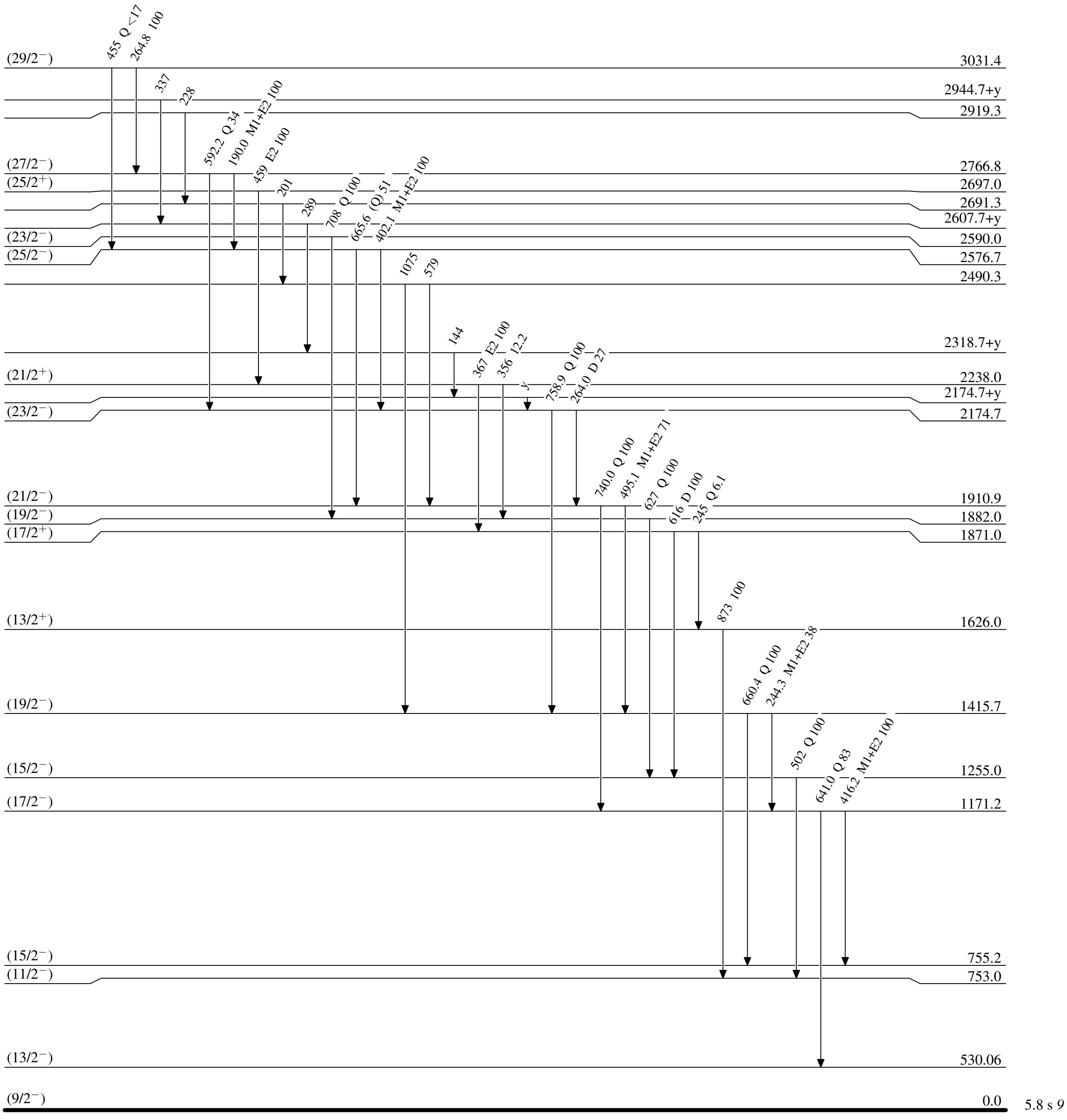


$^{139}_{64}Gd_{75}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

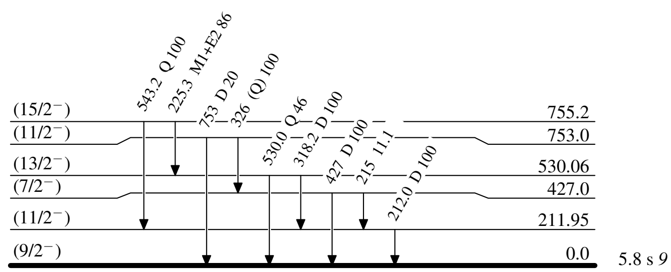


$^{139}_{64}Gd_{75}$

Adopted Levels, Gammas

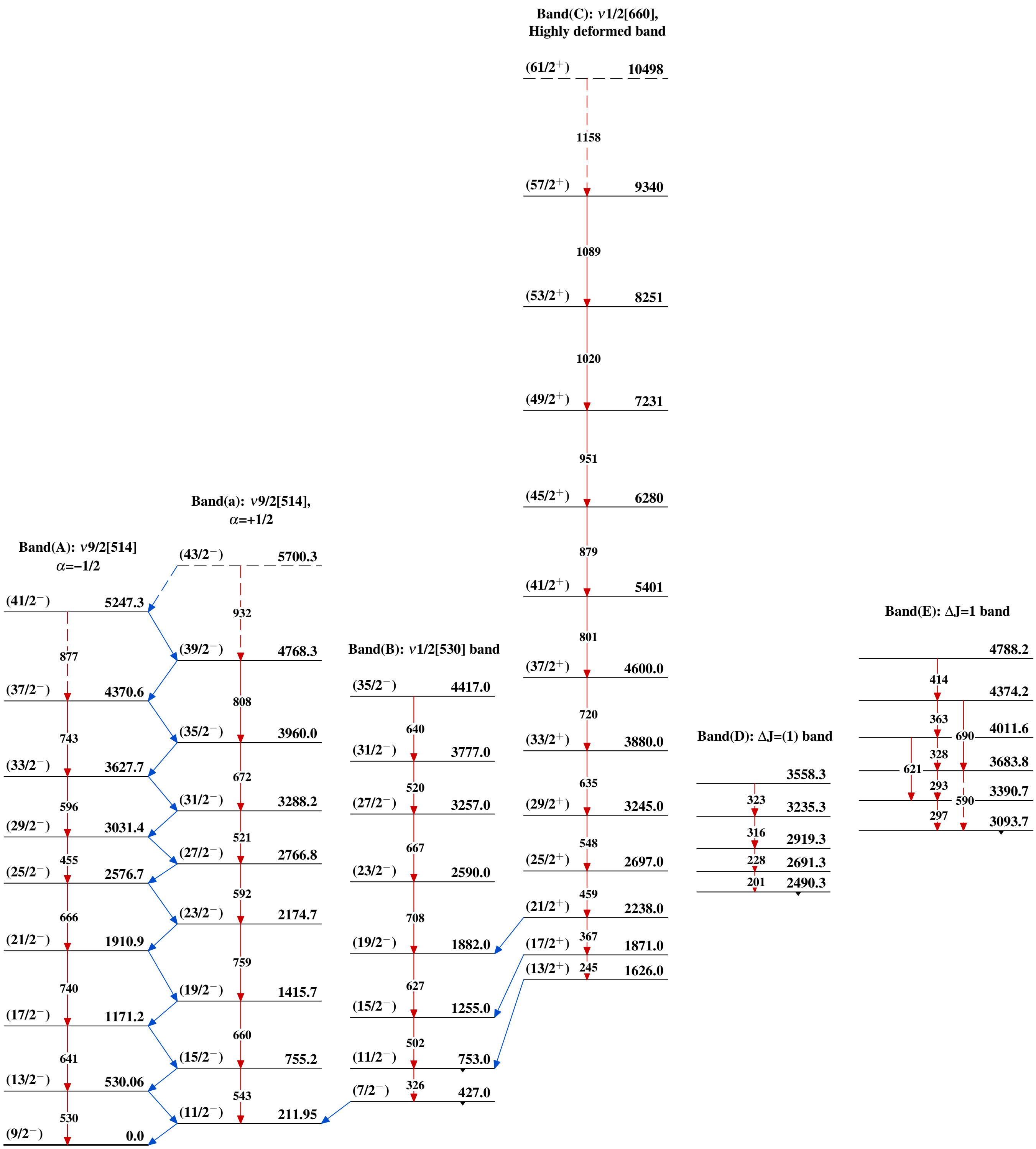
Level Scheme (continued)

Intensities: Relative photon branching from each level



$^{139}_{64}Gd_{75}$

Adopted Levels, Gammas



$^{139}_{64}Gd_{75}$

Adopted Levels, Gammas (continued)