Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	NDS 156, 1 (2019)	31-Jan-2019

Q(β^-)=−5150 *SY*; S(n)=7707 *12*; S(p)=3740 *SY*; Q(α)=8226 *8* 2017Wa10
Estimated uncertainties (2017Wa10): 300 for Q(β^-), 30 for S(p).
S(2n)=14291 *13*, S(2p)=6670 *11* (2017Wa10).
Production and assignment of ^{254}No isotope:
1958Gh40, 1966Do04: parent of ^{250}Fm; chemistry.
1966Do04: ^{238}U(^{22}Ne,6n); excitation function.
1966Za04: ^{243}Am(^{15}N,4n); parent of ^{250}Fm.
1967Gh01: ^{246}Cm(^{12}C,4n); excitation function.
1967Mi03: ^{242}Pu(^{16}O,4n); excitation function.
1988Tu07: ^{208}Pb(^{48}Ca,2n); chemistry; grandparent of ^{246}Cf.
Consult the NSR database at www.nndc.bnl.gov for numerous papers since 1988 for the production cross sections of ^{254}No in different reactions.
2018It04: measured mass excess=84675 keV *42*(stat) *19*(syst) using multireflection time-of-flight mass spectrograph at GARIS-RIKEN facility. This value can be compared to evaluated mass excess of 84723.4 keV *93* in 2017Wa10.
2012Mi27: measured mass excess using time-of-flight ion-cyclotron-resonance method.
2010Bl04, 2010Bl03, 2010Dw01: measured mass using SHIPTRAP Penning trap spectrometer at GSI.
Theoretical studies: consult the NSR database at www.nndc.bnl.gov for 100 references dealing with theoretical calculations of half-lives for different decay modes, binding energies, fission characteristics, level properties, moments and deformations.
Additional information 1.

^{254}No Levels

The decay scheme of the 184−μs isomer has been studied by 2010He10 at GSI, and by 2010Cl01 at LBNL. Very different decay schemes were proposed in the two experiments, although a similar rotational band, but with different J^π values and configuration, was assigned in both the studies. 2016WaZW conducted an independent experiment at Jyvaskyla (JYFL) to resolve the difference between the two studies. The author favored the decay scheme given by 2010He10, with a possible difference that the 605-keV transition deexcited the isomer directly rather than through an intermediate level as suggested by 2010He10. However, 2016WaZW concluded with the following statement about the 605-keV transition: “The 605 keV rays seen at the focal plane in coincidence with the decay of the fast isomer confirm that there is a transition with this energy in ^{254}No somewhere between the two isomers, but it does not give any more information about where in the level scheme the transition should be placed. Any of the level schemes in figure 9.1 is consistent with this observation”. Evaluator also consulted Prof. R.-D. Herzberg, thesis advisor of 2016WaZW, as well as the first author of 2006He19 paper for his opinion on the current status of the decay scheme of this isomer. Evaluator was advised (ref. e-mail reply of June 19, 2017 from Prof. Herzberg) that at this time, no definite decay scheme could be adopted, and that future experiments with more advanced detector arrays are needed to investigate the decay scheme between the two isomers: 184 μs and 265 ms. Thus, while the two currently proposed decay schemes are presented in this evaluation as separate datasets, no decay scheme has been adopted in this dataset.

Cross Reference (XREF) Flags

A	^{254}Lr ε decay (18.1 s)	D	^{254}No IT decay (184 μs):GSI
B	^{258}Rf α decay (12.0 ms)	E	^{254}No IT decay (184 μs):lbnl
C	^{254}No IT decay (265 ms)	F	^{208}Pb(^{48}Ca,2nγ):prompt γ

E(level)†	J^π‡	$T_{1/2}$	XREF	Comments
0.0#	0+	51.2 s *4*	BC	%α=90 *1*; %ε=10 *1* (2010He10); %SF=0.17 *2* (1994Hu18) Measured $\delta\nu$(^{254}No,^{253}No)=6.72 GHz *18*; $\delta\nu$(^{254}No,^{252}No)=10.08 GHz *69*; δ<r^2>(^{254}No,^{253}No)=−0.070 fm^2 *2*(stat) *5*(syst); δ<r^2>(^{254}No,^{252}No)=−0.105 fm^2

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Adopted Levels, Gammas (continued)

^{254}No Levels (continued)

E(level)[†]	J^{π}[‡]	$T_{1/2}$	XREF	Comments
				7(stat) *7*(syst) (2018Ra11, laser atomic spectroscopy using radiation detected resonance ionization spectroscopy (RADRIS) technique at SHIP-UNILAC-GSI facility. Measured %ε=10 *1*, %SF=0.23 *10* (2010He10) from the number of α decays and fission events from ^{254}No and the number of α decays from ^{254}Fm. Measured %ε=10 *4*, %SF=0.25 *+20−11* (1988Tu07) from α and fission activities of ^{254}No, and α activities of ^{254}Fm and ^{246}Cf. Measured %SF=0.17 *5* (1989La07) by comparing g.s. SF activity yield with α activity yields for ^{246}Cf and ^{242}Cm; %SF=0.17 *2* (1994Hu18) from the ratio of α and SF events; %$\alpha\approx$10 (1979Or02). $T_{1/2}$: from 2006He19, decay curve for 8.1-MeV α peak. Others: 48 s *3* (1999Le42), 53 s *20* (1994Hu18), 54 s *+8−6* (1989La07), 53 s *+46−24* (1988Tu07), 68 s *+36−18* (1985He22), 75 s *15* (1967Mi03), 52 s *5* (1967Gh01, value of 55 s *5* measured relative to $T_{1/2}$(^{214}Ra)=2.6 s was corrected by 1999Le42 for ^{214}Ra half-life), 50 s *10* (1966Do04). Weighted average of all the values is also 51.2 s *4* with reduced χ^2=0.5. $T_{1/2}$: $T_{1/2}$(SF)>25 h, estimated by 1966Fl04.
44.2[#] *4*	2+		BCDEF	Additional information 2. E(level): from ^{208}Pb(^{48}Ca,2nγ), estimated by 1999Le42 from Harris parameters extracted for the g.s. rotational band.
145.2[#] *7*	4+		CDEF	
304.6[#] *7*	6+		CDEF	
518.7[#] *7*	8+		CDEF	
786.0[#] *8*	10+		F	
987.5[@] *8*	(3+)		CDEF	J^{π}: γ rays to 2+ and 4+. Probable configuration=π1/2[521]⊗π7/2[514], K^{π}=(3+) (2006He19).
1033.2[@] *11*	(4+)		CDE	J^{π}: γ rays to (3+) and 4+; band member.
1091.1[@] *9*	(5+)		CDE	J^{π}: γ rays to (3+) and 6+; band member.
1104.1[#] *8*	12+		F	
1160.3[@] *9*	(6+)		CDE	J^{π}: γ rays to (4+) and 6+; band member.
1243.1[@] *9*	(7+)		CDE	J^{π}: γ rays to (5+) and 6+; band member.
1296.4[&] *11*	(8−)	265 ms *2*	CDE	%IT=100; %SF=0.020 *12* (2010He10); %$\alpha\leq$0.01 (2010He10) E(level): other: 1295 keV *2* (2010He10), 1297 keV *2* (2010Cl01). $T_{1/2}$: weighted average of 263 ms *2* (2010Cl01, recoil-ce(t)); 275 ms *7* (2010He10, recoil-ce(t)); 266 ms *10* (2006Ta19, summed electron spectrum decay curve); 266 ms *2* (2006He19, recoil-ce(t)). Other: 0.28 s *4* (1973Gh03, first identification of the isomer). J^{π}: 2010He10, 2006Ta19 and 2006He19 proposed π9/2[624]⊗π7/2[514], K^{π}=8−. However, 2010He10 and 2006He19 suggested that long half-life of this isomer may be due to contribution from 2-neutron configurations of ν7/2[624]⊗ν9/2[734] and ν7/2[613]⊗ν9/2[734],K^{π}=8−. 2010Cl01 proposed ν7/2[613]⊗ν9/2[734],K^{π}=8− configuration. See 2015Ko14 evaluation for γ-transition hindrance factors. unobservedGammaIntensity=49 *2*:From ^{254}No IT decay (265 ms).
1407.8[&] *11*	(9−)		DE	J^{π}: γ to (8−), band member.
1470.7[#] *8*	14+		F	
1530.8[&] *15*	(10−)		DE	J^{π}: γ to (9−), band member.
1530.8+x[a]	J1		DE	Additional information 3. E(level): this level is the 1532.0, (10−) level in ^{254}No IT decay (184 μs):GSI (2010He10), but at 2013.2, (10+) in ^{254}No IT decay (184 μs):LBNL (2010Cl01) decaying through 481.8 and 605.2 γ rays. 2016WaZW did not confirm the existence of the 482γ, and the 605γ was placed from a 2917-keV level feeding the

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Adopted Levels, Gammas (continued)

^{254}No Levels (continued)

E(level)[†]	Jπ[‡]	T1/2	XREF	Comments
				top member of the K=8 band. 2016WaZW suggested a possible placement of the 605γ directly from the isomer, but left open other possibilities. J_1=10⁻ in 2010He10, 10⁺ in 2010Cl01.
1664.4+x[a] *1*	J1+1		DE	
1809.1+x[a] *8*	J1+2		DE	
1883.4[#] *8*	16⁺		F	
1966.1+x[a] *8*	J1+3		DE	
2134.4+x[a] *8*	J1+4		DE	
2314.8+x[a] *8*	J1+5		DE	
2314.8+y	(16)	184 μs *3*	DE	%IT=100; %SF≤0.012 (2010He10) Additional information 4. This isomer was defined at 3001 keV with an ≈84−keV transition deexciting it in ^{254}No IT decay (184 μs):GSI (2010He10), and possibly at 2917 keV with direct deexcitation through the 605-keV γ ray by 2016WaZW. 2010Cl01 assigned it from 2928 keV with 312.4 and 133.4 gamma rays deexciting it in ^{254}No IT decay (184 μs):LBNL. E(level): 3001 keV *3* (2010He10), 2917 keV (2016WaZW); 2928 keV *3* (2010Cl01). $T_{1/2}$: weighted average of 184 μs *2* (2010Cl01, recoil-ce-ce(t)); 198 μs *13* (2010He10, recoil-ce(t)); 171 μs *9* (2006Ta19, summed electron decay curve). Jπ: configuration=$(\pi 7/2[514]\otimes\pi 9/2[624])_{8-}(\nu 7/2[613]\otimes\nu 9/2[734])_{8-}$,$K^\pi$=16⁺ (2010Cl01). In 2010He10, ν7/2[613] orbital is replaced by ν7/2[624]. See 2015Ko14 evaluation for γ-transition hindrance factors, where the isomer is considered to deexcite directly through the 605γ.
2339.4[#] *9*	18⁺		F	
2837.4[#] *14*	(20⁺)		F	
3373.4[#] *17*	(22⁺)		F	
3943.4?[#] *20*	(24⁺)		F	

[†] From least-squares fit to Eγ data, assuming uncertainty of 1 keV when not stated.
[‡] From band structures as proposed in several studies using ^{208}Pb(^{48}Ca,2nγ) reaction. Members of the ground-state from 4⁺ to 12⁺ are supported by E2 intraband transitions, higher members from continuing γ cascade.
[#] Band(A): K^π=0⁺, g.s. band. No indication of a backbend was found. The quadrupole deformation of β(2)=0.27 *3* was deduced by 1999Le42 from E(2⁺ state)=44.2 *4*, extrapolated from neighboring E(2⁺ states).
[@] Band(B): π1/2[521]⊗π7/2[514],K^π=(3⁺) band.
[&] Band(C): K^π=(8⁻) band.
[a] Band(D): ΔJ=1 band.

γ(^{254}No)

E_i(level)	J^π_i	Eγ[†]	Iγ	E_f	J^π_f	Mult.[†]	α[@]
44.2	2⁺	(44.2 *4*)	100	0.0	0⁺	[E2]	1510 *70*
145.2	4⁺	101.1 *6*	100	44.2	2⁺	E2	30.0 *10*
304.6	6⁺	159.5 *2*	100	145.2	4⁺	E2	3.94
518.7	8⁺	214.1 *1*	100	304.6	6⁺	E2	1.204
786.0	10⁺	267.3 *1*	100	518.7	8⁺	E2	0.535
987.5	(3⁺)	842 *1*	36[‡] *9*	145.2	4⁺		
		943 *1*	100[‡] *16*	44.2	2⁺		
1033.2	(4⁺)	(45)		987.5	(3⁺)		

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Adopted Levels, Gammas (continued)

$\gamma(^{254}No)$ (continued)

E_i(level)	J^π_i	E_γ†	I_γ	E_f	J^π_f	Mult.†	α@	Comments
1033.2	(4+)	887		145.2	4+			
1091.1	(5+)	(58)		1033.2	(4+)			
		103		987.5	(3+)			
		786 *1*		304.6	6+			
1104.1	12+	318.1 *2*	100	786.0	10+	(E2)	0.300	
1160.3	(6+)	69		1091.1	(5+)			
		126		1033.2	(4+)			
		856		304.6	6+			
1243.1	(7+)	82	100‡	1160.3	(6+)			
		151	110‡ *40*	1091.1	(5+)			
		940		304.6	6+			
1296.4	(8−)	53	100‡ *7*	1243.1	(7+)	(E1)	0.83 *5*	
		778	14‡ *4*	518.7	8+	[E1]	0.0085	
1407.8	(9−)	111.4 *2*	100	1296.4	(8−)	[M1]	9.51	E_γ: average of 111.4 *2* in ^{254}No IT decay (184 μs):GSI, and 111.4 *3* in ^{254}No IT decay (184 μs):LBNL.
1470.7	14+	366.6 *2*	100	1104.1	12+	[E2]	0.195	
1530.8	(10−)	123		1407.8	(9−)			
1664.4+x	J1+1	133.3 *1*	100	1530.8+x	J1			E_γ: average of 133.3 *1* in ^{254}No IT decay (184 μs):GSI, and 133.4 *4* in ^{254}No IT decay (184 μs):LBNL.
1809.1+x	J1+2	145 *1*	100	1664.4+x	J1+1			E_γ: from ^{254}No IT decay (184 μs):LBNL.
1883.4	16+	412.7 *2*	100	1470.7	14+	[E2]	0.1397	
1966.1+x	J1+3	156.9 *2*	100 *17*	1809.1+x	J1+2			E_γ: average of 156.9 *2* in ^{254}No IT decay (184 μs):GSI, and 156.9 *3* in ^{254}No IT decay (184 μs):LBNL.
		302		1664.4+x	J1+1			E_γ: from ^{254}No IT decay (184 μs):GSI.
2134.4+x	J1+4	168.5 *1*	100# *17*	1966.1+x	J1+3			E_γ: average of 168.5 *1* in ^{254}No IT decay (184 μs):GSI, and 168.9 *3* in ^{254}No IT decay (184 μs):LBNL.
		325.5 *5*	83# *33*	1809.1+x	J1+2			E_γ: 325 in ^{254}No IT decay (184 μs):GSI, and 325.5 *5* in ^{254}No IT decay (184 μs):LBNL.
2314.8+x	J1+5	179.5 *1*	100 *13*	2134.4+x	J1+4			E_γ: average of 179.5 *1* in ^{254}No IT decay (184 μs):GSI, and 179.4 *3* in ^{254}No IT decay (184 μs):LBNL.
		347.2 *2*	76 *22*	1966.1+x	J1+3			E_γ: average of 347.1 *2* in ^{254}No IT decay (184 μs):GSI, and 347.5 *5* in ^{254}No IT decay (184 μs):LBNL. I_γ: average of 57 *22* in ^{254}No IT decay (184 μs):GSI, and 100 25 in ^{254}No IT decay (184 μs):LBNL.
2339.4	18+	456.0 *3*		1883.4	16+			
2837.4	(20+)	498 *1*		2339.4	18+			
3373.4	(22+)	536 *1*		2837.4	(20+)			
3943.4?	(24+)	570&		3373.4	(22+)			

† For gamma rays from the g.s. rotational band members, and for the (3+) bandhead, energies, γ-ray branching ratios, and multipolarity assignments are from ^{208}Pb(^{48}Ca,2nγ):prompt γ. The multipolarity assignments are based on internal conversion data. For γ rays from the (4+) and higher members of the K^π=(3+) band, energies are from ^{254}No IT decay (265 ms).

‡ Relative branching ratios of 842γ and 943γ are from ^{254}No IT decay (265 ms).

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Adopted Levels, Gammas (continued)

$\gamma(^{254}No)$ (continued)

Branching ratios from ^{254}No IT decay (184 μs):LBNL.

@ Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

& Placement of transition in the level scheme is uncertain.

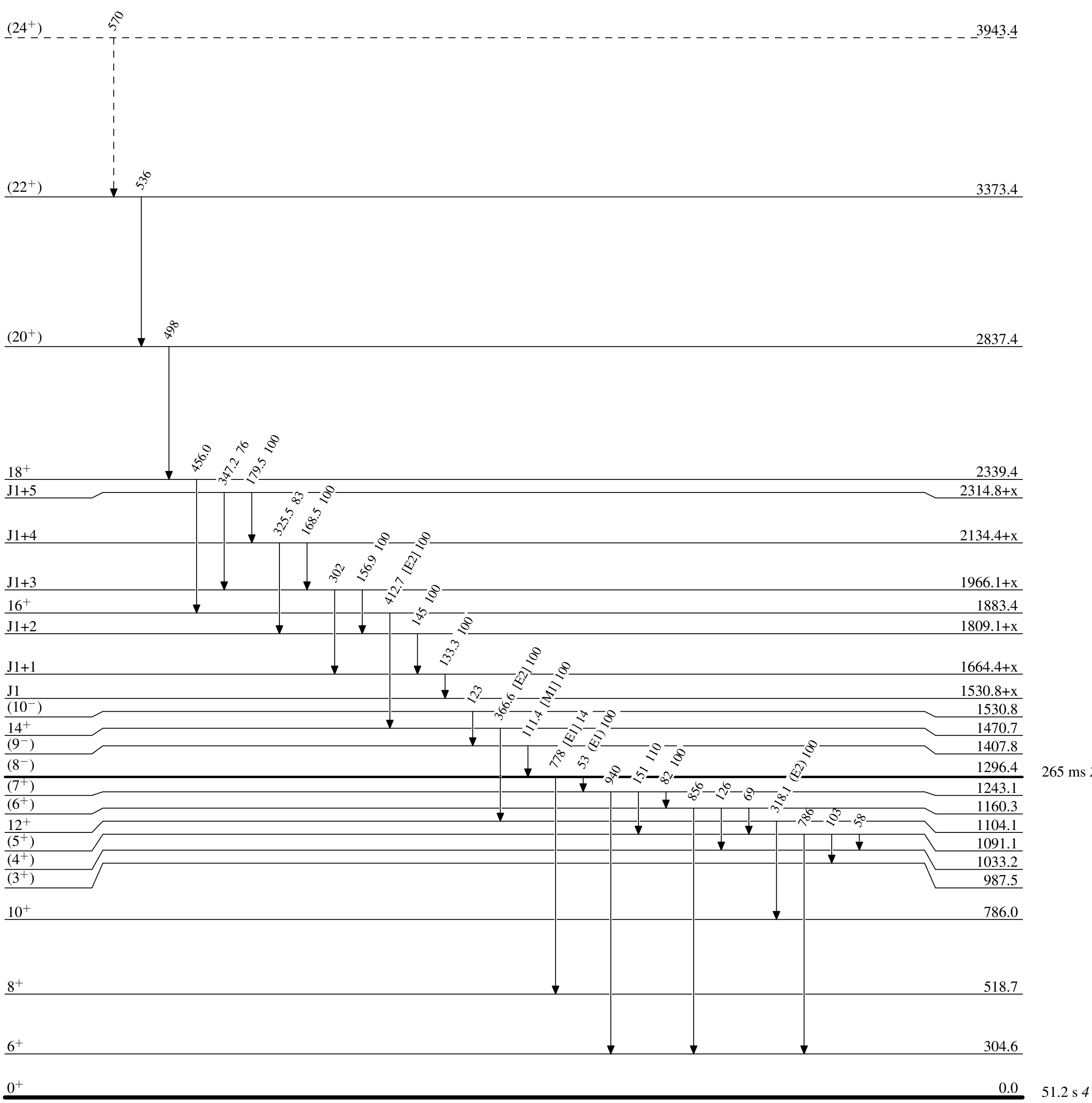
Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

- - - - ► γ Decay (Uncertain)



$^{254}_{102}No_{152}$

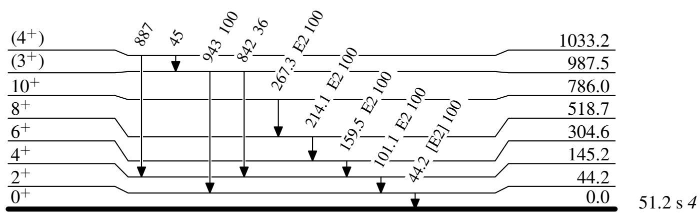
Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

Legend

- - - - - -► γ Decay (Uncertain)



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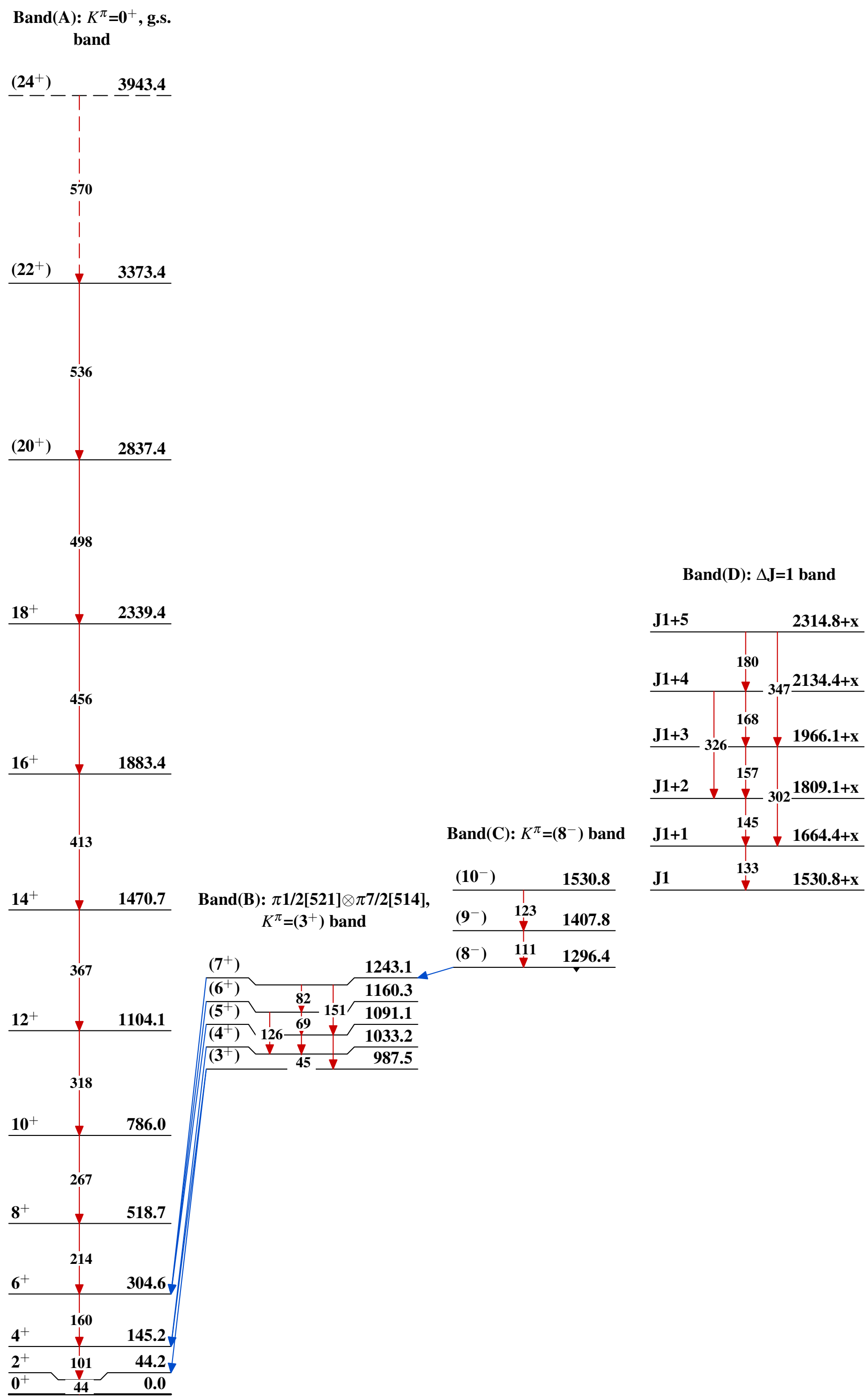
Adopted Levels, Gammas



$^{254}_{102}No_{152}$