^{254}No IT decay (184 μs):GSI 2010He10

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

Parent: ^{254}No: E=3002.0 *22*; $T_{1/2}$=184 μs *3*; %IT decay=100.0

This dataset includes 2016WaZW, experiment performed at Jyvaskyla to resolve the very different level decay schemes proposed in 2010He10 and in 2010Cl01 (from experiment at LBNL).

2010He10: ^{208}Pb(^{48}Ca,2nγ),E=213.6,218.4 MeV. The ^{48}Ca beam obtained from the UNILAC of GSI. Target=isotopically enriched, ^{208}PbS, 450 μg/cm^2 thick backed on 40 μg/cm^2 Carbon substrate and covered with a 10 μg/cm^2 carbon layer. The evaporated residues were separated using SHIP and implanted in Si PIPS detector. The α particles and fission fragments were detected with six Si detectors surrounding the PIPS. The γ-rays were detected using Ge clover detector surrounding the SHIP separator. Measured Eγ, Iγ, $\gamma\gamma$, γ(ce)-coin, (particle)γ(t), fission and α decay branches. Ph.D. thesis by B. Sulignano, Johannes Gutenberg-University Mainz (2007) also describes the experiment at GSI, and tabulates γ-ray energies emitted by the decay of both the isomers.

2016WaZW: ^{208}Pb(^{48}Ca,2n),E=219 MeV; measured Eγ, Iγ, ce, recoils, (recoil)γ-coin, $\gamma\gamma$-coin, and γ(ce)-coin using RITU separator, SAGE and GREAT spectrometers at JYFL accelerator facility. Recoil-decay tagging method. Deduced high-spin levels, J, π, conversion coefficients, multipolarities, decay scheme of the high-K, 184−μs isomer to feed the (8$^-$) 265-ms isomer. Comparison with different decay scheme between the 184−μs isomer and the 265-ms isomer proposed by 2010Cl01 and 2010He10, with preference for the latter. A 482γ reported by 2010Cl01 was not confirmed by 2016WaZW. Ph.D. thesis by M. Venhart, Comenius University, Bratislava (2008) also describes the experiment at Jyvaskyla, and tabulates γ-ray energies emitted by the decay of both the isomers.

2010He10 take level scheme up to (8$^-$) isomer from 2006He19 and 2006Ta19, except for the two new transitions 778 and 856 keV from their work. Above the (8$^-$) isomer, the level scheme is proposed by 2010He10.

^{254}No Levels

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$	Comments
0[#]	0$^+$	51.2 s *4*	%SF=0.23 *10* (2010He10) $T_{1/2}$: from timing of 8.1 MeV α peak from ^{254}No decay (2006He19).
44[#] *1*	2$^+$		
146[#] *1*	4$^+$		
304[#] *2*	6$^+$		
518[#] *2*	8$^+$		
987.3[@] *13*	(3$^+$)		
1032.8[@] *14*	(4$^+$)		
1090.6[@] *14*	(5$^+$)		
1159.5[@] *15*	(6$^+$)		
1241.7[@] *16*	(7$^+$)		
1295.2[&] *17*	(8$^-$)	265 ms *2*	%SF=0.020 *12* (2010He10) %$\alpha\leq$0.01 (2010He10) %SF determined from number of observed fission events correlated to an evaporation residue within Δt(ER-SF)$\leq$1 s and the number of ^{254}No nuclei produced in the isomeric state. Upper limit of %α estimated from energy summing of α-particles and conversion electrons from the first 2$^+$ to g.s. transition, while considering that α transition to the g.s., requiring ΔL=8, is highly unlikely. σ(265-ms isomer)/σ for ^{254}No=0.28 *2* (2010He10). E(level): 1295 keV *2* (2010He10). $T_{1/2}$: from Adopted Levels. 2010He10 measured 275 ms *7* from time distribution between the recoil implantations and the decay of the isomer through electron signals. Configuration=π9/2[624]$\otimes\pi$7/2[514], K^π=8$^-$. But long half-life of this isomer may be due to contribution from 2-neutron configurations of K^π=8$^-$: ν7/2[624]$\otimes\nu$9/2[734] and ν7/2[613]$\otimes\nu$9/2[734].

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^{254}No IT decay (184 μs):GSI 2010He10 (continued)

^{254}No Levels (continued)

E(level)†	Jπ‡	$T_{1/2}$	Comments
1406.5& *17*	(9⁻)		
1529.4& *18*	(10⁻)		Expected transition to 9⁻ overlaps with K-x rays of nobelium.
1662.7& *18*	(11⁻)		
1807.7& *20*	(12⁻)		Expected transition to 11⁻ overlaps with K-x rays of nobelium.
1964.6& *20*	(13⁻)		
2133.0& *20*	(14⁻)		
2312.3& *20*	(15⁻)		
2918.0?& *20*	(16)		E(level): 2917 *3* (2010He10).
3002.0 *22*		184 μs *3*	%SF≤0.012 (2010He10) Upper limit of %SF estimated from non-observation of spontaneous fission events following the implantation of an evaporation residue within Δt(ER-SF)<1 ms, and on the basis of the population intensity of the isomer. σ(184−μs isomer)/σ for ^{254}No=0.04 *1* (2010He10). Based on the possible delayed character of the 605.7-keV transition, 2016WaZW proposed that the 184−μs isomer decays directly through this transition, without going through an intermediate level, however, the statistics were weak, and this transition possibly mixed with a similar energy γ ray in the spectra resulting from ^{74}Ge(n,n′γ). While negating several observations in 2010Cl01, 2016WaZW also suggested that there could be two 605-keV transitions in ^{254}No, one delayed and the other prompt. 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". Further experiments, with better statistics, and perhaps better detector technology are needed to confirm the decay scheme of the 184−μs isomer feeding the 265-ms isomer. $T_{1/2}$: from Adopted Levels. 2010He10 measured 198 μs *13* from time distribution between the recoil implantations and the decay of the isomer through electron signals. E(level): all experimental evidences indicate that the 605.7γ is prompt, therefore, the K=(16) state cannot correspond to the 198 μs isomeric state. The isomer is probably built on a state of lower K value. There is weak evidence that there is an 84-keV γ-ray from this level. Jπ: $K^\pi=16^+$ with configuration=[(π7/2[514]⊗π9/2[624]),$K^\pi=8^-$] ⊗ [(ν7/2[624]⊗ν9/2[734]),$K^\pi=8^-$].

† From least-squares fit to Eγ values, assuming 1 keV uncertainty for Eγ when not stated.
‡ From 2010He10. Authors suggested that the assignments should be treated as tentative since no experimental data were obtained for determining multipolarities of the transitions.
# Band(A): g.s. band.
@ Band(B): π1/2[521]⊗π7/2[514],$K^\pi=3^+$.
& Band(C): π9/2[624]⊗π7/2[514],$K^\pi=8^-$.

γ(^{254}No)

Additional information 1.

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γ(^{254}No) (continued)

E_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.	α‡	$I_{(\gamma+ce)}$†	Comments
(44)	44	2^+	0	0^+				
45	1032.8	(4^+)	987.3	(3^+)				
53	1295.2	(8^-)	1241.7	(7^+)	[E1]	0.83 *5*		
58	1090.6	(5^+)	1032.8	(4^+)				
69	1159.5	(6^+)	1090.6	(5^+)				
82	1241.7	(7^+)	1159.5	(6^+)				
84#	3002.0		2918.0?	(16)				
102	146	4^+	44	2^+				
103	1090.6	(5^+)	987.3	(3^+)				
111.4 *2*	1406.5	(9^-)	1295.2	(8^-)	[M1]	9.51	98 *20*	
123	1529.4	(10^-)	1406.5	(9^-)				Expected line overlaps K-x rays.
126	1159.5	(6^+)	1032.8	(4^+)				
133.3 *1*	1662.7	(11^-)	1529.4	(10^-)	[M1]	5.67	100	
145	1807.7	(12^-)	1662.7	(11^-)				Expected line overlaps K-x rays.
151	1241.7	(7^+)	1090.6	(5^+)				
156.9 *2*	1964.6	(13^-)	1807.7	(12^-)	[M1]	15.23	101 *27*	E_γ: 159.7 *3* (2016WaZW in Table 9.1). It seems that Eγ is too high by ≈3 keV in 2016WaZW. $I_{(\gamma+ce)}$: 380 *210* (2016WaZW in Table 9.1).
159	304	6^+	146	4^+				
168.5 *1*	2133.0	(14^-)	1964.6	(13^-)	[M1]	12.47	98 *26*	
179.5 *1*	2312.3	(15^-)	2133.0	(14^-)	[M1]	10.43	74 *22*	E_γ: 179 *2* (2016WaZW in Table 9.1). $I_{(\gamma+ce)}$: 330 *190* (2016WaZW in Table 9.1).
214	518	8^+	304	6^+				Iγ(214)/Iγ(778)=0.93 *37* (2010He10).
x250								See only by 2016WaZW (Fig. 9.2), in the focal-plane clover detectors coincidence with the decay of the 184−μs isomer.
x256								Uncertain γ from 2010He10.
256#	1662.7	(11^-)	1406.5	(9^-)				
302	1964.6	(13^-)	1662.7	(11^-)				
325	2133.0	(14^-)	1807.7	(12^-)				
347.1 *2*	2312.3	(15^-)	1964.6	(13^-)	[E2]	0.229	4.5 *17*	
605.7 *1*	2918.0?	(16)	2312.3	(15^-)	[M1,E1]	0.19 *17*	92 *31*	The decay of the 184−μs isomer through an intermediate 605-keV transition was also proposed by 2006Ta19 (experiment at ANL using Gammasphere array). E_γ: 604 *3* (2016WaZW in Table 9.1). $I_{(\gamma+ce)}$: from I(γ+ce)=103 *19* if mult(605.7γ)=M1; 75 *14* if mult(605.7γ)=E1 (2010He10). Other I(γ+ce)(604γ):I(γ+ce)(179γ):I(γ+ce)(159.3γ)= 100 *30*: 330 *190*: 380 *210* (2016WaZW in Table 9.1).
778	1295.2	(8^-)	518	8^+				Iγ(778)/Iγ(841)=0.03 *2*, 0.16 *50* (2010He10).
841	987.3	(3^+)	146	4^+	[M1]	0.146		Iγ(778)/Iγ(841)=0.03 *2*, 0.16 *50* (2010He10).
856	1159.5	(6^+)	304	6^+				Iγ(856)/Iγ(159)=0.40 *15* (2010He10). [Iγ(778)+Iγ(856)]/Iγ(159)=0.83 *25* (2010He10).
887	1032.8	(4^+)	146	4^+				
943	987.3	(3^+)	44	2^+	[M1]	0.107		

† Relative to 100 for 133.3γ.

‡ 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.

x γ ray not placed in level scheme.

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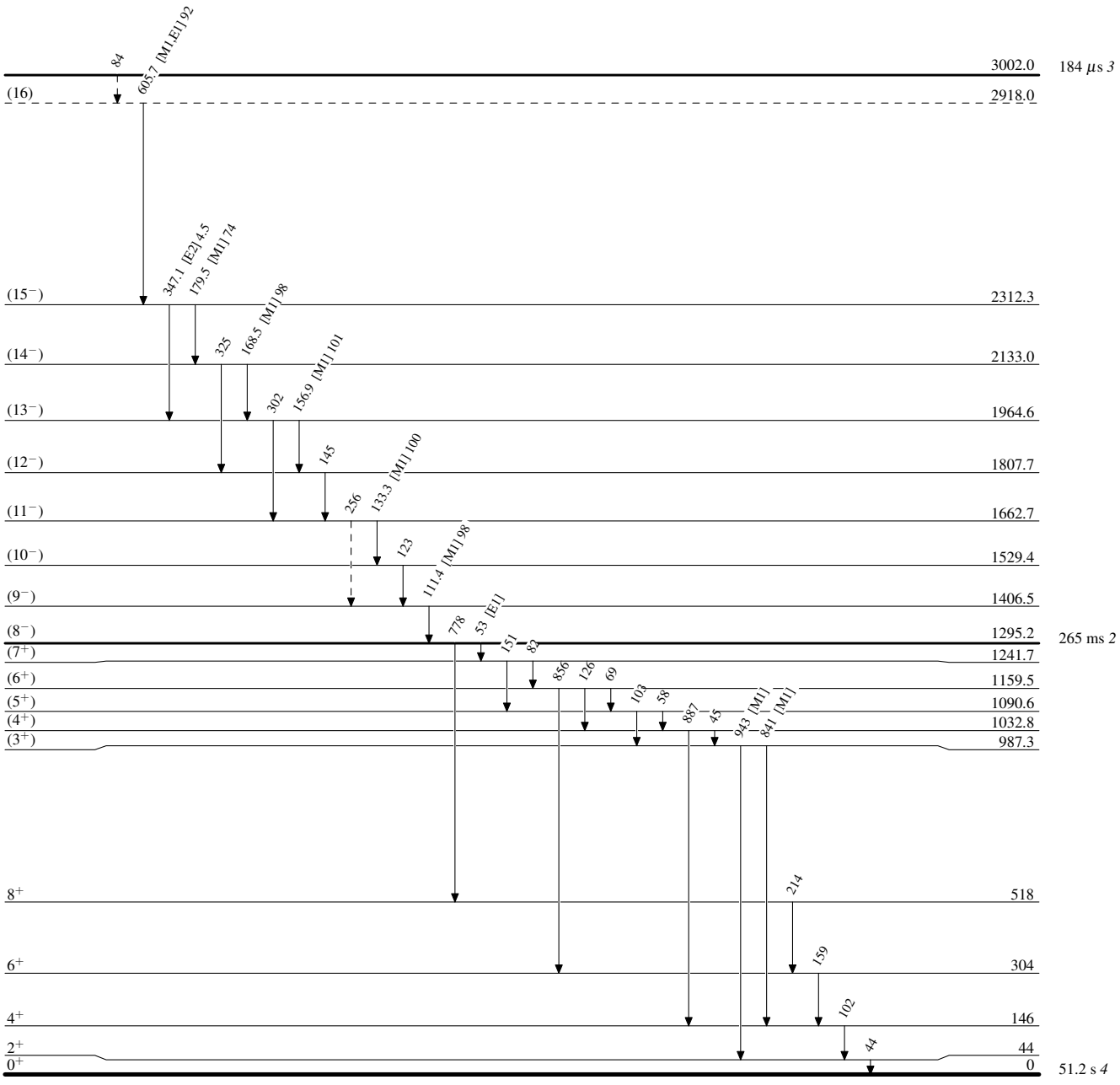
Legend

Decay Scheme

%IT=100.0

γ Decay (Uncertain)



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

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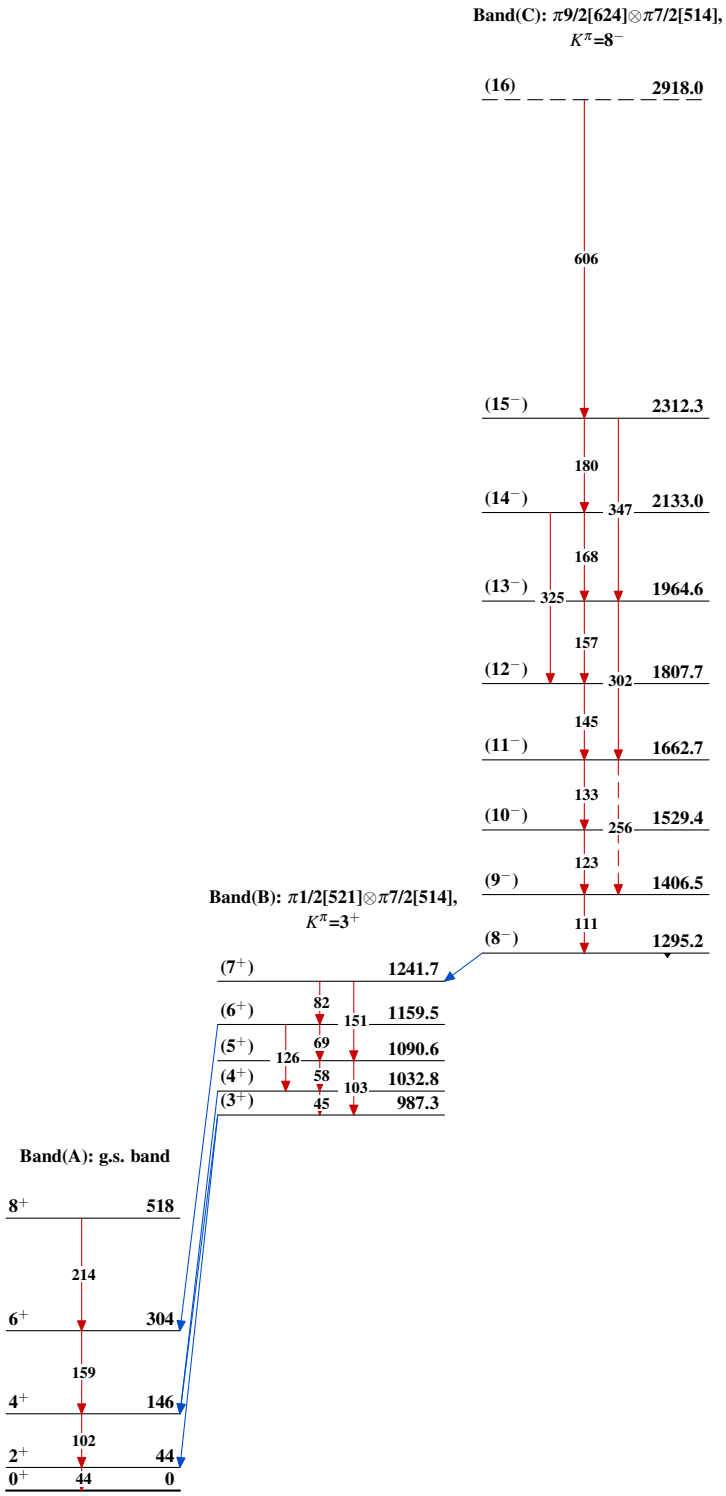

$^{254}_{102}No_{152}$