^{227}Pa α decay 1989Ah05,1990Sh15,1963Su10

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	E. Browne	NDS 93, 846 (2001)	1-May-2001

Parent: ^{227}Pa: E=0.0; J$^{\pi}$=(5/2^{-}); $T_{1/2}$=38.3 min *3*; Q(α)=6580.0 *21*; %α decay=85 *2*
^{227}Pa-%α decay: from εK(exp)/α=0.18 *2* (1951Me10).
Additional information 1.
Mass-separated sources. Measured Eγ, Iγ, Ice, $\alpha\gamma$ coin, (α)(ce) coin. Detectors:Ge(Li), Si(Li), plastic scin, Si (1989Ah05,1990Sh15). Other: 1963Su10.
Measured (α)(ce)(t), deduced level half-lives (1989Ah05).
See 1999Sc17, 1997Sc16 for measured I$\alpha(\theta)$ for oriented ^{227}Pa nuclei. Others: 1996St14, 1994Be30, 1992Wo14.

^{223}Ac Levels

E(level)[#]	J$^{\pi}$[†‡]	$T_{1/2}$[d]	Comments
0.0[@]	(5/2^{-})[c]	2.10 min *5*	$T_{1/2}$: from Adopted Levels.
4.1?[e]	(3/2^{-})		
12.5?[af] *2*	(3/2^{-})[c]		
42.4[@] *1*	(7/2^{-})[c]	≤0.25 ns	
50.7[a] *1*	(5/2^{-})[c]	≤0.25 ns	
64.62[&] *4*	(5/2^{+})[c]	≤0.25 ns	
88.9?[e]	(3/2^{+})		
89.1?[e]	(7/2^{-})		
90.7[@] *1*	(9/2^{-})[c]	≤0.25 ns	
97.3?[f] *2*	(3/2^{+})		
107.2[af] *2*	(7/2^{-})[c]	≤0.25 ns	
110.06[&] *4*	(7/2^{+})[c]	≤0.25 ns	
110.2?[e]	(5/2^{+})		
130.7[b] *1*	(7/2^{+})		
141[@] *5*	(11/2^{-})		
167.5[&] *1*	(9/2^{+})[c]	≤0.25 ns	
185.0?[e]	(9/2^{-})		

[†] Parity doublet rotational band assignments are from 1990Sh16, 1990Sh15, 1989Ah05, and 1990Ja11. Spin and parity assignments are based on rotational structure and γ-ray multipolarities.
[‡] Although octupole deformations are small in this region, nuclear states are no longer fully characterized by single Nilsson orbitals. This terminology, however, is used throughout this evaluation to label states rather than to accurately describe their nature.
[#] Deduced by evaluator from a least-squares fit to γ-ray energies.
[@] Band(A): 5/2(523) parity doublet rotational band.
[&] Band(B): 5/2(642) parity doublet rotational band.
[a] Band(C): 3/2(532) parity doublet rotational band.
[b] Band(D): 3/2(651) parity doublet rotational band.
[c] From Adopted Levels.
[d] From 1989Ah05.
[e] Reported by 1990Sh15 only.
[f] Reported by 1989Ah05 only.

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α radiations

Transition-intensity balance for each level using γ-ray data and the decay scheme of 1990Sh15 could not reproduce most of the measured α-particle intensities.

Eα[†]	E(level)	Iα[†#]	HF[‡]	Comments
6299 *5*	167.5	0.8	29	Iα: 0.6 *1* deduced by evaluator from γ-ray transition intensity balance.
6326 *5*	141	0.4	75	
6336 *5*	130.7	0.7	48	
6356.7 *3*	110.06	7.9 *3*	5.2	Iα: combined intensity to 107 and 110 levels. Iα≈4 (HF=11) to 110 level deduced by evaluator from γ-ray transition intensity balance.
6376 *5*	90.7	2.6	19	Iα: 3 *1* deduced by evaluator from γ-ray transition intensity balance.
6401.7 *3*	64.62	9.4 *4*	6.8	Iα: 9.7 *3* deduced by evaluator from γ-ray transition intensity balance.
6415.8 *3*	50.7	15.1 *4*	4.9	Iα: 17 *2* deduced by evaluator from γ-ray transition intensity balance.
6423.8 *3*	42.4	11.7 *4*	6.8	Iα: 14 *8* deduced by evaluator from γ-ray transition intensity balance.
6465.8 *3*	0.0	50.2 *16*	2.4	Iα: 48 *8* deduced by evaluator from γ-ray transition intensity balance.

† Intensities are per 100 α decays of ^{227}Pa (1958Hi78,1963Su10). Data for Eα≥6376 MeV have been evaluated by 1991Ry01, and recommended values are presented here. Fractional uncertainties in Iα are 2.5% (1958Hi78). Energies have been adjusted by 5.8 keV because of a change in the calibrating α-particle energies of ^{211}Bi (1991Ry01).

‡ Using $r_0(^{223}Ac)=1.529$, average of $r_0(^{222}Ra)=1.5383$ *8*, $r_0(^{224}Ra)=1.5332$ *8*, $r_0(^{222}Th)=1.522$ *22*, and $r_0(^{224}Th)=1.524$ *9* (1998Ak04).

\# For absolute intensity per 100 decays, multiply by 0.85 *2*.

γ(^{223}Ac)

Iγ normalization: from Iγ(65γ)=7.2 *3* per 100 α′s, experimental value (1990Sh15), and %α=85 *2* (1951Me10). Other values: 8.2 *8*, deduced from γ-ray transition intensity balance (1989Ah05); 6.2, experimental value (1963Su10).

Experimental relative K x ray intensity=22 *3* (1990Sh15) agrees with a value of 18 *4* deduced by evaluator from the decay scheme. All of the K x ray intensity originates from atomic vacancies created by the 110-, 125-, and 130-keV transitions.

E_γ	I_γ[@&]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	δ	α[a]	Comments
(8.0)		50.7	(5/2⁻)	42.4	(7/2⁻)	[M1]		1542	
(12.5)		12.5?	(3/2⁻)	0.0	(5/2⁻)				
21.1[#d] *1*	1.1[#] *4*	110.2?	(5/2⁺)	89.1?	(7/2⁻)	(E1)[#]		7.13	α(L)= 5.30; α(M)= 1.38 Populates 89.1 ((7/2⁻)) or 88.9 ((3/2⁺)).
22.3[‡] *1*	2.1 *6*	64.62	(5/2⁺)	42.4	(7/2⁻)	E1		6.17	I_γ,Mult.: from 1990Sh15.
38.4[#d] *2*	0.6[#] *3*	89.1?	(7/2⁻)	50.7	(5/2⁻)	(M1)[#]		59.8	α(L)= 45.3; α(M)= 10.9
42.4[‡] *1*	2.1 *5*	42.4	(7/2⁻)	0.0	(5/2⁻)	M1+E2	0.63 *1*	214	I_γ: other value: 5.0 *6* (1990Sh15). Mult.,δ: from ce(L1) + ce(L2)/ce(L3) exp=2.5+6-4 (1989Ah05). E_γ: other value: 42.5 *2* (1989Ah05).
45.6[†d] *2*	≈2.2	97.3?	(3/2⁺)	50.7	(5/2⁻)	(E1)		0.882	I_γ: from Iγ(doublet)=2.7 *6* (1989Ah05) and Iγ(45.6γ, 110 level)≈0.5. Mult.: from experimental α(doublet)=5.2 *15* (1989Ah05), assuming the other 45.6γ which deexcites the 110 level is M1. E_γ: other value: 45.5 *1* (1990Sh15).

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^{227}Pa α decay 1989Ah05,1990Sh15,1963Su10 (continued)

$\gamma(^{223}$Ac) (continued)

E_γ	I_γ[@&]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	α[a]	Comments
45.6[†] *2*	≈0.5	110.06	(7/2$^+$)	64.62	(5/2$^+$)	(M1)		36.0	I_γ: from Iγ(doublet)=2.7 *6*, experimental α(doublet)=5.2 *15*, and γ-ray transition intensity balance at 64.6 level needed to reproduce the experimental Iα=9.6. The existence of this doublet was inferred from the measured α=5.2 *15*, which could not be less than 36 (for pure M1) (1989Ah05). Mult.: from ce data (1989Ah05).
46.6[#d] *2*	1.5[#] *4*	50.7	(5/2$^-$)	4.1?	(3/2$^-$)	(M1)[#]		33.7	α(L)= 25.6; α(M)= 6.14
48.3[‡] *1*	1.4 *5*	90.7	(9/2$^-$)	42.4	(7/2$^-$)	M1		30.3	E_γ: other value: 48.5 *3* (1989Ah05). I_γ: other value: 1.3 *4* (1990Sh15).
50.7[b‡] *1*	1.9 *5*	50.7	(5/2$^-$)	0.0	(5/2$^-$)	M1+E2	0.26 *1*	41.9 *11*	E_γ: other value: 50.5 *2* (1989Ah05). I_γ: other value: 2.9 *6* (1990Sh15). Mult.,δ: from ce(L1) + ce(L2)/ce(L3) exp=5.3+25-15 (1989Ah05).
50.7[b‡#d] *1*	[#]	141	(11/2$^-$)	90.7	(9/2$^-$)	M1+E2[#]			
54.3[#d] *1*	2.4[#] *4*	185.0?	(9/2$^-$)	130.7	(7/2$^+$)	(E1)[#]		0.587	α(L)= 0.442; α(M)= 0.108; α(N+..)= 0.0368
56.6[†] *2*	≈2	107.2	(7/2$^-$)	50.7	(5/2$^-$)				Not observed by 1990Sh15.
57.5[‡]		167.5	(9/2$^+$)	110.06	(7/2$^+$)				Only ce lines were observed (1990Sh15).
59.5[c‡] *2*	1.7[c] *4*	110.06	(7/2$^+$)	50.7	(5/2$^-$)	E1		0.459	E_γ: other value: 59.7 *2* (1989Ah05). Mult.: from ce data (1989Ah05).
59.5[c#d] *2*	2.5[c#] *4*	110.2?	(5/2$^+$)	50.7	(5/2$^-$)	E1[#]			
60.5[#d] *3*	1.0[#] *4*	64.62	(5/2$^+$)	4.1?	(3/2$^-$)	(E1)[#]		0.439	α(L)= 0.331; α(M)= 0.0807; α(N+..)= 0.0275
64.62 *5*	100	64.62	(5/2$^+$)	0.0	(5/2$^-$)	E1		0.369	Mult.: from α=0.32 *11*, α(L3)exp<0.65, and ce(L1) + ce(L2)/ce(L3) exp= 1.6 *5* (1989Ah05). E_γ: other value: 64.9 *1* (1989Ah05).
67.6[‡] *1*	6.9 *8*	110.06	(7/2$^+$)	42.4	(7/2$^-$)	E1		0.327	E_γ: other value: 67.9 *1* (1989Ah05). I_γ: other value: 10.1 *8* (1990Sh15). Mult.: from ce data (1989Ah05).

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^{227}Pa α decay 1989Ah05,1990Sh15,1963Su10 (continued)

γ(^{223}Ac) (continued)

E_γ	I_γ [@&]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	α [a]	Comments
74.9[#d] *1*	3.2[#] *6*	185.0?	(9/2⁻)	110.06	(7/2⁺)	(E1)[#]	0.249	α(L)= 0.188; α(M)= 0.0455; α(N+..)= 0.0156
77.0[‡] *2*	0.8 *4*	167.5	(9/2⁺)	90.7	(9/2⁻)	(E1)	0.231	Iγ,Mult.: from 1990Sh15.
80.0[#d] *1*	2.4[#] *4*	130.7	(7/2⁺)	50.7	(5/2⁻)	E1[#]	0.209	α(L)= 0.158; α(M)= 0.0381; α(N+..)= 0.0132
84.8[c#d] *1*	14[c#] *2*	88.9?	(3/2⁺)	4.1?	(3/2⁻)	E1[#]		
84.8[c‡d] *1*	6.5[c] *9*	97.3?	(3/2⁺)	12.5?	(3/2⁻)	E1	0.179	
89.1[#d] *2*	2.2[#] *6*	89.1?	(7/2⁻)	0.0	(5/2⁻)	[#]		
107.0[†] *5*	≈2.5	107.2	(7/2⁻)	0.0	(5/2⁻)	M1	7.17	Iγ: from experimental Iα(6356α)=8.0, and Iα≈4 to 110 level. Only conversion electron lines were observed (1989Ah05).
110.05[‡] *5*	20.3 *15*	110.06	(7/2⁺)	0.0	(5/2⁻)	E1	0.393	Eγ: other value: 110.4 *1* (1989Ah05). Iγ: other value: 31 *3* (1990Sh15). Mult.: from α(K)exp<1.1 and α(L)exp<2.0 (1989Ah05).
125.1[‡] *1*	6.2 *9*	167.5	(9/2⁺)	42.4	(7/2⁻)	E1	0.288	Eγ: other value: 126.0 *2* (1989Ah05). Iγ: other value: 7 *1* (1990Sh15). Mult.: from 1990Sh15.
130.7[#d] *1*	4.3[#] *10*	130.7	(7/2⁺)	0.0	(5/2⁻)	E1[#]	0.259	α(K)= 0.202; α(L)= 0.0432; α(M)= 0.0104; α(N+..)= 0.00363

† From 1989Ah05.
‡ From 1990Sh15.
\# From 1990Sh15. Placement in the decay scheme is considered uncertain by evaluator. Multipolarity is from ce data.
@ From 1989Ah05, unless otherwise specified. Authors claim all γ rays with absolute intensities>0.2 (per 100 α′s) have been observed.
& For absolute intensity per 100 decays, multiply by 0.061 *3*.
a 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.
b Multiply placed.
c Multiply placed with intensity suitably divided.
d Placement of transition in the level scheme is uncertain.

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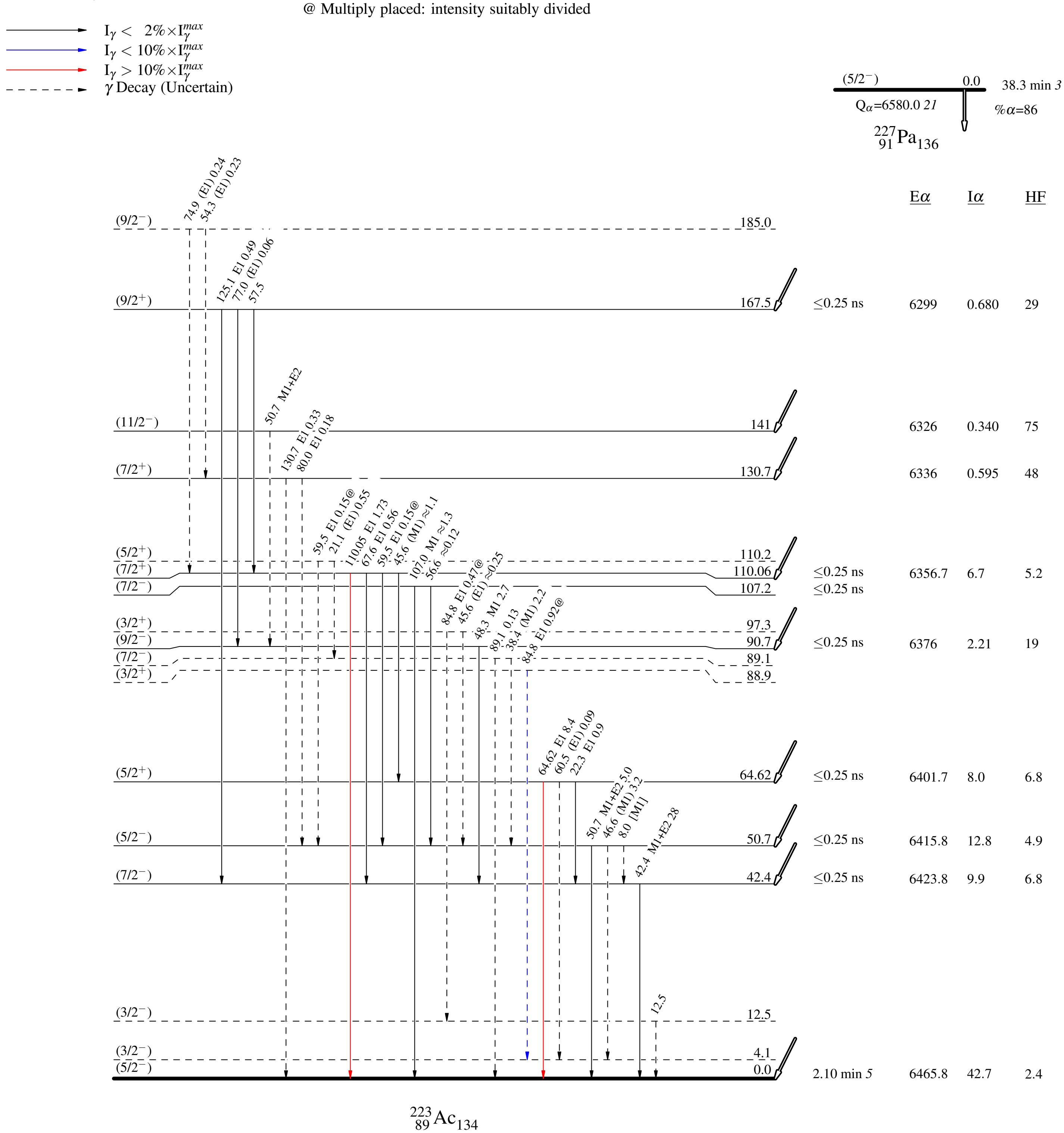
Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
@ Multiply placed: intensity suitably divided



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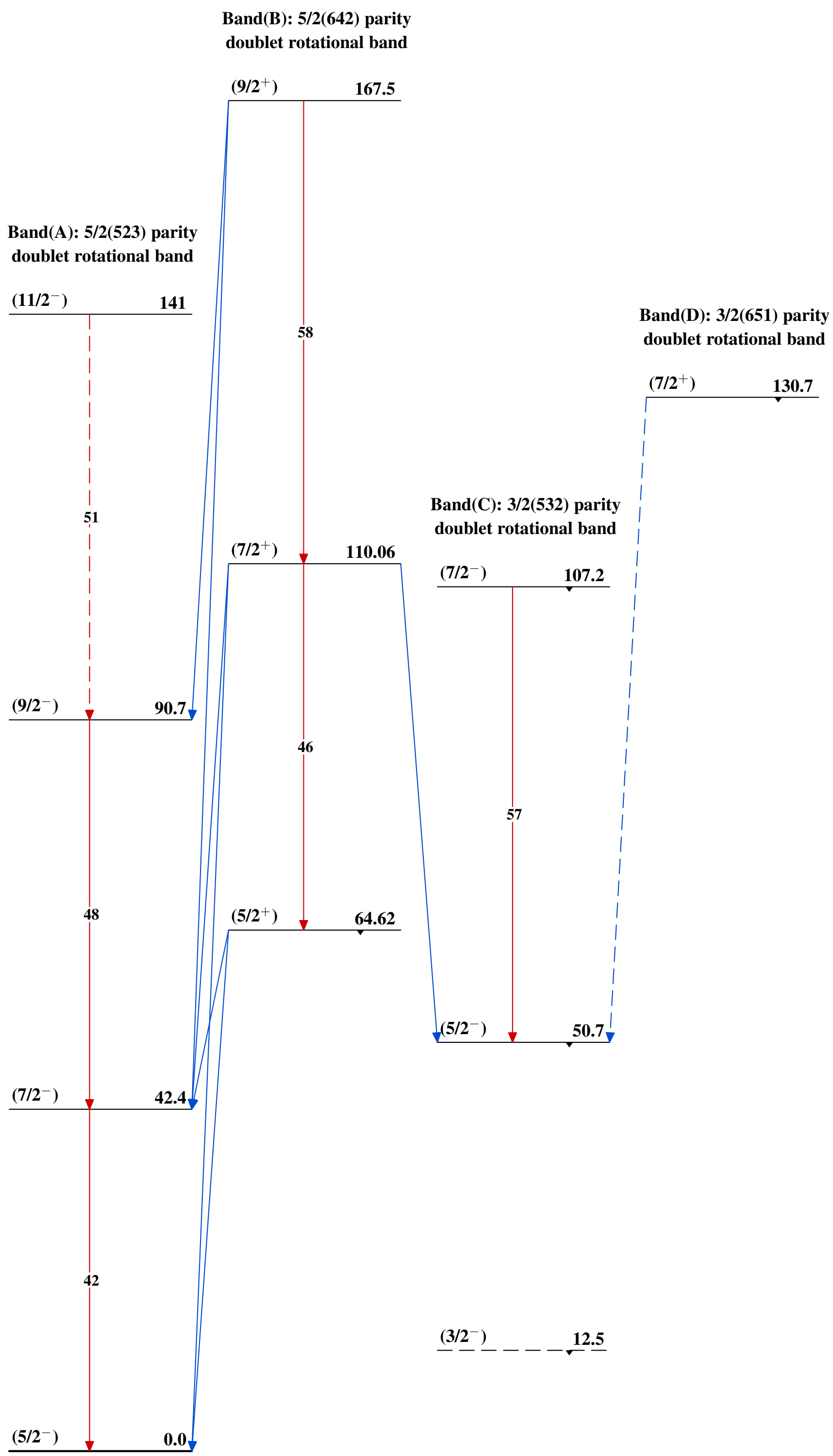

$^{223}_{89}Ac_{134}$