Nuclear Data Sheets 93, 763 (2001)
doi:10.1006/ndsh.2001.0016

Nuclear Data Sheets for A = 215,219,223,227,231*

E. BROWNE

Lawrence Berkeley Laboratory
Berkeley, California 94720, USA

(Received April 17, 2000; Revised July 23, 2001)

Abstract: The evaluator presents in this publication spectroscopic data and level schemes from radioactive decay and nuclear reaction studies for all nuclei with mass numbers A=215, 219, 223, 227, and 231.

Nuclei with mass number A=215 have spherical shape, and their nuclear structure have been interpreted in terms of the shell model. Nuclei with mass number A=219 belong to a transitional region with spherical, quadrupole, and possibly octupole deformations; those with mass numbers A=223 and 227 belong to a newly studied region of coexisting quadrupole with possible octupole deformations; and nuclei with mass number A=231 essentially have quadrupole deformation.

Highlights of this publication are given below:

A recent study of the ^{206}Pb(^{13}C,4nγ) reaction (1998St24) has extended up to Jπ=61/2+ the previously known level scheme from ^{208}Pb(^{13}C,6nγ) (1988Fu10,1983Lo16). This study has provided a new interpretation for all the spectroscopic data above the 2247–keV (Jπ=29/2–) level in ^{215}Ra.

A new isotope, ^{219}U (42 μs), which was identified with the recoil separator VASSILISSA (1994Ye08,1994AnZY,1993An07), has been included in this evaluation.

The first ^{223}Rn β– decay scheme (1992Ku03) and a significantly improved measurement of ^{227}Ac α decay (1995Sh03) are presented here. A level scheme of ^{223}Fr has been constructed on the basis of these studies, where most of the levels below 600 keV have been assigned to parity doublet bands and interpreted in terms of the reflection–asymmetric rotor model.

This evaluation includes the first level structures of ^{227}Fr and ^{227}Th. Levels in ^{227}Fr are from ^{227}Rn β– decay (1997Ku20); those in ^{227}Th, are from ^{231}U α decay, from ^{227}Pa electron–capture decay, and from ^{226}Ra(α,3nγ) (1997Mu08,1995Li04,1998Ma83).

A study of the β– decay of a mass–separated source of ^{231}Fr has produced the first level scheme of ^{231}Ra (2001Fr05).

The only published data (1994Br36,1996Le01) on the electron–capture decay of ^{231}U have provided much information on the level structure of ^{231}Pa. Studies on ^{232}Th(p,2nγ) and Coulomb Excitation of ^{231}Pa (1996Le01,1999Wu05), which have complemented the existing spectroscopic data from these reactions, have suggested the possibility of weak octupole correlations in ^{231}Pa.

A new isotope of plutonium, ^{231}Pu (1999La14), has been included in this evaluation.

Cutoff Date: All data received by May 2001 have been evaluated.

General Policies and Organization of Material: See the introductory pages.

General Comments: The alpha hindrance factors (HF) presented in this evaluation have been calculated using values of the radius parameter (r_0) interpolated from those for even–even adjacent nuclei given by 1998Ak04.

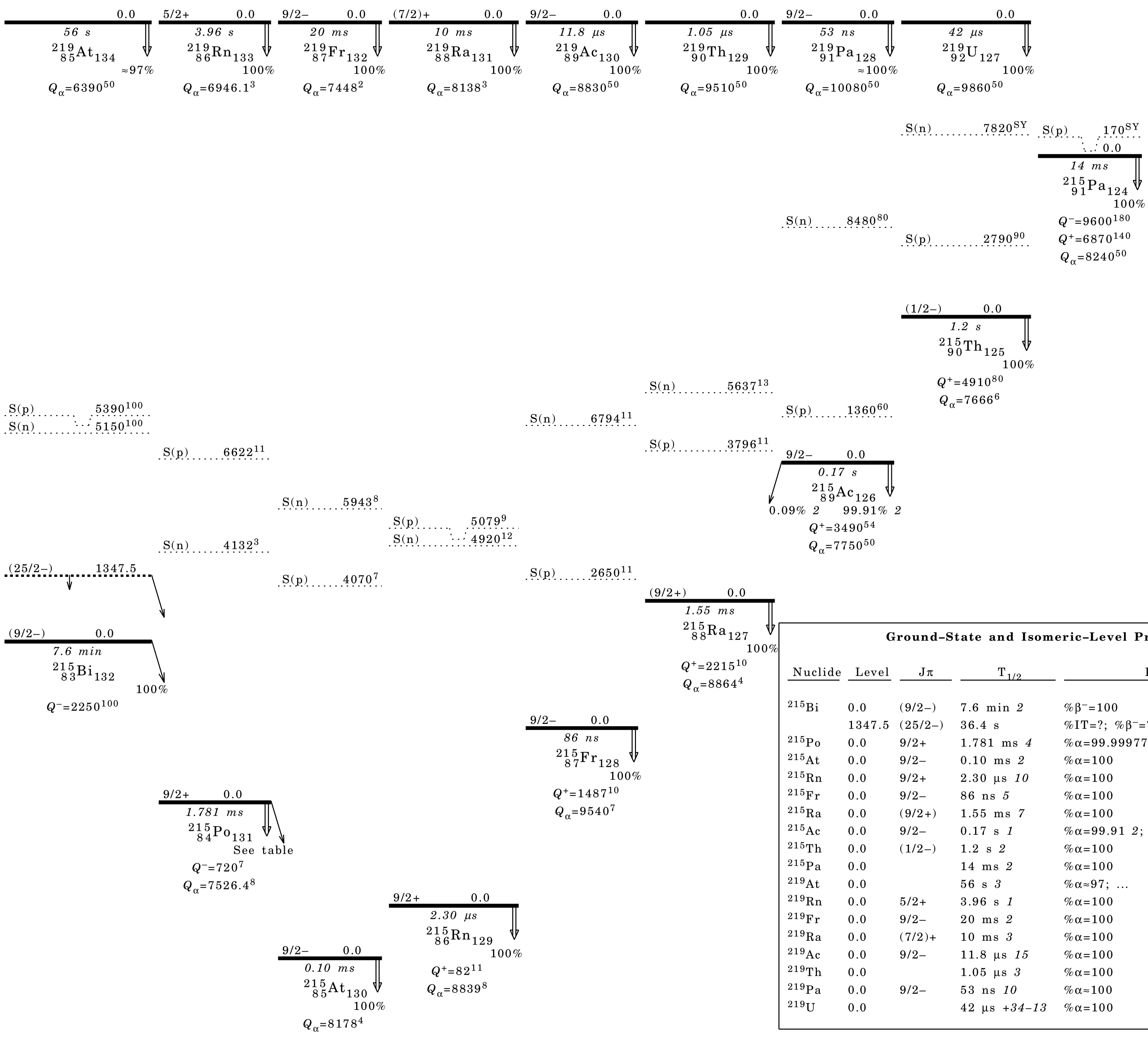
The *Limitation of Relative Statistical Weight (LWM)* method (1985ZiZY) has been used for discrepant data throughout this evaluation.

* This work was supported by the Director, Office of Energy Research, Office of High Energy and Nuclear Physics, Nuclear Physics Division of the US Department of Energy under contract DE–AC03–76SF00098.

0090–3752/01 $35.00

Index for A = 215

Skeleton Scheme for A=215



Ground-State and Isomeric-Level Properties

Nuclide	Level	Jπ	$T_{1/2}$	Decay Modes
^{215}Bi	0.0	(9/2−)	7.6 min *2*	%β⁻=100
	1347.5	(25/2−)	36.4 s	%IT=?; %β⁻=?
^{215}Po	0.0	9/2+	1.781 ms *4*	%α=99.99977 *2*; %β⁻=2.3×10⁻⁴ *2*
^{215}At	0.0	9/2−	0.10 ms *2*	%α=100
^{215}Rn	0.0	9/2+	2.30 μs *10*	%α=100
^{215}Fr	0.0	9/2−	86 ns *5*	%α=100
^{215}Ra	0.0	(9/2+)	1.55 ms *7*	%α=100
^{215}Ac	0.0	9/2−	0.17 s *1*	%α=99.91 *2*; %ε+%β⁺=0.09 *2*
^{215}Th	0.0	(1/2−)	1.2 s *2*	%α=100
^{215}Pa	0.0		14 ms *2*	%α=100
^{219}At	0.0		56 s *3*	%α≈97; ...
^{219}Rn	0.0	5/2+	3.96 s *1*	%α=100
^{219}Fr	0.0	9/2−	20 ms *2*	%α=100
^{219}Ra	0.0	(7/2)+	10 ms *3*	%α=100
^{219}Ac	0.0	9/2−	11.8 μs *15*	%α=100
^{219}Th	0.0		1.05 μs *3*	%α=100
^{219}Pa	0.0	9/2−	53 ns *10*	%α≈100
^{219}U	0.0		42 μs *+34−13*	%α=100

Adopted Levels, Gammas

Q(β⁻)=2250 *100*; S(n)=5150 *100*; S(p)=5390 *100*; Q(α)≈5200 1995Au04.
Q(α): estimated by evaluator from 1995Au04.
Descendant of ^{227}Ac (1953Hy83,1965Nu03). Parent of ^{215}Po (1953Hy83).
Source produced by spallation of 200–MeV protons on targets of ^{232}Th. ^{215}Bi(7.6 min) activity was identified by mass separation and by the observation of known γ rays in the daughter nucleus ^{215}Po (1990Ru02).
^{215}Bi(36.4 s) activity was produced by spallation of 1–GeV protons on targets of ^{238}U. The activity was identified by mass separation and resonant laser ionization (2001FrZZ).

^{215}Bi Levels

Cross Reference (XREF) Flags

A ^{219}At α Decay
B ^{215}Bi IT Decay (34.6 s)

E(level)	Jπ	XREF	$T_{1/2}$	Comments
0.0	(9/2−)	AB	7.6 min *2*	$T_{1/2}$: weighted average of 7.7 min *2* (1990Ru02), 7.5 min *4* (1989Bu09), and 7.4 min *6* (1965Nu03). Other value: 8 min *2* (1953Hy83). Jπ: analogy to ^{209}Bi, ^{211}Bi, and ^{213}Bi suggests $\pi h_{9/2}$ configuration. Strong 293–keV γ ray suggests significant β⁻ feeding to 293–keV (11/2)+ level and corroborates this configuration assignment. %β⁻=100. β⁻ particles were detected in a 4π plastic scintillator (1990Ru02). β⁻ decay had been previously inferred by measurements of the α decay of the ^{215}Po daughter nucleus (1953Hy83). %α≈$8.\times10^{-5}$ from systematics of α branching versus Q(α) for ^{212}Bi, ^{213}Bi, and ^{214}Bi.
746.6?	(13/2−)	B		
1160.7?	(17/2−)	B		
1347.5?	(25/2−)	B	36.4 s	Jπ: Possible configuration=$[\pi h_{9/2} + \nu(g_{9/2})^6{}_{8+}]_{25/2-}$. %IT=?; %β⁻=?

γ(^{215}Bi)

E(level)	Eγ†
746.6?	746.6‡
1160.7?	414.1‡
1347.5?	186.8‡

† From ^{215}Bi IT decay (34.6 s).
‡ Placement of transition in the level scheme is uncertain.

^{215}Bi IT Decay (34.6 s) 2001FrZZ

^{215}Bi(36.4 s) activity was produced by spallation of 1–GeV protons on targets of ^{238}U. The activity was identified by mass separation and resonant laser ionization.

^{215}Bi Levels

E(level)	Jπ	$T_{1/2}$	Comments
0.0	(9/2−)	7.6 min *2*	
746.6?	(13/2−)		
1160.7?	(17/2−)		
1347.5?	(25/2−)	36.4 s	Jπ: Possible configuration=$[\pi h_{9/2} + \nu(g_{9/2})^6{}_{8+}]_{25/2-}$.

^{215}Bi IT Decay (34.6 s) 2001FrZZ (continued)

$\gamma(^{215}Bi)$

Eγ†	E(level)
186.8‡	1347.5?
414.1‡	1160.7?
746.6‡	746.6?

† Measured βγγ x coin. Detector: plastic scintillator, hi–purity germanium.
‡ Placement of transition in the level scheme is uncertain.

^{219}At α Decay 1953Hy83

Parent ^{219}At: E=0.0; Jπ=?; $T_{1/2}$=56 s *3*; Q(g.s.)=6390 *50*; %α decay≈97.

α radiations

Measured Eα. Detector: ion chamber.

Eα	Iα†	Comments
6275 *50*	100	Eα: original energy of 1953Hy83 has been increased by 5 keV because of a change in the calibration energy of ^{211}Bi α particles from 6618 and 6272 keV to 6622.9 and 6278.2 keV, respectively (1991Ry01).

† For α intensity per 100 decays, multiply by ≈0.97.

Adopted Levels, Gammas

Q(β⁻)=720 *7*; S(n)=4132 *3*; S(p)=6622 *11*; Q(α)=7526.4 *8* 1995Au04.

^{215}Po Levels

Cross Reference (XREF) Flags

A ^{219}Rn α Decay
B ^{215}Bi β⁻ Decay

E(level)†	Jπ	XREF	$T_{1/2}$	Comments
0.0‡	9/2+	AB	1.781 ms *4*	$T_{1/2}$: weighted average of 1.778 ms *5* (1961Vo06), and 1.784 ms *6* (1971Er02). Other value: 1.83 ms *4* (1942Wa04). Jπ: favored α decay (HF=1.4) to ^{211}Pb (Jπ=9/2+). %α=99.99977 *2*; %β⁻=2.3×10⁻⁴ *2*. %β⁻ from 1950Av61. Other values: %β⁻≈5×10⁻⁴ (1944Ka01,1944Ka02); %β⁻≈4×10⁻⁴ (1955Ad09).
271.228‡ *10*	7/2+	AB	195 ps *15*	$T_{1/2}$: (α)(ce)(t) coin (1974Bo11). Other value: <250 ps (1969Be67). Jπ: 271.2γ M1+E2 to 9/2+, 130.6γ M1+E2 from 5/2+.
293.56§ *4*	(11/2)+	AB		Jπ: 293γ M1(+E2) to 9/2+.
401.812‡ *10*	5/2+	AB	66 ps *7*	Jπ: favored α decay (HF=3.4) from ^{219}Rn (Jπ=5/2+). $T_{1/2}$: from $T_{1/2}$(402 level)/$T_{1/2}$(271 level)=0.336 *23* (Doppler shift measurement in ^{219}Rn α decay) and using $T_{1/2}$(271 level)=195 ps *15* (1974Bo11).
517.60§ *6*	7/2+,9/2+	AB		Jπ: 517.6γ M1(+E2) to 9/2+, 224.0γ to (11/2)+. Jπ=7/2+ member of possible configuration=$(\pi h_{9/2})^2$ $(\nu g_{9/2})^4$ $(\nu i_{11/2})$.
608.30‡ *7*	(11/2+,13/2+)	A		Jπ: 608.3γ to 9/2+ and no gamma rays to 7/2+, 5/2+. Possible Jπ=13/2+ member of configuration=$(\pi h_{9/2})^2$ $(\nu g_{9/2})^5$.
676.66 *7*		AB		
708.1 *5*		A		
732.7 *4*		A		
835.32 *22*		AB		
877.2 *6*		A		
891.1 *3*		A		
930 *1*		A		
1073.7 *4*	(5/2+)	A		Jπ: low α hindrance factor (HF=31). Level belongs to possible ground state configuration=$(\pi h_{9/2})^2$ $(\nu g_{9/2})^5$.
1094.2 *10*		A		

† From ^{219}Rn α decay.
‡ Configuration=$(\pi h_{9/2})^2$ $(\nu g_{9/2})^5$.
§ Configuration=$(\pi h_{9/2})^2$ $(\nu g_{9/2})^4$ $(\nu i_{11/2})$.

γ(^{215}Po)

E(level)	Eγ†	Iγ†	Mult.†‡	δ†	α	Comments
271.228	271.23 *1*	100	M1+E2	3.7 *4*	0.210 *6*	B(M1)(W.u.)=0.00032 *7*; B(E2)(W.u.)=19.9 *16*.
293.56	293.56 *4*	100	M1(+E2)		0.35 *21*	α: for δ=1.0, assumed by evaluator.
401.812	130.60 *3*	2 *1*	M1+E2	0.64 *6*	4.55 *12*	B(M1)(W.u.)=0.0017 *3*; B(E2)(W.u.)=14 *3*.
	401.81 *1*	100 *3*	E2		0.0561	B(E2)(W.u.)=9.2 *11*.
517.60	224.0§ *7*	3.2 *5*				
	517.63 *6*	100 *5*	M1(+E2)		0.08 *5*	α: for δ=1.0, assumed by evaluator.
608.30	608.3 *2*	100				
676.66	383.1 *6*	2.5 *4*				
	405.4 *6*	1.4 *3*				
	676.64 *7*	100 *13*				
708.1	436.9 *6*	93 *7*				
	708.1 *8*	100 *30*				
732.7	330.8 *4*	100 *11*				
	461.6 *8*	17 *3*				
	732.8 *10*	7 *4*				
835.32	564.1 *3*	93 *20*				
	835.3 *3*	100 *20*				
877.2	877.2 *6*	100				
891.1	373.5 *6*	33 *4*				

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

γ(^{215}Po) (continued)

E(level)	Eγ†	Iγ†
891.1	489.3 *5*	83 *11*
	619.9 *6*	43 *14*
	891.1 *4*	100 *29*
930	321.8 *10*	100
1073.7	556.1 *10*	17 *10*
	671.9 *6*	70 *30*
	802.5 *6*	100 *30*
	1073.7 *6*	100 *30*
1094.2	576.6 *10*	100

† From ^{219}Rn α decay.
‡ From conversion electron data in ^{219}Rn a decay, although no specific electron intensities are given (1999Li05).
§ Placement of transition in the level scheme is uncertain.

^{215}Bi β$^-$ Decay 1990Ru02

Parent ^{215}Bi: E=0.0; Jπ=?; $T_{1/2}$=7.7 min *2*; Q(g.s.)=2250 *100*; %β$^-$ decay=100.

^{215}Po Levels

E(level)†	Jπ‡
0.0	9/2+
271.7 *1*	7/2+
293.74 *5*	(11/2)+
402.4 *3*	5/2+
517.6 *2*	7/2+,9/2+
676.5 *3*	
835.5 *3*	

† From γ-ray energies.
‡ From adopted levels.

γ(^{215}Po)

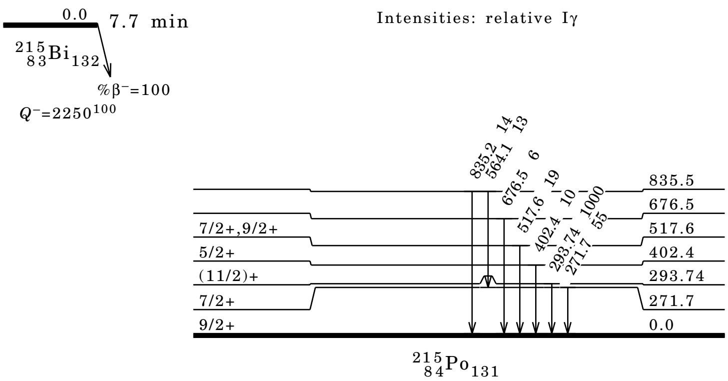
^{215}Bi mass-separated source produced by spallation of 200-MeV protons on targets of ^{232}Th. Measured Eγ, Iγ, γγ coin, βγ coin. Detectors: 4π plastic scintillator, Ge(Li).
β$^-$ feeding to ^{215}Po g.s. has not been determined, so the decay scheme normalization was not deduced.

Eγ‡	E(level)	Iγ
271.7† *1*	271.7	55 *5*
293.74† *5*	293.74	1000 *70*
402.4 *3*	402.4	10 *4*
517.6 *2*	517.6	19 *3*
564.1 *3*	835.5	13 *3*
676.5 *3*	676.5	6 *2*
835.2 *3*	835.5	14 *3*

† Assignment of this transition to ^{215}Bi β$^-$ decay was confirmed by its coincidence with Po x rays, and also by its decay rate, which is consistent with a half-life of 7.7 min for ^{215}Bi.
‡ All γ-ray transitions given here have been previously observed in the α decay of ^{219}Rn.

^{215}Bi β^- Decay 1990Ru02 (continued)

Decay Scheme



^{219}Rn α Decay 1999Li05,1976Bl13,1970Kr08

Parent ^{219}Rn: E=0.0; Jπ=5/2+; $T_{1/2}$=3.96 s *1*; Q(g.s.)=6946.1 *3*; %α decay=100.

^{215}Po Levels

E(level)†	Jπ‡	$T_{1/2}$	Comments
0.0§	9/2+	1.781 ms *4*	$T_{1/2}$: from adopted levels.
271.228§ *10*	7/2+	195 ps *15*	$T_{1/2}$: (α)(ce)(t) coin (1974Bo11). Other value: <250 ps (1969Be67).
293.56# *4*	(11/2)+		
401.812§ *10*	5/2+	66 ps *7*	$T_{1/2}$: from $T_{1/2}$(402)/$T_{1/2}$(271)=0.336 *23* (Doppler shift measurement), and $T_{1/2}$(271)=195 ps *15* (1974Bo11).
517.60# *6*	7/2+,9/2+		
608.30§ *20*	(11/2+,13/2+)		
676.66 *7*			
708.1 *5*			
732.7 *4*			
835.32 *22*			
877.2 *6*			
891.1 *3*			
930? *1*			
1073.7 *4*	(5/2+)		
1094.2 *10*			

† Deduced by evaluator from a least–squares fit to γ rays from 1999Li05, 1976Bl13, 1970Kr08, 1970Da09, 1968Br17, and 1967Da20.
‡ From adopted levels.
§ Configuration=$(\pi h_{9/2})^2$ $(\nu g_{9/2})^5$.
# Configuration=$(\pi h_{9/2})^2$ $(\nu g_{9/2})^4$ $(\nu i_{11/2})$.

α radiations

Values of Eα from 1962Wa18 given in comments were measured with a magnetic spectrograph. Original Eα values have been increased by evaluator an average of 1.5 keV because of changes in the calibration energies of ^{215}Po and ^{211}Bi (1977Ma30).

α particle energies of 1957Pi31 presented in comments have been increased by 3 keV because of a change in the calibration energy of ^{242}Cm (1977Ma30). Other: 1992Sc26.

Eα	E(level)	Iα@	HF#	Comments
5744§ *15*	1094.2	0.0001§	244	Iα: Iα=9×10^{-5} *5*, deduced by evaluator from γ–ray transition intensity balance.
5764§ *8*	1073.7	0.001§	30.5	Other value: Eα=5786.5, Iα≈0.001 (1965Va10). Iα: Iα=0.0009 *2*, deduced by evaluator from γ–ray transition intensity balance.
5900§ *15*	930?	≈0.0001§	≈1430	Iα: deduced by evaluator from γ–ray transition intensity balance.

Continued on next page (footnotes at end of table)

^{219}Rn α Decay 1999Li05,1976Bl13,1970Kr08 (continued)

α radiations (continued)

Eα	E(level)	Iα@	HF#	Comments
5944§ *6*	891.1	0.002§	107	Other value: Eα=5947.9, Iα=0.0037, originally assigned by 1962Wa18 to ^{211}Bi α decay. Reassigned by 1965Va10 (on the basis of αγ coin measurements) to ^{219}Rn α decay. Iα: Iα=0.0020 *3*, deduced by evaluator from γ–ray transition intensity balance.
5958§ *15*	877.2	0.0001§	2480	Iα: Iα=0.0003 *1*, deduced by evaluator from γ–ray transition intensity balance.
6000§ *6*	835.32	0.003§	127	Eα=6000.8, Iα=0.0044 (1962Wa18). Iα: Iα=0.0031 *5*, deduced by evaluator from γ–ray transition intensity balance.
6100§ *8*	732.7	0.001§	1080	Other value: Eα=6102.0, Iα=0.003 (1962Wa18). Iα: Iα=0.0012 *2*, deduced by evaluator from γ–ray transition intensity balance.
6124§ *8*	708.1	0.001§	1380	Iα: Iα=0.0006 *1*, deduced by evaluator from γ–ray transition intensity balance.
6158§ *4*	676.66	0.018§	105	Other value: Eα=6158.6, Iα=0.0174 (1962Wa18). Iα: Iα=0.018 *2*, deduced by evaluator from γ–ray transition intensity balance.
6223§ *6*	608.30	0.004§	919	Other value: Eα=6223.6, Iα=0.0026 (1962Wa18). Iα: Iα=0.004 *1*, deduced by evaluator from γ–ray transition intensity balance.
6311§ *3*	517.60	0.054§	162	Other value: Eα=6311.8, Iα=0.054 (1962Wa18). Iα: Iα=0.049 *4*, deduced by evaluator from γ–ray transition intensity balance.
6425.0† *10*	401.812	7.5‡ *6*	3.4	Other values: Iα=7.5 *5* (1962Gi04). Eα=6423.9 (1961Ry02). Eα=6422, Iα=5 (1957Pi31,1977Ma30). Eα=6425 *1*, Iα=7.5 (1999Li05). Iα: Iα=7.7 *7*, deduced by evaluator from γ–ray transition intensity balance.
6530§ *2*	293.56	0.12§	577	Other value: Eα=6529, Iα=0.12 (1962Wa18). Iα: Iα=0.10 *1*, deduced by evaluator from γ–ray transition intensity balance.
6552.6† *10*	271.228	12.9‡ *6*	6.5	Other values: Eα=6552.8 (1962Wa18,1977Ma30). Iα=12.9 *6* (1962Gi04). Eα=6550.9 (1961Ry02). Eα=6550, Iα=13 (1957Pi31,1977Ma30). Eα=6553 *1*, Iα=13 (1999Li05). Iα: Iα=12.3 *9*, deduced by evaluator from γ–ray transition intensity balance.
6819.1† *3*	0.0	79.4‡ *10*	11.0	Other values: Eα=6819.0 (1962Wa18,1977Ma30). Iα=79.6 *10* (1962Gi04). Eα=6817.6 *10* (1961Ry02). Eα=6816 *2*, Iα=82 (1957Pi31,1977Ma30). Eα=6819.1 *3*, Iα=79.3 (1999Li05). Iα: Iα=79.8 *12*, deduced by evaluator from γ–ray transition intensity balance.

† From 1971Gr17, detector: magnetic spectrometer. Adjusted value as recommended by 1991Ry01.
‡ From 1962Wa18, detector: magnetic spectrograph. Adjusted value as recommended by 1991Ry01.
§ From 1999Li05.
# Using $r_0(^{215}Po)=1.557$, average of $r_0(^{214}Po)=1.559$ and $r_0(^{216}Po)=1.555$ (1998Ak04).
@ For α intensity per 100 decays, multiply by 1.0.

γ(^{215}Po)

1976Bl13: precise measurement of Eγ, Iγ. Detector: Ge(Li).
1970Kr08: measured Eγ, Iγ, αγ(θ), αγ(lin pol, θ), Ice. Detectors: Ge(Li), magnetic spectrometer.
1970Da09: measured Eγ, Iγ, γγ coin, Ice. Detectors: Ge(Li), scint, magnetic spectrometer.
1968Br17, 1967Da20: measured Eγ, Iγ. Detector: Ge(Li).
1999Li05: measured Eγ, Iγ, Ice, αγ coin, αe coin. Detectors: Ge, Si(Li).
Others: 1972HeYM, 1969Be67, 1966Po02, 1965Va10, 1957Pa07, 1957Pi31.
For αγ(θ) measurements see: 1972HeYM, 1970Kr08, 1970Da09, 1969Be67, 1967Le05, 1965Cl05, and 1961Br32.
For αγ linear polarization correlations and γγ(θ) measurements see 1970Kr08.
Iγ normalization: from Iγ(271γ, ^{219}Rn)/Iγ(269γ, ^{223}Ra)=0.786 *42*, measured from a ^{223}Ra source with ^{219}Rn in equilibrium (1976Bl13), and using %Iγ(269γ, ^{223}Ra)=13.7 *2* (see ^{223}Ra α decay). The excellent agreement of the α–particle abundances to the g.s., 271, and 402 levels (deduced from γ–ray transition intensity balances) with values measured directly confirm the quality of the γ-ray data and that of the decay scheme normalization.

Eγ†	E(level)	Iγ†#	Mult.	δ	α	Comments
130.60 *3*	401.812	1.2 *8*	M1+E2	0.64 *6*	4.65 *12*	Others: 1968Br17, 1965Va10. Mult.,δ: from ce(L1)/ce(L2) exp=2.4 *5* and ce(L1)/ce(L3) exp=2.8 *4* (1970Da09). δ=1.7 from conversion electron data not explicitly given (1999Li05).
x221.5§ *3*		0.28 *4*				This γ ray has been assigned by 1968Br17 and 1970Kr08 to the decay of ^{223}Ra, and by 1970Da09 to the decay of ^{219}Rn (1977Ma30). Not seen by 1999Li05.
224.0 *7*	517.60	0.013 *2*				

Continued on next page (footnotes at end of table)

^{219}Rn α Decay 1999Li05,1976Bl13,1970Kr08 (continued)

γ(^{215}Po) (continued)

Eγ†	E(level)	Iγ†#	Mult.	δ	α	Comments
271.23 *1*	271.228	100 *2*	M1+E2	3.7 *4*	0.210 *6*	Mult.,δ: from ce(L1)/ce(L2) exp=0.516 *47*, ce(L1)/ce(L3) exp=1.035 *92* (1970Da09), and ce(K):ce(L1):ce(L2):ce(L3) exp=30.6 *9*:4.5:8.3 *5*:3.6 *9* (1972HeYM). Other values: α(K)exp=0.107 *16*, α(L3)exp=0.016 *5*, ce(L3)/ce(L1)+ce(L2) exp=0.40 *6* (1970Kr08). δ=4.0 from conversion electron data not explicitly given (1999Li05). Other values: Eγ=271.6, Iγ=87 (1957Pi31), Eγ=268, Iγ=11.0 (1957Pa07). Other: 1966Po02.
293.56 *4*	293.56	0.68 *4*	M1(+E2)		0.35‡ *21*	
321.8& *10*	930?	8×10^{-04} *4*				
x324.9§ *10*		<0.06				Eγ,Iγ: from 1967Da20. Not seen by 1999Li05.
330.8 *4*	732.7	0.009 *1*				
x337.7§ *10*		0.08 *2*				Not seen by 1999Li05.
x370.9§ *15*		<0.1				Eγ,Iγ: from 1967Da20. Other value: Iγ≈0.02 (1965Va10). Not seen by 1999Li05.
373.5 *6*	891.1	0.0023 *3*				
x380§		≈0.0003				γ ray is uncertain (1965Va10). Not seen by 1999Li05.
383.1 *6*	676.66	0.0040 *6*				
401.81 *1*	401.812	61 *2*	E2		0.0561	Other values: Eγ=401, Iγ=77 (1966Po02); Eγ=400.6, Iγ=48 (1957Pi31). Others: 1965Va10, 1957Pa07. Mult.: from α(K)exp=0.027 *12* and ce(K)/ce(L3) exp=7 *2* (1970Kr08). Other: 1999Li05.
405.4 *6*	676.66	0.0023 *4*				
436.9 *6*	708.1	0.0028 *5*				
x438.2§ *6*		<0.28				Eγ,Iγ: from 1967Da20. Other value: Eγ=438.7 *3*, Iγ=0.48 *5* (1968Br17). 1968Br17 assigned this transition to the decay of ^{215}Po. 1967Da20 suggested (on the basis of αγ–coin results of 1965Va10) that the contribution from ^{215}Po decay is 0.26≤Iγ≤0.44, which establishes an upper limit of Iγ≈0.28 from ^{219}Rn decay (1977Ma30). Not seen by 1999Li05.
461.6 *8*	732.7	0.0015 *3*				
489.3 *5*	891.1	0.0058 *8*				
517.60 *6*	517.60	0.41 *2*	M1(+E2)		0.08‡ *5*	Mult.: from α(K)exp (1999Li05). Eγ,Iγ: Eγ=516.5 *5*, Iγ=0.22 *5* (1970Da09) were not included in the input for averaging. Other: 1965Va10.
x538.2 *15*		0.06 *3*				Eγ,Iγ: from 1967Da20. Other value: Iγ≈0.003 (1965Va10). Not seen by 1999Li05.
556.1 *10*	1073.7	5×10^{-04} *3*				
564.1 *3*	835.32	0.014 *3*				Iγ: other value: Iγ≈0.02 (1965Va10).
576.6 *10*	1094.2	8×10^{-04} *4*				
608.3 *2*	608.30	0.040 *10*				Other value: Iγ≈0.026 (1965Va10).
619.9 *6*	891.1	0.003 *1*				
671.9 *6*	1073.7	0.002 *1*				
676.66 *7*	676.66	0.16 *2*				Other value: Iγ≈0.1 (1965Va10).
708.1 *8*	708.1	0.003 *1*				
732.8 *10*	732.7	6×10^{-04} *3*				
802.5 *6*	1073.7	0.003 *1*				
835.3 *3*	835.32	0.015 *3*				Eγ,Iγ: other values: Eγ≈833, Iγ≈0.01 (1965Va10).
877.2 *6*	877.2	0.003 *1*				
891.1 *4*	891.1	0.007 *2*				Eγ,Iγ: other values: Eγ=889.0 *15*, Iγ=0.015 *7* (1967Da20). Iγ≈0.01 (1965Va10).
x1055 *2*		0.006 *3*				Eγ,Iγ: from 1967Da20. Other value: Iγ≈0.003 (1965Va10). Not seen by 1999Li05.
1073.7 *6*	1073.7	0.003 *1*				

† Weighted average from 1999Li05, 1976Bl13, 1970Kr08, 1970Da09, 1968Br17, and 1967Da20.
‡ For δ=1.0, assumed by evaluator.
§ Uncertain γ ray.

Footnotes continued on next page

^{219}Rn α Decay 1999Li05,1976Bl13,1970Kr08 (continued)

γ(^{215}Po) (continued)

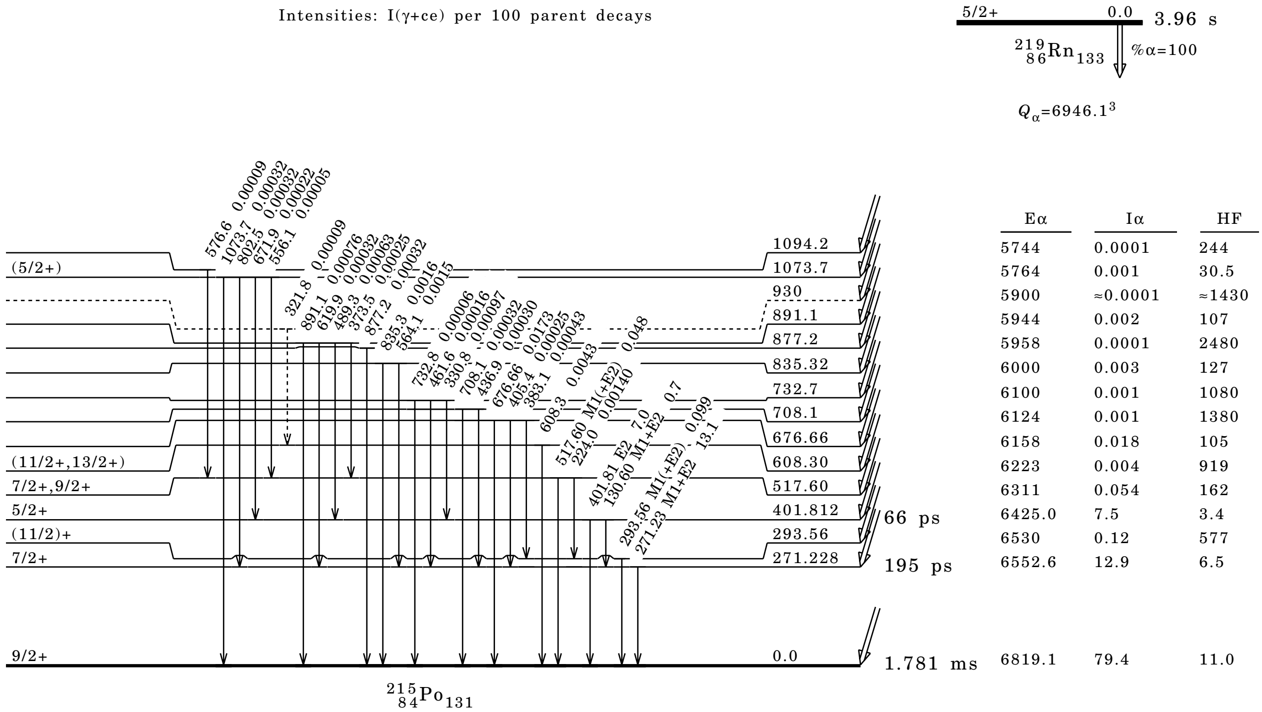
For absolute intensity per 100 decays, multiply by 0.108 *6*.

& Placement of transition in the level scheme is uncertain.

x γ ray not placed in level scheme.

Decay Scheme

Intensities: I(γ+ce) per 100 parent decays



Adopted Levels, Gammas

Q(β⁻)=–82 *11*; S(n)=5943 *8*; S(p)=4070 *7*; Q(α)=8178 *4* 1995Au04.

^{215}At Levels

Shell–model configuration assignments are based on predicted level energies, and on those observed in ^{214}Po and ^{216}Rn (1993Li07).

Cross Reference (XREF) Flags

A ^{219}Fr α Decay

E(level)†	Jπ	XREF	$T_{1/2}$	Comments
0.0‡	9/2–	A	0.10 ms *2*	%α=100. $T_{1/2}$: from 1951Me10. Jπ: favored α decay (HF=3.3) to ^{211}Bi g.s. (Jπ=9/2–). Analogy to other odd–a isotopes of at.
169.88§ *10*	(7/2)–	A		Jπ: 169.9γ M1+E2 to 9/2–. In analogy with 896 level (Jπ=7/2–) in ^{209}Bi, and to other odd–a isotopes of At. Shell model.
352.00‡ *10*	(5/2)–	A		Jπ: 352.0γ E2 to 9/2–. In analogy with 2826 level (Jπ=5/2–) in ^{209}Bi. Shell model.
363.0#	(13/2+)	A		Jπ: shell model.
472.29‡ *17*	(7/2–)	A		Jπ: 472.2γ (M1) to 9/2–. Shell model.
517.00‡ *20*	(13/2)–	A		Jπ: 517.0γ E2 to 9/2–. 153γ to 363 level (13/2+). Shell model.
580‡	(3/2–)	A		Jπ: shell model.

† Deduced by evaluator from a least–squares fit to γ–ray energies.
‡ Configuration=$(\pi h_{9/2})^3\ (\nu g_{9/2})^4$.
§ Configuration=$(\pi h_{9/2})^2\ (\pi f_{7/2})(\nu g_{9/2})^4$.
# Configuration=$(\pi h_{9/2})^2\ (\pi i_{13/2})(\nu g_{9/2})^4$.

γ(^{215}At)

E(level)	Eγ†§	Iγ†§	Mult.‡	δ	α	Comments
169.88	169.9 *1*	100	M1+E2	0.78 *17*	2.09 *21*	Mult.,δ: from α(K)exp=1.5 *2* (1993Li07).
352.00	352.0 *1*	100	E2		0.084	Mult.: from α(K)exp=0.06 *1* (1993Li07).
472.29	302.6 *3*	≈12				
	472.2 *2*	100 *30*	(M1)		0.170	Mult.: from α(K)exp≈0.1 (1993Li07).
517.00	153#	≈3	[E1]		0.163	
	517.0 *2*	100 *21*	E2		0.0313	Mult.: from α(K)exp=0.03 *1* (1993Li07).

† From ^{219}Rn α decay (1993Li07).
‡ From K x ray/Iγ ratios in coincidence with individual α–particle groups (1993Li07).
§ From ^{219}Fr α decay (1993Li07).
# Placement of transition in the level scheme is uncertain.

^{219}Fr α Decay 1993Li07,1968Ba73,1966Gr07

Parent ^{219}Fr: E=0.0; Jπ=9/2–; $T_{1/2}$=20 ms *2*; Q(g.s.)=7448 *2*; %α decay=100.

1993Li07: ^{219}Fr activity was produced as descendant of a mass–separated source of ^{223}Ac. Measured Eα, Iα, Eγ, Iγ, αγ coin. Detectors: Ge(Li) for γ rays, Si(Li) for α particles.

1968Ba73: descendant of ^{227}Pa. Measured Eα, Iα. Detector: magnetic spectrograph.

1966Gr07: descendant of ^{227}Pa. Measured Eα, Iα, Eγ, αγ coin. Detectors: semi, scint.

1982Bo04: ^{219}Fr source produced by spallation of 5–GeV protons on targets of U and Th. Measured Eα, Iα. Detectors: semi.

Other: 1982Bo04.

^{215}At Levels

Shell–model configuration assignments are based on predicted level energies, and on those observed in ^{214}Po and ^{216}Rn.

Continued on next page (footnotes at end of table)

^{219}Fr α Decay 1993Li07,1968Ba73,1966Gr07 (continued)

^{215}At Levels (continued)

E(level)†	Jπ‡	$T_{1/2}$	Comments
0.0§	9/2−	0.10 ms *2*	$T_{1/2}$: from 1951Me10.
169.88# *10*	(7/2)−		
352.00§ *10*	(5/2)−		
363.0@	(13/2+)		
472.29§ *17*	(7/2−)		
517.00§ *20*	(13/2)−		
580§	(3/2−)		

† Deduced by evaluator from a least–squares fit to γ–ray energies.
‡ From adopted levels.
§ Configuration=$(\pi h_{9/2})^3$ $(\nu g_{9/2})^4$.
# Configuration=$(\pi h_{9/2})^2$ $(\pi f_{7/2})(\nu g_{9/2})^4$.
@ Configuration=$(\pi h_{9/2})^2$ $(\pi i_{13/2})(\nu g_{9/2})^4$.

α radiations

Eα†	E(level)	Iα†§	HF‡	Comments
6744	580	<0.03	>29	Eα,Iα: from 1993Li07.
6802.9 *20*	517.00	0.25	6.1	Other value: Eα=6780 *10*, value deduced by 1977Ma30 from an α spectrum presented in 1966Gr07. Original Eα=6680 is probably a typographical error. Iα=0.3 *1* (1966Gr07). Eα=6805, Iα=0.25 (1993Li07). Iα: 0.20 *4*, deduced by evaluator from γ–ray transition intensity balance.
6846.2 *25*	472.29	0.05	44	Other value: Eα=6820 *10*; value deduced by 1977Ma30 from an α spectrum presented in 1966Gr07. Original Eα=6720 is probably a typographical error. Iα=0.2 *1* (1966Gr07). Eα=6849, Iα=0.05 (1993Li07). Iα: 0.06 *2*, deduced by evaluator from γ–ray transition intensity balance.
6956.6 *30*	363.0	≈0.02	≈275	Other values: Eα=6958, Iα≈0.02 (1993Li07).
6967.3 *20*	352.00	0.6	10.0	Other values: Eα=6950 *10*, Iα(6967α + 6957α)=0.8 *1* (1966Gr07); Eα=6968, Iα=0.6 (1993Li07). Iα: 0.61 *5*, deduced by evaluator from γ–ray transition intensity balance.
7145.7 *20*	169.88	0.25 *7*	104	Iα: weighted average of 0.3 *1* (1966Gr07) and 0.2 *1* (1968Ba73,1977Ma30). Iα: 0.30 *3*, deduced by evaluator from γ–ray transition intensity balance. Other value: 0.2 (1993Li07). Eα: other values: 7140 *10* (1966Gr07), 7148 (1993Li07).
7312.3 *18*	0.0	98.8 *2*	1.0	Eα: value adjusted from Eα=7312.2 *20* (1968Ba73) and Eα=7317 *4* (1982Bo04), as recommended by 1991Ry01. Other values: Eα=7300 *10*, Iα=98.4 (1966Gr07); Eα=7307 *20*, energy has been increased by 7 keV to account for changes in calibration energies (1951Me10,1977Ma30); Eα=7313 (1993Li07). Iα: from 1991Ry01.

† From 1968Ba73, unless otherwise specified.
‡ Using $r_0(^{215}At)$=1.558, average of $r_0(^{214}Po)$=1.559, $r_0(^{216}Po)$=1.5555, $r_0(^{214}Rn)$=1.563, and $r_0(^{216}Rn)$=1.556 (1998Ak04).
§ For α intensity per 100 decays, multiply by 1.0.

γ(^{215}At)

Iγ normalization: measured absolute γ–ray intensities (1993Li07).

Eγ†	E(level)	Iγ†§	Mult.‡	δ	α	Comments
153#	517.00	≈0.06	[E1]		0.163	
169.9 *1*	169.88	1.0 *1*	M1+E2	0.78 *17*	2.09 *21*	Mult.,δ: from α(K)exp=1.5 *2* (1993Li07).
x225#		≈0.1				
302.6 *3*	472.29	≈0.06				
352.0 *1*	352.00	5.6 *5*	E2		0.084	Mult.: from α(K)exp=0.06 *1* (1993Li07).
472.2 *2*	472.29	0.50 *15*	(M1)		0.170	Mult.: from α(K)exp=0.1 (1993Li07).
517.0 *2*	517.00	1.9 *4*	E2		0.0313	Mult.: from α(K)exp=0.03 *1* (1993Li07).

† From 1993Li07. Other: 1968Gr07.
‡ From K x ray/Iγ ratios in coincidence with individual α–particle groups (1993Li07).
§ For absolute intensity per 100 decays, multiply by 0.1.

Footnotes continued on next page

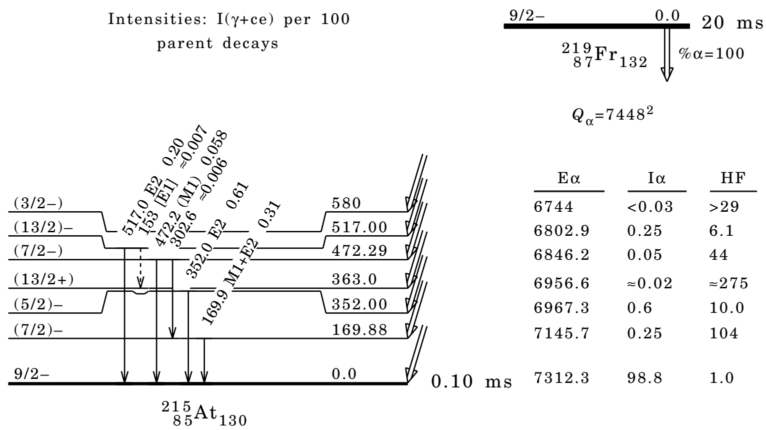
^{219}Fr α Decay 1993Li07,1968Ba73,1966Gr07 (continued)

γ(^{215}At) (continued)

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

[x] γ ray not placed in level scheme.

Decay Scheme



Adopted Levels, Gammas

Q(β⁻)=–1487 *10*; S(n)=4920 *12*; S(p)=5079 *9*; Q(α)=8839 *8* 1995Au04.

^{215}Rn Levels

Cross Reference (XREF) Flags

A ^{219}Ra α Decay

E(level)†	Jπ	XREF	$T_{1/2}$	Comments
0.0	9/2+	A	2.30 μs *10*	$T_{1/2}$: from 1970Va13. Jπ: favored α decay (HF=1.5) to ^{211}Po (Jπ=9/2+). configuration: odd–neutron configuration=(ν $1g_{9/2}$). %α=100. %ε<1.0×10^{-11} for log *ft*>5.9. %ε+%$β^+$<3×10^{-7}, theory (1973Ta30).
214.1 *2*	(7/2,9/2)+	A		Jπ: 592γ M1 from (7/2)+, 214.1γ? to 9/2+.
290.8 *3*	(7/2,9/2,11/2)–	A		Jπ: 291γ E1 to 9/2+.
315.82 *4*	(7/2)+	A		Jπ: Jπ=(7/2,11/2)+ from αγ(θ) (1989Ha26). 316γ M1 to 9/2+. Low α hindrance factor (HF=4.7) from ^{219}Ra (Jπ=(7/2)+) suggests Jπ=(7/2)+ for this level.
805.7 *4*	(7/2)+	A		Jπ: 805γ M1 to 9/2+. Low α hindrance factor (HF=3.3) from ^{219}Ra (Jπ=(7/2)+) suggests Jπ=(7/2)+ for this level.

† From ^{219}Ra α decay.

γ(^{215}Rn)

E(level)	Eγ†	Mult.†	α	I(γ+ce)†
214.1	214.1‡ *2*			100
290.8	290.8 *3*	E1	0.0360	100
315.82	315.82 *4*	M1(+E2)		100
805.7	489‡ *1*			≤42
	592.0 *3*	M1(+E2)		100 *17*
	805.2 *4*	M1(+E2)		58 *17*

† From ^{219}Ra α decay.
‡ Placement of transition in the level scheme is uncertain.

^{219}Ra α Decay 1987El02,1970Va13,1994Sh02

Parent ^{219}Ra: E=0.0; Jπ=(7/2)+; $T_{1/2}$=10 ms *3*; Q(g.s.)=8138 *3*; %α decay=100.
1969Ha32.
1987El02: ^{219}Ra activity was produced as descendant of ^{223}Th. Measured Eα, Eγ, Iγ, Ice, αγ coin, α–ce coin. Detectors: semi, Ge(Li), Si(Li). Assignment of α–particle groups to ^{219}Ra has been based on the agreement with Eα from 1970Va13, and on the observation of Rn K x ray in coincidence with α particles.
Because of the decay scheme normalization, evaluator interpreted absolute γ–ray transition intensities reported by authors as absolute I(γ+ce) (photons plus conversion electrons) intensities.
1970Va13: ^{219}Ra activity was produced by ^{208}Pb(^{16}O,αn), and identified by excitation functions, cross bombardment, and genetic relationship to its α–decay daughter nucleus ^{215}Rn. Measured Eα, Iα. Detector: semi.
1969Ha32: ^{219}Ra activity was produced as descendant of ^{227}U, ^{223}Th, and identified by its genetic relationship to its α–decay daughter nucleus ^{215}Rn. Measured Eα, Iα. Detector: semi.
1994Sh02: ^{219}Ra activity was produced as the daughter nuclide of ^{223}Th through the ^{208}Pb(^{18}O,3n)^{223}Th reaction. Measured Eα, Iα, αγ coin from a source in equilibrium with ^{223}Th. Detectors: semi, Ge(Li).

^{215}Rn Levels

1994Sh02 interpreted the level structure in ^{215}Rn in terms of both the reflection asymmetric model and the shell model.

E(level)@	Jπ#	$T_{1/2}$	Comments
0.0§	9/2+	2.30 μs *10*	$T_{1/2}$: from adopted levels.
214.1§ *2*	(7/2,9/2)+		

Continued on next page (footnotes at end of table)

^{219}Ra α Decay 1987El02,1970Va13,1994Sh02 (continued)

^{215}Rn Levels (continued)

E(level)[@]	Jπ[#]
290.8[‡] *3*	(7/2,9/2,11/2)−
315.82[†] *4*	(7/2)+
805.7[†] *4*	(7/2)+

[†] Configuration=$\nu g_{9/2}^2\ i_{11/2}$.
[‡] Configuration=$\nu g_{9/2}^2\ j_{15/2}$.
[§] Configuration=$\nu g_{9/2}^3$.
[#] From adopted levels.
[@] From γ–ray energies of 1987El02.

α radiations

Eα	E(level)	Iα[‡]	HF[†]	Comments
7198 *6*	805.7	2.4 *3*	3.3	Eα: weighted average of 7220 *20* (in coin with 592γ), 7250 *40* (in coin with 805γ)(1987El02), and 7196 *5* (1994Sh02). Iα: deduced by evaluator from γ–ray transition intensity balance.
7678 *3*	315.82	66.2 *15*	4.7	Eα: weighted average of 7675 *5* (1987El02), 7675 *10* (1970Va13), 7700 (20) 1969Ha32, 7679 *3* (1994Sh02). Iα: Iα=65.7 *15* deduced by evaluator from γ–ray transition intensity balance. Other values: Iα=65 *5* (1970Va13), Iα=70 *10* (1969Ha32), Iα=62 (1994Sh02).
7706 *10*	290.8	0.9 *2*	413	Eα: weighted average of 7720 *20* (measured in coin with 291γ, 1987El02), and 7703 *10* (1994Sh02). Iα: deduced by evaluator from γ–ray transition intensity balance.
7780 *10*	214.1	≈0.5	≈1270	Eα,Iα: inferred from αγ coin (1994Sh02).
7988 *3*	0.0	30.5 *15*	90	Iα: deduced by evaluator using ΣIα=100%. Other values: Iα=30 *10* (1969Ha32), Iα=35 *2* (1970Va13), Iα=34 (1994Sh02). Other: 1952Me13. Iα: Iα=30.7 *16* deduced by evaluator from γ–ray transition intensity balance. Eα: weighted average of 7980 *10* (1970Va13), 7990 *20* (1969Ha32), and 7989 *3* (1994Sh02).

[†] Using $r_0(^{215}Rn)=1.559$, average of $r_0(^{214}Rn)=1.563$, $r_0(^{216}Rn)=1.556$ (1998Ak04).
[‡] For α intensity per 100 decays, multiply by 1.0.

γ(^{215}Rn)

See 1989Ha26 for αγ(θ).

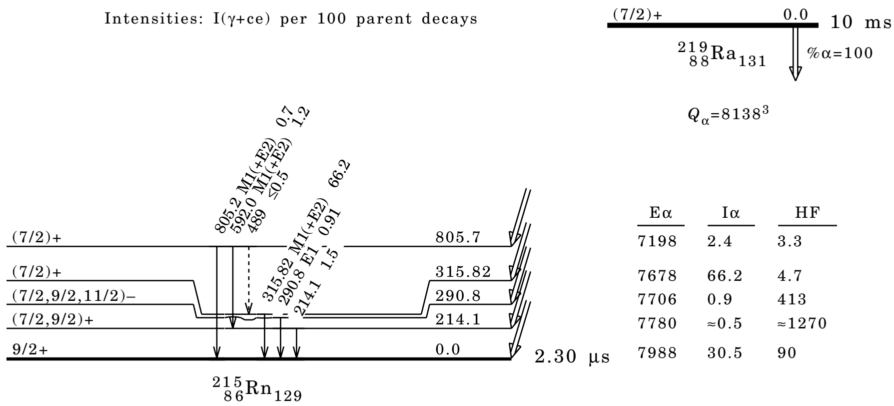
Eγ[†]	E(level)	Mult.	α	I(γ+ce)[†‡§]	Comments
214.1 *2*	214.1			1.5 *3*	K x ray/γ≈1 (α(K)exp≈0.1) (1994Sh02), α(L)exp=0.14 *3* (1987El02). Assignment to 219Ra a decay is not definite.
290.8 *3*	290.8	E1	0.0360	0.91 *18*	Eγ: other value: 290.6 (1994Sh02). Mult.: from α(K)exp<0.05 (1987El02).
315.82 *4*	315.82	M1(+E2)	0.545	66.2 *15*	I(γ+ce): from a precise measurement of 7675α abundance (1987El02). Mult.: from α(K)exp=0.55 *8*, α(L)exp=0.10 *2*, and α(M)exp=0.020 *3* (1987El02). Eγ: other value: 316.0 (1994Sh02).
489[#] *1*	805.7			≤0.5	
592.0 *3*	805.7	M1(+E2)	0.101	1.2 *2*	Mult.: from α(K)exp=0.07 *2* and α(L)exp=0.03 *1* (1987El02).
805.2 *4*	805.7	M1(+E2)	0.045	0.7 *2*	Mult.: from α(K)exp=0.03 *2* (1987El02).

[†] From 1987El02, unless otherwise specified.
[‡] Absolute transition intensity measured relative to % I(γ+ce)=66.2 *15* for 316γ. This value resulted from a precise measurement of the α–particle abundance that populates the 316 level (1987El02).
[§] For absolute intensity per 100 decays, multiply by 1.0.
[#] Placement of transition in the level scheme is uncertain.

^{219}Ra α Decay 1987El02,1970Va13,1994Sh02 (continued)

Decay Scheme

Intensities: I(γ+ce) per 100 parent decays



Eα	Iα	HF
7198	2.4	3.3
7678	66.2	4.7
7706	0.9	413
7780	≈0.5	≈1270
7988	30.5	90

Adopted Levels, Gammas

Q(β⁻)=−2215 *10*; S(n)=6794 *11*; S(p)=2650 *11*; Q(α)=9540 *7* 1995Au04.

^{215}Fr Levels

The low–lying states of ^{215}Fr result from the coupling of an h9/2 proton to the 0+, 2+, 4+, 6+, and 8+ states of the even core (^{214}Rn). The energies of these even–spin states are similar to those of the 9/2, and (11/2,13/2), (15/2,17/2), (21/2,19/2) doublets in ^{215}Fr. The long–range α particle groups emitted from these states in ^{215}Fr are analogous to those emitted from the g.s., 4+, 6+, and 8+ states in ^{216}Ra. Their branchings from each level have not been measured, only their intensities relative to the total number of α particles in the spectrum in coincidence with γ rays are given (1984Sc25).

Cross Reference (XREF) Flags

A ^{208}Pb(^{11}B,4nγ)
B ^{219}Ac α Decay

E(level)#	Jπ‡	XREF	$T_{1/2}$#	Comments
0.0	9/2−	AB	86 ns *5*	$T_{1/2}$: slope of α–decay time spectrum fitted to two components: 86 and 30 ns (1984De16). Other values: 87 ns *6* (1973HaZO); 104 ns *16*, slope of time spectrum measurement (1984Sc25); 118 ns *21*, measured for about 130 ns only (1974No02). Jπ: favored α decay (HF≈1) to ^{211}At (Jπ=9/2−). Configuration=(π $1h_{9/2}$) coupled to 0+. %α=100. No ε decay. Evaluator calculated %ε+%β⁺=1.0×10^{-8} for logft=5.0. %ε+%β⁺<1.0×10^{-8}, theory (1973Ta30).
670.3 *1*	(13/2)−	A		Jπ: 670γ E2 to 9/2−. Configuration=(π $1h_{9/2}$) coupled to 2+.
700.0 *1*	(11/2)−	A		Jπ: 700γ M1+E2 to 9/2−. Configuration=(π $1h_{9/2}$) coupled to 2+.
835.5† *1*	(13/2)+	A		Level also decays by α emission. Eα=10160 *30*, Iα=0.038 *15* (1984Sc25). Jπ: 135γ E1 to (11/2)−.
1121.5† *1*	(17/2)−	A		Level also decays by α emission. Eα=10460 *30*, Iα(1121+1149)=0.008 *1* (1984Sc25). Other values: Eα=10493 *20*, Iα(1121+1149)=0.005 (1984De16). Jπ: 451γ E2 to (13/2)−. Configuration=(π $1h_{9/2}$) coupled to 4+.
1149.0† *1*	(15/2)−	A		Jπ: 479γ M1+E2 to (13/2)−. Configuration=(π $1h_{9/2}$) coupled to 4+.
1440.0†§ *1*	(19/2)−	A		Level also decays by α emission. Eα=10740 *30*, Iα=0.041 *3* (1984Sc25). Other values: Eα=10789 *15*, Iα=0.015 (1984De16). Jπ: 318γ M1+E2 to (17/2)−. Configuration=(π $1h_{9/2}$) coupled to 6+.
1457.4§ *2*	(21/2)−	A		Jπ: 336γ E2 to (17/2)−. Configuration=(π $1h_{9/2}$) coupled to 6+.
1573.1†§ *2*	(23/2)−	A	3.5 ns *14*	Level also decays by α emission. Eα=10890 *30*, Iα=0.036 *3* (1984Sc25). Eα=10919 *15*, Iα=0.030 (1984De16). Jπ: 115.8γ M1 to (21/2)−. Theoretical g–factor=0.12 (1984Sc25) for the assigned shell–model configuration compares with experimental g–factor=0.33 *10* (1984De16). Configuration=(π $1h_{9/2}{}^{+5}$+ν $2g_{9/2}{}^{+1}$ ν $1i_{11/2}{}^{+1}$).
1680.5 *2*	(25/2)−	A		Jπ: 107.4γ M1(+E2) to (23/2)−. Configuration=((π $1h_{9/2})^{+5}$+(ν $2g_{9/2})^{+1}$+(ν $1i_{11/2})^{+1}$).
1813.6 *2*	(27/2)−	A	2.1 ns *14*	$T_{1/2}$: from 1984Sc25. Jπ: 133γ M1+E2 to (25/2)−, 240.5γ E2 to (23/2)−. Configuration=(π $1h_{9/2}{}^{+4}$,$2f_{7/2}{}^{+1}$)+ (ν $2g_{9/2}{}^{+1}$,$1i_{11/2}{}^{+1}$).
2015.9 *2*	(29/2)+	A	4.7 ns *12*	$T_{1/2}$: weighted average of 5.5 ns *14* (1984Sc25) and 3 ns *2* (1984De16). Jπ: 202γ E1 to (27/2)−. Theoretical g–factor=0.43 (1984Sc25) for the assigned shell–model configuration agrees with experimental g–factor=0.47 *20* (1984De16). Configuration=(π $1h_{9/2}{}^{+4}$,$1i_{13/2}{}^{+1}$)+(ν $2g_{9/2}{}^{+2}$). μ=6.8 *29*. μ: DPAD (1984De16,1989Ra17).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{215}Fr Levels (continued)

E(level)#	Jπ‡	XREF	$T_{1/2}$#	Comments
2251.3 *3*	(33/2)+	A	5.3 ns *11*	$T_{1/2}$: weighted average of 5.5 ns *14* (1984Sc25) and 5 ns *2* (1984De16). Jπ: 235.4γ E2 to (29/2)+. Theoretical g–factor=0.49 (1984Sc25) for the assigned shell–model configuration agrees with experimental g–factor=0.47 *10* (1984De16). configuration= (π $1h_{9/2}^{+4}$,$1i_{13/2}^{+1}$)+(ν $2g_{9/2}^{+1}$,$1i_{11/2}^{+1}$). μ=7.8 *17*. μ: DPAD (1984De16,1989Ra17).
2806.8 *3*	(35/2)–	A		Jπ: 555.5γ E1 to (33/2)+. Configuration=(π $1h_{9/2}^{+5}$)+(ν $2g_{9/2}^{+1}$,$1i_{11/2}^{+1}$).
2900.4 *3*	(35/2–)	A		Jπ: predicted by shell model (1984Sc25). Configuration=(π $1h_{9/2}^{+4}$,$2f_{7/2}^{+1}$)+ (ν $2g_{9/2}^{+1}$,$1i_{11/2}^{+1}$).
3013.9 *4*	(37/2–)	A		Jπ: 113.7γ (M1) to (35/2–). Configuration=(π $1h_{9/2}^{+5}$)+(ν $2g_{9/2}^{+1}$,$1i_{11/2}^{+1}$).
3068.9 *3*	(39/2)–	A	14.6 ns *14*	$T_{1/2}$: γγ(t) (262γ–555γ time curves fitted to a two–level decay formula) (1984Sc25). Jπ: 818γ E3 to (33/2)+. Theoretical g–factor=0.41 (1984Sc25) for the assigned shell model configuration agrees with experimental g–factor=0.47 *2* (1984De16). Configuration=((π $1h_{9/2}^{+4}$,$1i_{13/2}^{+1}$)+ (ν $1i_{11/2}^{+1}$,$1j_{15/2}^{+1}$). μ=9.17 *20*. μ: DPAD (1984De16,1989Ra17).
3207.5 *4*	(41/2–)	A		Jπ: 138.5γ (M1) to (39/2)–. Configuration=(π $1h_{9/2}^{+5}$)+(ν $2g_{9/2}^{+1}$ $1i_{11/2}^{+1}$).
3409.2? *3*		A		
3417.1 *4*	(45/2–)	A		Jπ: 210γ (E2) to (41/2–).
3419.4? *3*		A		
3462.3 *5*	(47/2+)	A	23 ns *2*	$T_{1/2}$: γγ(t) (262γ–555γ time curves fitted to a two–level decay formula), and from 210γ time spectrum (1984Sc25). Other values: $T_{1/2}$=33 ns *5*, γγ(t) for all γ rays; $T_{1/2}$=30 ns *5*, time spectrum of g.s. α transition fitted to a two–component decay (1984De16). Jπ: 45γ E1 to (45/2–). Jπ: configuration=(π $1h_{9/2}^{+4}$,$1i_{13/2}^{+1}$)+(ν $2g_{9/2}^{+1}$,$1i_{11/2}$ $^{+1}$).

† Emission of long–range α particles from this level has been observed (1984Sc25).
‡ Multiple quasi–particle shell model configurations presented here are from 1984Sc25.
§ Measured $T_{1/2}$ (1984Sc25) and g–factor=0.33 *10* (1984De16) correspond to 1440, 1457, or 1573 level.
# From ^{208}Pb(^{11}B,4nγ).

γ(^{215}Fr)

E(level)	Eγ†	Iγ†	Mult.†	δ†	α	Comments
670.3	670.3 *1*	100	E2		0.0193	
700.0	700.0 *1*	100	M1+E2	–3.75 *+55–40*	0.0212 *6*	
835.5	135.4 *1*	100 *4*	E1		0.229	
	165.0 *1*	57 *3*	(E1)		0.142	
1121.5	451.2 *1*	100	E2		0.0479	
1149.0	(28)					
	313.4 *1*	17 *1*	E1		0.0312	
	449.1 *1*	100 *3*	E2		0.0485	
	478.8 *1*	76 *5*	M1+E2	–3.75 *+50–40*	0.0515 *18*	
1440.0	290.9 *1*	100 *3*	E2		0.162	
	318.5 *1*	20 *1*	M1+E2	10 *+6–2*	0.128	
1457.4	335.9 *1*	100	E2		0.106	
1573.1	115.8 *2*	5.3 *6*	M1		9.96	B(M1)(W.u.)=5.0×10^{-5} *22*.
	133.0 *1*	100 *9*	E2		2.72	B(E2)(W.u.)=12 *5*.
1680.5	107.4 *3*	100	M1(+E2)		10 *3*	α: for δ=1.0, assumed by evaluator.
1813.6	133.0 *1*	41 *11*	M1+E2	0.50 *15*	5.9 *4*	B(M1)(W.u.)=0.0004 *3*; B(E2)(W.u.)=1.7 *15*.
	240.5 *1*	100 *4*	E2		0.297	B(E2)(W.u.)=1.1 *8*.
2015.9	202.3 *1*	100	E1		0.0865	B(E1)(W.u.)=4.5×10^{-6} *12*.
2251.3	235.4 *1*	100	E2		0.319	B(E2)(W.u.)=1.5 *3*.
2806.8	555.5 *1*	100	E1		0.00929	
2900.4	649.1 *1*	100				

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

γ(^{215}Fr) (continued)

E(level)	Eγ†	Iγ†	Mult.†	α	Comments
3013.9	113.7 *3*	100	(M1)	10.5	
3068.9	262.1 *1*	100 *3*	E2	0.224	B(E2)(W.u.)=0.26 *3*.
	817.5 *1*	34 *3*	E3	0.0336	B(E3)(W.u.)=27 *4*.
3207.5	138.5 *3*	52 *10*	(M1)	5.98	
	193.6 *2*	100 *20*	E2	0.634	
3409.2?	340.25‡ *15*	100	D		
3417.1	209.6 *2*	100	E2	0.476	
3419.4?	519.0‡ *3*	100			
3462.3	45.2 *3*	100	E1	0.910	B(E1)(W.u.)=4.6×10^{-5} *5*.

† From ^{208}Pb(^{11}B,4nγ).
‡ Placement of transition in the level scheme is uncertain.

^{219}Ac α Decay 1970Bo13,1989Mi17

Parent ^{219}Ac: E=0.0; Jπ=9/2–; $T_{1/2}$=11.8 μs *15*; Q(g.s.)=8830 *50*; %α decay=100.
1970Bo13: ^{219}Ac activity was produced as descendant of ^{223}Pa by the following reactions: ^{205}Tl(^{22}Ne,4n),(^{208}Pb(^{19}F,4n), ^{209}Bi(^{20}Ne,α2n), and ^{209}Bi(^{22}Ne,α4n), E=90–135 MeV. the activity was identified by excitation functions, cross bombardments, and by genetic relationships between parent and daughter nuclei. Measured Eα. Detector: semi.
1989Mi17: ^{219}Ac activity was produced by ^{209}Bi(^{16}O,α2n) and ^{205}Tl(^{16}O,2n), E=87.4–101.9 MeV, and identified by mass separation and excitation functions. Measured Eα. Detector: semi. Deduced ^{219}Ac half-life.

^{215}Fr Levels

E(level)	Jπ	$T_{1/2}$
0.0	9/2–	86 ns *5*

α radiations

Eα	E(level)	Iα†	HF	Comments
8664 *10*	0.0	100	1.1	HF: using r_0(^{215}Fr)=1.5597, average of r_0(^{214}Rn)=1.563, r_0(^{216}Rn)=1.556, r_0(^{214}Ra)=1.554, and r_0(^{216}Ra)=1.566 (1998Ak04). Eα: from 1970Bo13. Original energy has been decreased by 1 keV because of a change in the calibration energy of ^{212}Po (1991Ry01).

† For α intensity per 100 decays, multiply by 1.0.

^{208}Pb(^{11}B,4nγ) 1984Sc25,1984De16,1985Dr04

^{204}Hg(^{15}N,4nγ), ^{207}Pb(^{11}B,3n) (1984De16).
1984Sc25: target: >99% enriched ^{208}Pb, E(^{11}B)=66 MeV. Measured Eγ, Iγ, γγ coin, αγ coin, γγ(t), αγ(t), γ(θ) for θ=90°, 115°, 127°, 138°, and 149°. Measured level half–lives, α decay from g.s. and excited levels. Deduced γ–ray multipolarities. Detectors: Ge(Li), high–purity germanium, Si surface barrier.
1984De16: ^{208}Pb(^{11}B,4n), target: 98% enriched ^{208}Pb, E(^{11}B)=58, 62 MeV. Measured Eγ, Iγ, γγ coin, αγ coin, ce ce coin, γγ(t), αγ(t), differential perturbed angular distribution (DPAD) of α particles, α decay from g.s. and excited levels, level half–lives. The ^{207}Pb(^{11}B,3n) reaction was used to confirm the assignment of measured α particles to ^{215}Fr.
1984De16: ^{204}Hg(^{15}N,4nγ), target: 98% enriched ^{204}Hg cooled to –30° C, E(^{15}N)≈78 MeV. Measured differential perturbed angular distribution (DPAD) for γ rays. Deduced γ–ray multipolarities, g–factors, half–lives.
1985Dr04: target: enriched ^{208}Pb, E(^{11}B)=45–66 MeV. Measured Eγ, Iγ, γγ coin, γ(θ) for θ=0° to 90° in 15° increments, γ–ray excitation functions and linear polarizations. Deduced γ–ray multipolarities. Detectors: Ge(Li).

^{208}Pb(^{11}B,4nγ) 1984Sc25,1984De16,1985Dr04 (continued)

^{215}Fr Levels

E(level)†	Jπ	$T_{1/2}$	Comments
0.0	9/2−	86 ns *5*	$T_{1/2}$: slope of α–decay time spectrum fitted to two components: 86 and 30 ns (1984De16). Other values: 87 ns *6* (1973HaZO); 104 ns *16*, slope of time spectrum measurement (1984Sc25); 118 ns *21*, measured for about 130 ns only (1974No02).
670.3 *1*	(13/2)−		
700.0 *1*	(11/2)−		
835.5 *1*	(13/2)+		
1121.5 *1*	(17/2)−		
1149.0 *1*	(15/2)−		
1440.0‡ *1*	(19/2)−		
1457.4‡ *2*	(21/2)−		
1573.1‡ *2*	(23/2)−	3.5 ns *14*	$T_{1/2}$: γγ(t) centroid shift method (1984Sc25). Other value: 4 ns *2*, γγ(t) centroid shift method (1984De16).
1680.5 *2*	(25/2)−		E(level): the order of the 133γ–107γ cascade is unknown. E=1706 is possible for this level.
1813.6 *2*	(27/2)−	2.1 ns *14*	$T_{1/2}$: γγ(t), αγ(t) centroid shift method (1984Sc25).
2015.9 *2*	(29/2)+	4.7 ns *12*	$T_{1/2}$: weighted average of 5.5 ns *14*, γγ(t), αγ(t) centroid shift method (1984Sc25), and 3 ns *2*, γγ(t) centroid shift method (1984De16). g–factor=0.47 *20*, DPAD of γ rays (1984De16).
2251.3 *3*	(33/2)+	5.3 ns *11*	$T_{1/2}$: weighted average of 5.5 ns *14*, γγ(t), αγ(t) centroid shift method (1984Sc25), and 5 ns *2*, γγ(t) centroid shift method (1984De16). g–factor=0.47 *10*, DPAD of γ rays (1984De16).
2806.8 *3*	(35/2)−		
2900.4 *3*	(35/2−)		
3013.9 *4*	(37/2−)		
3068.9 *3*	(39/2)−	14.6 ns *14*	$T_{1/2}$: γγ(t) (262γ–555γ time curves fitted to a two–level decay formula) (1984Sc25). g–factor=0.47 *2* (corrected for diamagnetism and Knight shift), DPAD of γ rays (1984De16). g–factor=0.48 *2*, DPAD of α particles (1984De16).
3207.5 *4*	(41/2−)		
3409.2? *3*			
3417.1 *4*	(45/2−)		
3419.4? *3*			
3462.3 *5*	(47/2+)	23 ns *2*	$T_{1/2}$: γγ(t) (262γ–555γ time curves fitted to a two–level decay formula), and from 210γ time spectrum (1984Sc25). Other values: $T_{1/2}$=33 ns *5*, γγ(t) for all γ rays; $T_{1/2}$=30 ns *5*, time spectrum of g.s. α transition fitted to a two–component decay (1984De16).

† Deduced by evaluator from a least–squares fit to γ–ray energies of 1984Sc25 and 1985Dr04.
‡ Measured $T_{1/2}$ (1984Sc25) and g–factor=0.33 *10* (1984De16) correspond to 1440, 1457, or 1573 level.

γ(^{215}Fr)

Eγ†	E(level)	Iγ‡	Mult.§	δ	α	Comments
(28)	1149.0					
45.2 *3*	3462.3	16.8 *20*	E1		0.910	
107.4 *3*	1680.5	7.9 *10*	M1(+E2)			
113.7 *3*	3013.9	0.40 *10*	(M1)		10.5	
115.8 *2*	1573.1	1.68 *20*	M1		9.96	
133.0 *1*	1573.1	32 *3*	E2		2.72	
	1813.6	11 *3*	M1+E2	0.50 *15*	5.9 *4*	δ: from γ–ray time differential perturbed angular distribution (1984De16).
135.4 *1*	835.5	7.0 *3*	E1		0.229	
138.5 *3*	3207.5	2.6 *5*	(M1)		5.98	
165.0 *1*	835.5	4.0 *2*	(E1)		0.142	Iγ: from Iγ(165)/Iγ(135)=0.567 (1985Dr04).
193.6 *2*	3207.5	5.0 *10*	E2		0.634	
202.3 *1*	2015.9	100 *3*	E1		0.0865	
209.6 *2*	3417.1	25.7 *10*	E2		0.476	
235.4 *1*	2251.3	78 *3*	E2		0.319	
240.5 *1*	1813.6	26.7 *10*	E2		0.297	
262.1 *1*	3068.9	37.6 *10*	E2		0.224	
290.9 *1*	1440.0	96 *3*	E2		0.162	
313.4 *1*	1149.0	6.9 *3*	E1		0.0312	
318.5 *1*	1440.0	18.8 *10*	M1+E2	10 *+6−2*	0.128	δ: from γ(θ) (1985Dr04).

Continued on next page (footnotes at end of table)

$^{208}Pb(^{11}B,4n\gamma)$ 1984Sc25,1984De16,1985Dr04 (continued)

$\gamma(^{215}Fr)$ (continued)

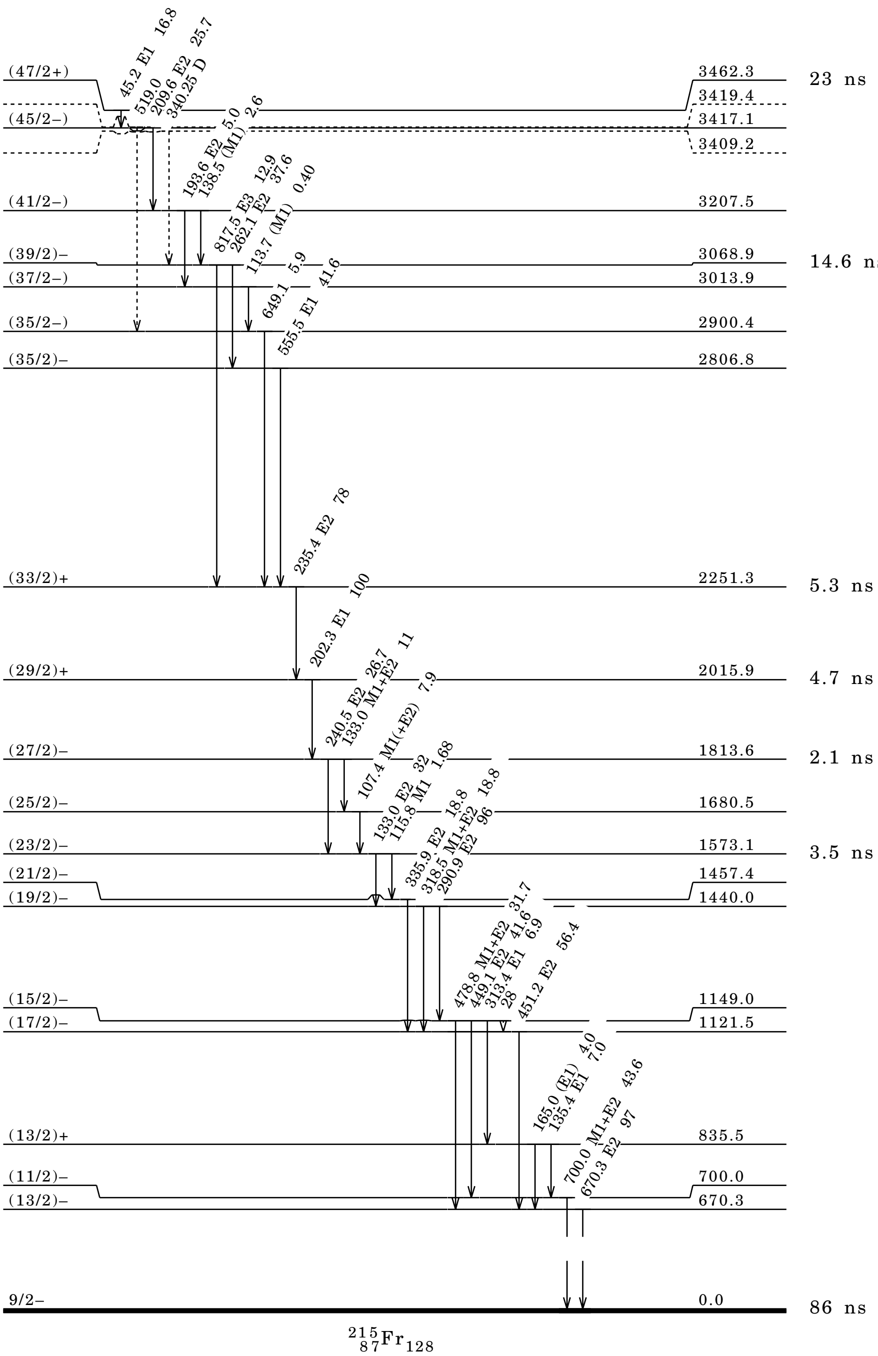
Eγ†	E(level)	Iγ‡	Mult.§	δ	α	Comments
335.9 *1*	1457.4	18.8 *10*	E2		0.106	
340.25# *15*	3409.2?		D			Eγ: from 1985Dr04. γ ray was also observed, but not placed in the decay scheme, by 1984Sc25.
449.1 *1*	1149.0	41.6 *10*	E2		0.0485	
451.2 *1*	1121.5	56.4 *20*	E2		0.0479	
478.8 *1*	1149.0	31.7 *20*	M1+E2	−3.8 *+5−4*	0.0515 *18*	δ: from γ(θ) (1985Dr04). Other value: −6 *+3−4*, γ−ray time differential perturbed angular distribution (1984De16).
519.0# *3*	3419.4?					Eγ: observed by 1985Dr04 only.
555.5 *1*	2806.8	41.6 *20*	E1		0.00929	
649.1 *1*	2900.4	5.9 *10*				(E1) from (1984Sc25); E2+M1 (δ=−1.2 *+18−12*), (1985Dr04).
670.3 *1*	670.3	97 *4*	E2		0.0193	
700.0 *1*	700.0	43.6 *20*	M1+E2	−3.8 *+6−4*	0.0212 *6*	δ: from γ(θ) (1985Dr04). Other value: −7 *+3−13*, γ−ray time differential perturbed angular distribution (1984De16).
817.5 *1*	3068.9	12.9 *10*	E3		0.0336	

† Weighted average from 1984Sc25 and 1985Dr04.
‡ From 1984Sc25, unless otherwise specified.
§ From differential perturbed angular distribution of γ rays, and conversion electron data (1984De16); γ(θ) and transition intensity balances (1984Sc25); and γ(θ) and asymmetry values from γ−ray linear polarization measurements (1985Dr04).
# Placement of transition in the level scheme is uncertain.

$^{208}Pb(^{11}B,4n\gamma)$ 1984Sc25,1984De16,1985Dr04 (continued)

Level Scheme

Intensities: relative Iγ



Adopted Levels, Gammas

Q(β⁻)=–3490 *54*; S(n)=5637 *13*; S(p)=3796 *11*; Q(α)=8864 *4* 1995Au04.

^{215}Ra Levels

The level structure of ^{215}Ra, described by a multiparticle octupole coupling mechanism, leads to configuration mixed isomers with characteristic enhanced E3 transitions. These have been explained by the coupling of octupole vibrations to the shell–model configurations presented here for the six protons and single neutron outside closed shells (1998St24).

The low–lying yrast levels in ^{215}Ra also have been interpreted in terms of the shell model by coupling the odd neutron to experimentally determined energies in ^{214}Ra (1983Lo16). The enhancement of the 773–keV E3 transition in ^{215}Ra is due mostly to the coupling of the particle orbital to the octupole phonon in the ^{208}Pb core. Its B(E3)(W.u.)=37 *2* agrees with the systematics for E3 transitions in the ^{208}Pb region (1983Lo16). See also 1998St24, 1989Dr02, 1985Be05, and 1988Fu10 for further discussions on B(E3) values for this nucleus.

γ–rays reported by 1988Fu10, 1983Lo16, and 1987AdZU from ^{206}Pb(^{12}C,3nγ), ^{206}Pb(^{13}C,4nγ), ^{208}Pb(^{12}C,5nγ), and ^{208}Pb(^{13}C,6nγ) agree with most of those adopted here. However, because of the 2246.9+x level proposed by 1998St24, only level energies up to 2054 keV agree with those adopted in this evaluation.

Cross Reference (XREF) Flags

A ^{206}Pb(^{13}C,4nγ)
B ^{219}Th α Decay
C ^{208}Pb(^{13}C,6nγ)

E(level)†	Jπ‡	XREF	$T_{1/2}$	Comments
0.0§	(9/2+)	ABC	1.55 ms *7*	$T_{1/2}$: weighted average of 1.62 ms *+16–13* (2000Ni02), 1.68 ms *2* (2000He17), 1.56 ms *10* (1970To08), 1.7 ms *2* (1968Va18), 1.5 ms *1* (1991An10), and 1.5 ms *3* (1991An13). Other value: 1.6 ms (1961Gr43,1962Gr20). Jπ: analogy to N=127 isotones (*i.e.* ^{211}Po and ^{213}Rn) suggest Jπ=(9/2+). Shell model configuration for the odd neutron is expected to be g9/2. %α=100. No ε decay. Evaluator calculated %ε+%β⁺=1.0×10⁻⁴ for logft=5.2. %ε+%β⁺<2×10⁻⁴, theory (1973Ta30). %ε+%β⁺<7×10⁻⁵, theory (1997Mo25).
773.0# *3*	(15/2–)	A C	70 ns *3*	$T_{1/2}$: weighted average (LWM, χ^2/ν=5.9) of 68.6 ns *21*, γγ(t) (1989Dr02); 77 ns *2*, γγ(t) (1988Fu10), 67 ns *3* (1987AdZU), and 67.2 ns 14, pulsed beam method (1998St24). Other values: 110 ns *8*, pulsed beam method (1989Dr02); 120 ns *10*, pulsed beam method (1983Lo16). These values, measured with the pulsed beam method, may have been affected by a systematic error. The reason being that most of the 773γ intensity decays with 7.1 µs, the half–life of the 1877 level, making it more difficult to measure a shorter half–life (in the ns range) with the pulsed beam method. Jπ: 773γ E3 to (9/2+). Analogy with 896–keV state (Jπ=(15/2–)) in ^{213}Rn.
1625.3§ *4*	(17/2+)	A C		Jπ: 852γ E1 to (15/2–). Analogy with 1529–keV state (Jπ=(17/2+)) in ^{213}Rn.
1821.2§ *4*	(21/2+)	A C	24.8 ns *14*	$T_{1/2}$: weighted average of 23 ns *5* (1983Lo16) and 25.0 ns *14* (1998St24). Jπ: 196γ E2 to (17/2+), 1048γ E3 to (15/2–). Analogy with 1664–keV state (Jπ=(21/2+)) in ^{213}Rn (1988Fu10).
1877.8@ *5*	(25/2+)	A C	7.1 µs *2*	$T_{1/2}$: weighted average of 7.2 µs *2* (1988Fu10) and 6.9 µs *3* (1998St24). Other value: ≥2 µs, pulsed beam method (1983Lo16). Jπ: analogous state at >1664 keV with $T_{1/2}$≈1 µs has been observed in ^{213}Rn (1988Fu10). Mixed with 2053.8 level by particle octupole coupling.
1994.5@ *5*	(23/2+)	A C		
2053.8§ *5*	(25/2+)	A C		Mixed with 1877.8 level by particle octupole coupling.
2214.4& *6*	(27/2–)	A		
2246.9a *5*	(29/2–)	A	1.39 µs *7*	$T_{1/2}$: pulsed beam method (1998St24).
2246.9+xa	(31/2–)	A		E(level): x≤35 keV. Level was assumed at this energy because both systematics and theory predict that a Jπ=31/2– state must lie near a Jπ=29/2– level at 2246.9 keV (1998St24).
3088.8+xb *3*	(33/2+)	A		
3143.7+xc *5*	(35/2+)	A		
3331.1+xc *5*	(37/2+)	A		
3413.4+xa *5*	(37/2–)	A		
3415.6+xc *5*	(37/2+)	A		
3586.4+xd *5*	(37/2+)	A		
3738.6+xa *5*	(39/2–)	A		

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{215}Ra Levels (continued)

E(level)[†]	Jπ[‡]	XREF	$T_{1/2}$	Comments
3756.6+x[a] *6*	(43/2−)	A	0.555 µs *10*	$T_{1/2}$: pulsed beam method (1998St24). Other value:0.59 µs *18* (1987AdZU). Octupole−mixed state. g−factor=+0.726 *3*. Theoretical value: +0.73 (1998St24). Other value: 0.734 *7* (1987AdZU).
3765.7+x *6*		A		
3855.0+x *6*		A		
3935.4+x[&] *6*	(43/2−)	A		Octupole−mixed state.
4207.3+x *7*		A		
4366.9+x[b] *6*	(45/2+)	A		
4553.6+x[a] *6*	(47/2−)	A		
4567.0+x[b] *6*	(49/2+)	A	10.5 ns *2*	$T_{1/2}$: pulsed beam method (1998St24). Other value: ≈10 ns (1987AdZU). g−factor=+0.77 *1*. Theoretical value: +0.80 (1998St24).
4686.2+x[&] *7*	(47/2−)	A		
4882.7+x[&] *6*	(51/2−)	A		
5372.7+x[b] *7*	(53/2+)	A		
5608.6+x[e] *7*	(55/2−)	A		
5608.7+x[b] *7*	(57/2+)	A	1.7 ns *2*	$T_{1/2}$: pulsed beam method (1998St24).
6033.5+x[f] *8*	(57/2+)	A		
6076.4+x[f] *8*	(59/2+)	A		
6283.2+x[f] *9*	(61/2+)	A		

[†] Deduced by evaluator from a least−squares fit to γ−ray energies.
[‡] Spin and parity assignments are based on γ−ray multipolarities, angular distributions, transition strengths, and excitation functions. Shell model configuration assignments are based on level energies and γ−ray transition rates (1998St24).
[§] Configuration=$(\pi h_{9/2})^6$ $(\nu g_{9/2})$.
[#] Configuration=$(\pi h_{9/2})^6$ $(\nu j_{15/2})$.
[@] Configuration=$(\pi h_{9/2})^5$ $(\pi f_{7/2})$ $(\nu g_{9/2})$.
[&] Configuration=$(\pi h_{9/2})^4$ $(\pi f_{7/2})$ $(\pi i_{13/2})$ $(\nu_{9/2})$.
[a] Configuration=$(\pi h_{9/2})^5$ $(\pi i_{13/2})$ $(\nu g_{9/2})$.
[b] Configuration=$(\pi h_{9/2})^4$ $(\pi i_{13/2})^2$ $(\nu g_{9/2})$.
[c] Configuration=$(\pi h_{9/2})^5$ $(\pi f_{7/2})$ $(\nu g_{9/2})$.
[d] Configuration=$(\pi h_{9/2})^4$ $(\pi f_{7/2})^2$ $(\nu g_{9/2})$.
[e] Configuration=$(\pi h_{9/2})^3$ $(\pi f_{7/2})^2$ $(\pi i_{13/2})$ $(\nu g_{9/2})$.
[f] Configuration=$(\pi h_{9/2})^3$ $(\pi f_{7/2})$ $(\pi i_{13/2})^2$ $(\nu g_{9/2})$.

γ(^{215}Ra)

E(level)	Eγ[†]	Iγ[†]	Mult.[‡]	δ[‡]	α	Comments
773.0	773.0	100	E3		0.0409	B(E3)(W.u.)=36.8 *17*.
1625.3	852.3	100	E1		0.0042 *7*	
1821.2	196.0	100 *1*	E2		0.642	B(E2)(W.u.)=0.48 *4*.
	1048.2	48.6 *4*	E3		0.0199	B(E3)(W.u.)=2.92 *18*.
1877.8	56.5	100	E2		147	B(E2)(W.u.)=0.0122 *12*.
1994.5	173.3	100	M1		3.45	
2053.8	59.3	16 *2*	M1		15.1	
	176.0	100 *2*	M1		3.31	
2214.4	336.6	100	(E1)		0.0274	
2246.9	(32.5)					
	193.1	100 *2*	M2(+E3)			
	369.1	32 *3*	M2+E3	1.1 *2*	0.83 *9*	B(M2)(W.u.)=0.0012 *4*; B(E3)(W.u.)=5.3 *15*.
2246.9+x	(≤35)					
3088.8+x	841.9	100	E1			
3143.7+x	54.9	100	M1		18.9	
3331.1+x	187.4	100	M1		2.77	
3413.4+x	269.7	100				
3415.6+x	271.9	100	M1		0.98	
3586.4+x	170.8	19 *4*	M1		3.60	
	255.4	100 *12*	M1		1.17	
	442.6	10 *4*				
3738.6+x	152.2	46.5 *5*	E1		0.176	
	323.1	31 *1*	E1		0.0300	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

γ(^{215}Ra) (continued)

E(level)	Eγ†	Iγ†	Mult.‡	α	Comments
3738.6+x	325.3	4 *1*			
	407.4	100 *1*	E1	0.0181	
3756.6+x	(18.1)				
	425.5		E3	0.246	
3765.7+x	434.6	100			
3855.0+x	439.4	100			
3935.4+x	178.6	100	M1	3.17	
4207.3+x	352.3	100			
4366.9+x	431.5	99 *3*	E1	0.0161	
	610.2	100 *5*			
4553.6+x	797.3	100			
4567.0+x	(12.9)				
	200.1	100 *2*			
	810.2	59 *2*			
4686.2+x	750.7	100			
4882.7+x	196.3	23 *3*	E2	0.638	
	315.6	100 *4*			
	329.5	12 *3*			
5372.7+x	490.1	100 *3*			
	805.7	48 *2*			
5608.6+x	725.9	100			
5608.7+x	236.0	100	E2	0.334	B(E2)(W.u.)=4.5 *6*.
6033.5+x	424.8	100			
6076.4+x	467.7	100			
6283.2+x	249.7	100			

† From ^{206}Pb(^{13}C,4nγ) (1998St24).
‡ From conversion electron data and γ(θ) in ^{206}Pb(^{13}C,4nγ) (1998St24).

^{219}Th α Decay 1973Ha32

Parent ^{219}Th: E=0.0; Jπ=?; $T_{1/2}$=1.05 μs *3*; Q(g.s.)=9510 *50*; %α decay=100.
^{219}Th activity was produced by ^{206}Pb(^{16}O,3n), E=80–90 MeV. Isotopic assignment is based on its genetic relationship to ^{215}Ra, and on measured excitation functions. Measured Eα. Detector: semi.

^{215}Ra Levels

E(level)	Jπ	$T_{1/2}$	Comments
0.0	(9/2+)	1.55 ms *7*	Jπ,$T_{1/2}$: from adopted levels.

α radiations

Eα	E(level)	Iα†	HF	Comments
9340 *20*	0.0	100	2.0	HF: using r_0(^{215}Ra)=1.560, average of r_0(^{214}Ra)=1.554 and r_0(^{216}Ra)=1.56 (1998Ak04).

† For α intensity per 100 decays, multiply by 1.0.

^{206}Pb(^{13}C,4nγ) 1998St24

Target: 92% enriched ^{206}Pb. E=78 MeV. Measured Eγ, Iγ, γγ coin, γγ(t), γγ(θ), Ice, differential perturbed angular distributions, excitation functions for E=66–84 MeV. Deduced γ–ray multipolarities, angular distribution coefficients, levels half–life (pulsed–beam measurements), gyromagnetic factors, detectors: hyperpure Ge, superconducting solenoidal electron spectrometer with a cooled Si(Li) detector (1998St24).

The nucleus of ^{215}Ra has six valence protons and a single valence neutron outside the Z=82, N=126 closed shells. Most of the states up to about 6 MeV have configurations involving four to six protons in the $h_{9/2}$ orbital, for which E2 decays are retarded or forbidden, and dipole and octupole transitions are prominent. The authors have explained the strength of E3 transitions as well as the measured gyromagnetic factors in terms of the multi–particle octupole coupling mechanism (1998St24).

Other measurements:

1988Fu10: ^{206}Pb(^{12}C,3nγ), E=67 MeV, ≥90% enriched ^{206}Pb target. Measured Eγ, Iγ, γγ coin, γ(θ) for 9 angles between θ=80° and 160°, γ–ray linear polarization, γγ(t). Detectors: Ge(Li). Deduced transition multipolarities. Measured levels half–life using a pulsed beam method, and also γγ(t).

1983Lo16: ^{208}Pb(^{13}C,6nγ), E=95 MeV, 99% enriched ^{208}Pb target. Measured Eγ, Iγ, γ(θ) for 8 angles between 6° and 158°, γγ coin, γγ(θ). Detector: Ge(Li). Deduced transition multipolarities. Measured levels half–life using a pulsed beam method.

1989Dr02: ^{208}Pb(^{12}C,5nγ), E=80 MeV, 99% enriched ^{208}Pb target. Measured Eγ, Iγ. Detector: Ge(Li).

1989Dr02: ^{206}Pb(^{13}C, 4nγ), E=78 MeV, 92% enriched ^{206}Pb target. Measured Eγ, Iγ, Ice, γγ(t). Detectors: Ge(Li) Compton–suppression system, Si(Li). Deduced conversion coefficients and multipolarities. Measured levels half–life using a pulsed beam method and γγ(t).

1987AdZU: ^{206}Pb(^{13}C,4nγ), E=80 MeV. Measured Eγ, γγ coin, γγ(t). Detector:Ge(Li), high–purity Ge. Measured levels half–life. Measured g–factor by stroboscopic observation of γ–ray perturbed angular distributions.

^{215}Ra Levels

The level scheme presented here is from 1998St24. Up to 2054 keV it agrees well with that from 1988Fu10, 1983Lo16, and 1987AdZU.

E(level)[†]	Jπ[‡]	$T_{1/2}$	Comments
0.0[§]	9/2+	1.55 ms *7*	$T_{1/2}$: from adopted levels.
773.0[#] *3*	15/2−	67.2 ns *14*	$T_{1/2}$: from 1998St24, pulsed beam method. Other values: 68.6 ns *21* (1989Dr02), 77 ns *2* (1988Fu10), and 67 ns *3* (1987AdZU).
1625.3[§] *4*	17/2+		
1821.2[§] *4*	21/2+	24.9 ns *14*	$T_{1/2}$: pulsed beam method (1998St24). Other value: 22.9 ns *49* (1983Lo16).
1877.8[@] *5*	25/2+	6.9 μs *3*	$T_{1/2}$: pulsed beam method (1998St24). other value: 7.2 μs *2* (1988Fu10). Mixed with 2053.8 level by particle octupole coupling.
1994.5[@] *5*	23/2+		
2053.8[§] *5*	25/2+		Mixed with 1877.8 level by particle octupole coupling.
2214.4[&] *6*	27/2(−)		Configuration assignment was confirmed by γ–ray transition rates.
2246.9[a] *5*	29/2−	1.39 μs *7*	$T_{1/2}$: pulsed beam method (1998St24).
2246.9+x[a]	31/2−		E(level): x≤35 keV.
3088.8+x[b] *3*	33/2+		
3143.7+x[c] *5*	35/2+		
3331.1+x[c] *5*	37/2+		
3413.4+x[a] *5*	37/2−		
3415.6+x[c] *5*	37/2+		
3586.4+x[d] *5*	37/2+		
3738.6+x[a] *5*	39/2−		
3756.6+x[a] *6*	43/2−	0.555 μs *10*	$T_{1/2}$: pulsed beam method (1998St24). Other value: 0.59 μs *18* (1987AdZU). Octupole–mixed state. g–factor=+0.726 *3*. Theoretical value: +0.73 (1998St24).
3765.7+x *6*			
3855.0+x *6*			
3935.4+x[&] *6*	43/2−		Octupole–mixed state.
4207.3+x *7*			
4366.9+x[b] *6*	45/2+		
4553.6+x[a] *6*	47/2−		
4567.0+x[b] *6*	49/2+	10.5 ns *2*	$T_{1/2}$: pulsed beam method (1998St24). Other value: ≈10 ns (1987AdZU). g–factor=+0.77 *1*. Theoretical value: +0.80 (1998St24).
4686.2+x[&] *7*	47/2−		
4882.7+x[&] *6*	51/2−		
5372.7+x[b] *7*	53/2+		
5608.6+x[e] *7*	55/2−		
5608.7+x[b] *7*	57/2+	1.7 ns *2*	$T_{1/2}$: pulsed beam method (1998St24).
6033.5+x[f] *8*	57/2+		
6076.4+x[f] *8*	59/2+		
6283.2+x[f] *9*	61/2+		

Footnotes continued on next page

$^{206}Pb(^{13}C,4n\gamma)$ 1998St24 (continued)

^{215}Ra Levels (continued)

† Deduced by evaluator from a least–squares fit to Eγ from 1998St24, using ΔE=0.3 keV (not given in 1998St24) for all γ rays.
‡ Spin and parity assignments are based on γ–ray multipolarities, angular distributions, transition strengths, and excitation functions. Shell model configuration assignments are based on level energies and γ–ray transition rates (1998St24).
§ Configuration=$(\pi h_{9/2})^6$ $(\nu g_{9/2})$.
# Configuration=$(\pi h_{9/2})^6$ $(\nu j_{15/2})$.
@ Configuration=$(\pi h_{9/2})^5$ $(\pi f_{7/2})$ $(\nu g_{9/2})$.
& Configuration=$(\pi h_{9/2})^4$ $(\pi f_{7/2})$ $(\pi i_{13/2})$ $(\nu_{9/2})$.
a Configuration=$(\pi h_{9/2})^5$ $(\pi i_{13/2})$ $(\nu g_{9/2})$.
b Configuration=$(\pi h_{9/2})^4$ $(\pi i_{13/2})^2$ $(\nu g_{9/2})$.
c Configuration=$(\pi h_{9/2})^5$ $(\pi f_{7/2})$ $(\nu g_{9/2})$.
d Configuration=$(\pi h_{9/2})^4$ $(\pi f_{7/2})^2$ $(\nu g_{9/2})$.
e Configuration=$(\pi h_{9/2})^3$ $(\pi f_{7/2})^2$ $(\pi i_{13/2})$ $(\nu g_{9/2})$.
f Configuration=$(\pi h_{9/2})^3$ $(\pi f_{7/2})$ $(\pi i_{13/2})^2$ $(\nu g_{9/2})$.

$\gamma(^{215}Ra)$

Eγ†	E(level)	Iγ†	Mult.	δ	α	Comments
(12.9)	4567.0+x					
(18.1)	3756.6+x					
(32.5)	2246.9					
(≤35)	2246.9+x					
54.9	3143.7+x	21 *2*	M1		18.9	Eγ=54.9 *10* (1987AdZU). Mult.: from α(exp)=11 *4*.
56.5	1877.8	8 *1*	E2		147	Mult.: from α(exp)=94 *40*.
59.3	2053.8	16 *2*	M1		15.1	From α(exp)=17 *7*.
152.2	3738.6+x	94 *1*	E1		0.176	Eγ=152 *1* (1987AdZU). Mult.: from α(exp)<0.42. A_2=–0.12 *4*.
170.8	3586.4+x	10 *2*	M1		3.60	Mult.: from α(exp)=5.2 *33*.
173.3	1994.5	39 *1*	M1		3.45	Eγ=173.0 *10* (1983Fu10), Eγ=173.4 (1987AdZU). Mult.: from α(exp)=3.6 *14*. A_2=0.03 *6*.
176.0	2053.8	100 *2*	M1		3.31	Eγ=175.8 *10* (1988Fu10), Eγ=175.9 (1987AdZU). Mult.: from α(exp)=5.0 *5*, α(L)exp=0.40 *3*. A_2=0.16 *4*.
178.6	3935.4+x	16 *2*	M1		3.17	Eγ=178.6 *10* (1987AdZU). Mult.: from α(exp)=3.6 *3*. A_2=0.4 *3*.
187.4	3331.1+x	98 *2*	M1		2.77	Eγ=187.4 *10* (1987AdZU). Mult.: from α(exp)=2.7 *7*. A_2=–0.15 *4*.
193.1	2246.9	59 *1*	M2(+E3)			Eγ=193.2 *10* (1987AdZU). Mult.: from α(exp)=9.1 *6*, α(L)exp=3 *1*, α(M)exp=0.63 *6*. A_2=0.13 *6*.
196.0	1821.2	467 *3*	E2		0.642	Eγ=195.9 *10* (1988Fu10), Eγ=195.1 (1983Lo06), Eγ=196.0 (1987AdZU).
196.3	4882.7+x	28 *4*	E2		0.638	Eγ=195.9 *10* (1988Fu10).
200.1	4567.0+x	54 *1*				Eγ=199.9 *10* (1987AdZU).
236.0	5608.7+x	55 *1*	E2		0.334	Eγ=235.9 *10* (1987AdZU). Mult.: from α(exp)<0.7. A_2=0.36 *6*.
249.7	6283.2+x	13 *4*				
255.4	3586.4+x	52 *6*	M1		1.17	Eγ=255.2 *10* (1988Fu10). Mult.: from α(exp)=1.6 *7*. A_2=0.33 *12*.
269.7	3413.4+x	98 *1*				Eγ=269.3 *10* (1988Fu10).
271.9	3415.6+x	42 *2*	M1		0.98	Eγ=271.6 (1987AdZU). Mult.: from α(exp)=1.4 *4*. A_2=–0.06 *5*.
315.6	4882.7+x	120 *5*				Eγ=315.5 *10* (1987AdZU).
323.1	3738.6+x	62 *2*	E1		0.0300	Eγ=323.0 *10* (1987AdZU). Mult.: from α(exp)<0.48. A_2=–0.15 *9*.
325.3	3738.6+x	8 *2*				
329.5	4882.7+x	14 *3*				
336.6	2214.4	42 *2*	(E1)		0.0274	Mult.: from α(exp)<0.27.
352.3	4207.3+x	10 *2*				
369.1	2246.9	19 *2*	M2+E3	1.1 *2*	0.83 *9*	Mult.: from α(K)exp=0.51 *6*, α(L)exp=0.19 *3*, α(M)exp=0.08 *2*. δ: deduced by evaluator from α(K)exp=0.51 *6*.
407.4	3738.6+x	202 *2*	E1		0.0181	Eγ=404.7 *10* (1987AdZU). Mult.: from α(K)exp=0.024 *5*. A_2=–0.11 *2*.
424.8	6033.5+x	18 *4*				

Continued on next page (footnotes at end of table)

$^{206}Pb(^{13}C,4n\gamma)$ 1998St24 (continued)

$\gamma(^{215}Ra)$ (continued)

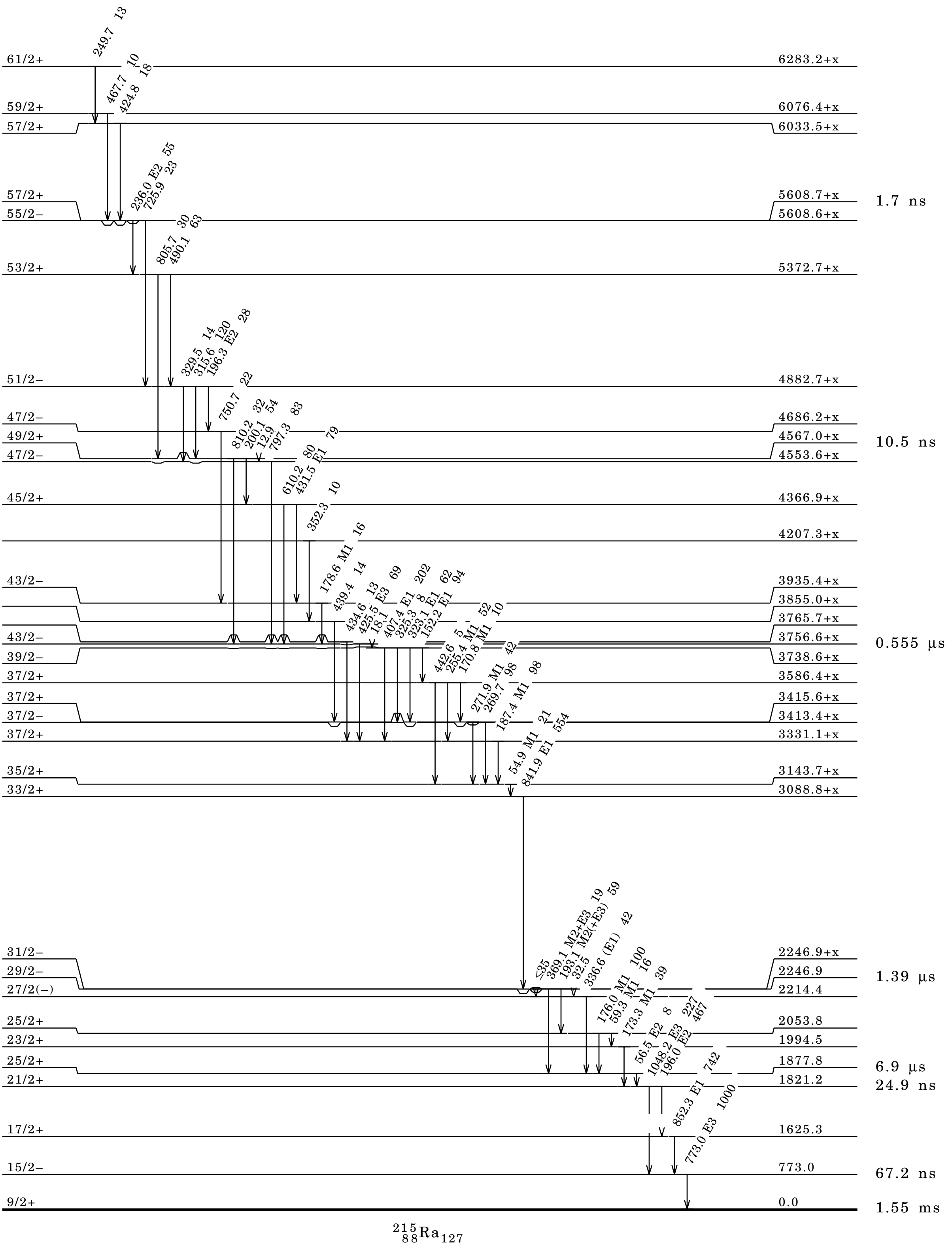
Eγ†	E(level)	Iγ†	Mult.	α	Comments
425.5	3756.6+x	69 *2*	E3	0.246	Mult.: from α(K)exp=0.126 *14*, α(L)exp=0.08 *1*, α(M)exp=0.04 *1*. A_2=0.20 *8*.
431.5	4366.9+x	79 *2*	E1	0.0161	Eγ=431.6 *10* (1987AdZU). Mult.: from α(exp)<0.07. A_2=−0.20 *5*.
434.6	3765.7+x	13 *2*			
439.4	3855.0+x	14 *2*			
442.6	3586.4+x	5 *2*			
467.7	6076.4+x	10 *2*			
490.1	5372.7+x	63 *2*			Eγ=490.2 *10* (1987AdZU).
610.2	4366.9+x	80 *4*			Eγ=610.0 *10* (1987AdZU).
725.9	5608.6+x	23 *4*			
750.7	4686.2+x	22 *1*			
773.0	773.0	1000	E3	0.0409	Eγ=773.2 *10* (1987AdZU). Mult.: from α(K)exp=0.0239 *7*, α(L)exp=0.0091 *3*, α(M)exp=0.0028 *2*. A_2=0.12 *2*. Other values: α(K)exp=0.0257 *11*, α(L)exp=0.0096 *6*, α(M)exp=0.0027 *5* (1989Dr02).
797.3	4553.6+x	83 *2*			Eγ=796.3 *10* (1987AdZU).
805.7	5372.7+x	30 *1*			
810.2	4567.0+x	32 *1*			
841.9	3088.8+x	554 *4*	E1		Eγ=841.8 *10* (1988Fu10). Mult.: from α(K)exp<0.013. A_2=−0.21 *1*.
852.3	1625.3	742 *5*	E1	0.0042 *7*	Eγ=852.4 *10* (1988Fu10). Mult.: from α(K)exp=0.0046 *4*, α(L)exp=0.0010 *2*, α(M)exp=0.00016 *11*. A_2=−0.09 *1*.
1048.2	1821.2	227 *2*	E3	0.0199	Eγ=1048.3 *10* (1988Fu10). Mult.: from α(K)exp=0.0127 *7*, α(L)exp=0.0059 *5*, α(M)exp=0.0037 *10*. A_2=0.06 *2*.

† From $^{206}Pb(^{13}C,4n\gamma)$ (1998St24).

$^{206}Pb(^{13}C,4n\gamma)$ 1998St24 (continued)

Level Scheme

Intensities: relative Iγ



$^{208}Pb(^{13}C,6n\gamma)$ 1988Fu10,1983Lo16,1987AdZU

1989Dr02.
$^{206}Pb(^{12}C,3n\gamma)$, $^{206}Pb(^{13}C,4n\gamma)$, $^{208}Pb(^{12}C,5n\gamma)$.
1988Fu10: $^{206}Pb(^{12}C,3n\gamma)$, E=67 MeV, ≥90% enriched ^{206}Pb target. Measured Eγ, Iγ, γγ coin, γ(θ) for 9 angles between θ=80° and 160°, γ–ray linear polarization, γγ(t). Detectors: Ge(Li). Deduced transition multipolarities. Measured level half–lives using a pulsed beam method, and also γγ(t).
1983Lo16: $^{208}Pb(^{13}C,6n\gamma)$, E=95 MeV, 99% enriched ^{208}Pb target. Measured Eγ, Iγ, γ(θ) for 8 angles between 6° and 158°, γγ coin, γγ(t). Detector: Ge(Li). Deduced transition multipolarities. Measured level half–lives using a pulsed beam method.
1989Dr02: $^{208}Pb(^{12}C,5n\gamma)$, E=80 MeV, 99% enriched ^{208}Pb target. Measured Eγ, Iγ. Detector: Ge(Li).
1989Dr02: $^{206}Pb(^{13}C,4n\gamma)$, E=78 MeV, 92% enriched ^{206}Pb target. Measured Eγ, Iγ, Ice, γγ(t). Detectors: Ge(Li) Compton suppression system, Si(Li). Deduced transition conversion coefficients and multipolarities. Measured level half–lives using a pulsed beam method, and γγ(t).
1987AdZU: $^{206}Pb(^{13}C,4n\gamma)$, E=80 MeV. Measured Eγ, γγ coin, γγ(t). Detector: Ge(Li), high–purity germanium. Measured level half–lives. Measured g–factor by stroboscopic observation of γ–ray perturbed angular distributions.

^{215}Ra Levels

E(level)†	Jπ‡	$T_{1/2}$	Comments
0.0	(9/2+)	1.59 ms 9	
773 1	(15/2−)	72 ns 3	$T_{1/2}$: from adopted levels.
1626 1	(17/2+)		
1821 1	(21/2+)	23 ns 5	$T_{1/2}$: from 1983Lo16.
1878 2	(25/2+)	7.2 μs 2	$T_{1/2}$: pulsed beam method (1988Fu10). Other value: ≥2 μs, pulsed beam method (1983Lo16).
1994 2			
2054 2			
2247 2			
3088 2			
3275 2			
3358 2			
3427 2			
3682 2			
3737 3		0.59 μs 18	$T_{1/2}$: pulsed beam method (1987AdZU). g–factor=0.734 7, stroboscopic observation of γ–ray perturbed angular distributions (1987AdZU).
4052 3			
4484 3			
4663 3			
4848 3			
4863 3		≈10 ns	$T_{1/2}$: from 1987AdZU.
5353 3			
5589 3			

† Deduced by evaluator from a least–squares fit to γ–ray energies, using 1 keV uncertainty for γ–ray energies from 1987AdZU. Levels above 1877 keV have been reported by 1987AdZU only.
‡ From adopted levels.

$\gamma(^{215}Ra)$

Eγ†	E(level)	Iγ†	Mult.§	α	Comments
(15)	4863				
54.9‡ 10	3737				
(56)	1878				
59.1‡ 10	2054				
152‡ 1	3427				
173.0 10	1994	2 1			Eγ=173.4 (1987AdZU).
175.8 10	2054	5 2			Eγ=175.9 (1987AdZU).
178.6‡ 10	4663				
187.4‡ 10	3275				
193.2‡ 10	2247				
195.9 10	1821	42 12	E2	0.643	Eγ: Eγ=195.1 (1983Lo16); Eγ=196.0 (1987AdZU).
199.9‡ 10	4863				
235.9‡ 10	5589				
255.2‡ 10	3682				
269.3 10	3358	5 2			Eγ=271.6 (1987AdZU).

Continued on next page (footnotes at end of table)

^{208}Pb(^{13}C,6nγ) 1988Fu10,1983Lo16,1987AdZU (continued)

γ(^{215}Ra) (continued)

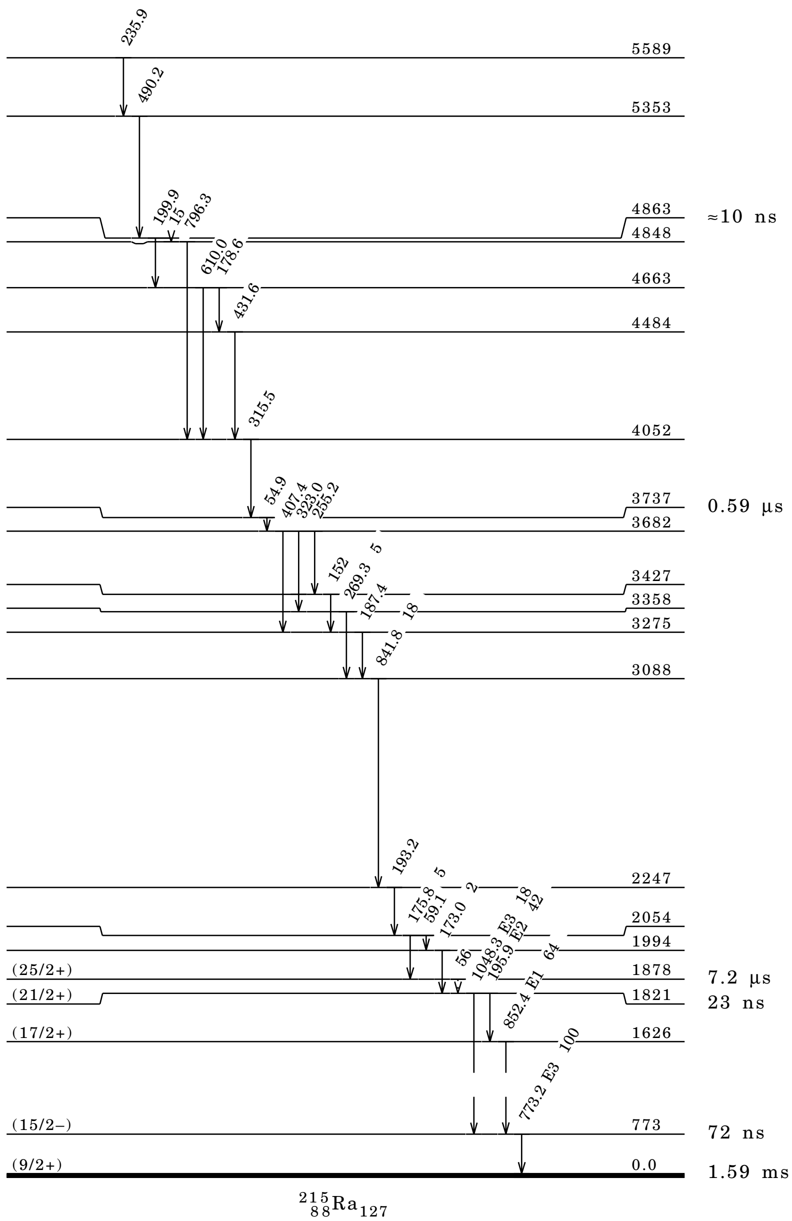
Eγ†	E(level)	Iγ†	Mult.§	α	Comments
315.5‡ *10*	4052				
323.0‡ *10*	3682				
407.4‡ *10*	3682				
431.6‡ *10*	4484				
490.2‡ *10*	5353				
610.0‡ *10*	4663				
773.2 *10*	773	100	E3	0.0409	Mult.: α(K)exp=0.0257 *11*, α(L)exp=0.0096 *6*, and α(M)exp=0.00027 *5* confirm the E3 multipolarity of this transition (1989Dr02). Eγ: Eγ=771.5 (1983Lo16).
796.3‡ *10*	4848				
841.8 *10*	3088	18 *2*			
852.4 *10*	1626	64 *3*	E1	0.00427	Eγ: Eγ=850.1 (1983Lo16).
1048.3 *10*	1821	18 *2*	E3	0.0198	

† From 1988Fu10 at E(^{12}C)=67 MeV, unless otherwise specified.
‡ From 1987AdZU.
§ From γ(θ) and γ–ray linear polarization measurements (1983Lo16,1988Fu10).

$^{208}Pb(^{13}C,6n\gamma)$ 1988Fu10,1983Lo16,1987AdZU (continued)

Level Scheme

Intensities: relative Iγ



Adopted Levels, Gammas

Q(β⁻)=–4910 *80*; S(n)=8480 *80*; S(p)=1360 *60*; Q(α)=7750 *50* 1995Au04.

^{215}Ac Levels

States in ^{215}Ac have been interpreted in terms of the shell model configurations $h_{9/2}$, $f_{7/2}$, and $i_{13/2}$ available for the seven protons beyond closed shell (Z=82) (1983De08).

Cross Reference (XREF) Flags

A ^{204}Pb(^{15}N,4nγ)
B ^{219}Pa α Decay

E(level)§	Jπ†	XREF	$T_{1/2}$‡	Comments
0.0	9/2–	AB	0.17 s *1*	$T_{1/2}$: from 1968Va04. Jπ: favored α decay (HF=1.3) to ^{211}Fr (Jπ=9/2–). %α=99.91 *2*; %ε+%β⁺=0.09 *2*. %α: from 1968Va04.
1317.0 *5*	13/2–	A		Jπ: 1317γ stretched E2 to 9/2–. configuration: (π $1h_{9/2})^{+7}$.
1621.0 *7*	17/2–	A	30 ns *10*	Jπ: 304γ stretched E2 to 13/2–. configuration: (π $1h_{9/2})^{+7}$. μ=7.82 *16*. μ: DPAD (1983De08,1989Ra17).
1796.0 *9*	21/2–	A	185 ns *30*	Jπ: 175γ stretched E2 to 17/2–. configuration: (π $1h_{9/2})^{+7}$. μ=9.66 *20*. μ: DPAD (1983De08,1989Ra17).
1796.0+x	(23/2–)	A		configuration: (π $1h_{9/2}{}^{+6}$, $2f_{7/2}{}^{+1}$).
2438+x	(29/2+)	A	335 ns *10*	Jπ: 642γ stretched E3 to (23/2–). B(E3)(W.u.)=24.7 *9* is similar to that of the corresponding E3 transition in ^{213}Fr, and typical of fast E3 transitions in this region. configuration: (π $1h_{9/2}{}^{+6}$, $1i_{13/2}{}^{+1}$). μ=15.13 *30*. μ: DPAD (1983De08,1989Ra17).

† Spin and parity and proton configuration assignments are based on the analogy with the corresponding levels in the isotones ^{211}At and ^{213}Fr, and also on the agreement of experimental g–factors with shell–model predictions (*i.e.* constant values for h9/2 states). Additional arguments are given with individual levels.
‡ From ^{204}Pb(^{15}N,4nγ), measured with the DPAD method.
§ X=50 keV *50*, extrapolated from Eγ=511 keV in ^{211}At, and Eγ=265 keV in ^{213}Fr.

γ(^{215}Ac)

E(level)	Eγ†	Iγ	Mult.†	α	Comments
1317.0	1317.0 *5*	100	E2	0.00572	
1621.0	304.0 *5*	100	E2	0.156	B(E2)(W.u.)=0.08 *3*.
1796.0	175.0 *5*	100	E2	1.04	B(E2)(W.u.)=0.119 *20*.
2438+x	642.0 *5*	100	E3	0.0711	B(E3)(W.u.)=27.4 *9*. B(E3)(W.u.)=27.4 *9* is similar to that of the corresponding E3 transition in ^{213}Fr, and typical of fast E3 transitions in this region. The strength enhancement of such transitions is due to the coupling with octupole vibrations in the even core nucleus.

† From ^{204}Pb(^{15}N,4nγ).

^{219}Pa α Decay 1987FaZS

Parent ^{219}Pa: E=0.0; Jπ=9/2−; $T_{1/2}$=53 ns *10*; Q(g.s.)=10080 *50*; %α decay≈100.
^{219}Pa was produced by ^{204}Pb(^{19}F,4n), E=100 MeV. Assignment of this activity to ^{219}Pa is based on excitation functions, and on the systematics of α–particle energies and half–lives for other protactinium isotopes. Measured Eα. Detector: annular system of gas detectors.

^{215}Ac Levels

E(level)	Jπ	$T_{1/2}$
0.0	9/2−	0.17 s *1*

α radiations

Eα	E(level)	Iα†	HF	Comments
9900 *50*	0.0	100	≈1.0	HF: using r_0(^{215}Ac)=1.52, average of r_0(^{214}Ra)=1.554, r_0(^{216}Ra)=1.566, r_0(^{214}Th)=1.46, and r_0(^{216}Th)≈1.50 (1998Ak04).

† For α intensity per 100 decays, multiply by ≈1.00.

^{204}Pb(^{15}N,4nγ) 1983De08

Target: 99.7% enriched ^{204}Pb, E(^{15}N)=84 MeV. Measured Eγ, Iγ, γγ coin. Measured γ–ray differential perturbed angular distributions (DPAD), level half–lives, and g–factors. Measured γ rays in coincidence with delayed α particles. Deduced transition multipolarities. Detectors: Ge(Li), high–purity germanium, semi.

^{215}Ac Levels

E(level)†	Jπ‡	$T_{1/2}$§	Comments
0.0	9/2−	0.17 s *1*	$T_{1/2}$: from adopted levels.
1317.0 *5*	13/2−		
1621.0 *7*	17/2−	30 ns *10*	g–factor=0.91 *1*, uncorrected for diagmagnetism and Knight shift.
1796.0 *9*	21/2−	185 ns *30*	g–factor=0.91 *1*, uncorrected for diagmagnetism and Knight shift.
1796.0+x	(23/2−)		X=50 *50*, extrapolated from Eγ=511 keV in ^{211}At, and Eγ=265 keV in ^{213}Fr.
2438+x	(29/2+)	335 ns *10*	g–factor=1.033 *10*, uncorrected for diagmagnetism and Knight shift.

† From γ–ray energies. X=50 keV *50*, extrapolated from Eγ=511 keV in ^{211}At, and Eγ=265 keV in ^{213}Fr.
‡ From adopted levels.
§ From DPAD measurements.

γ(^{215}Ac)

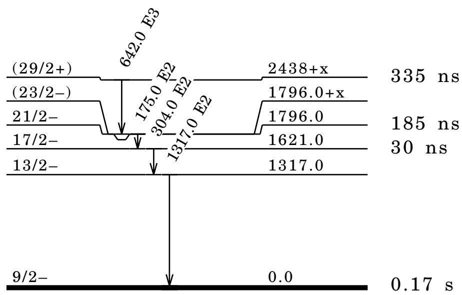
The assignment of γ rays to ^{215}Ac was based on the measurement of coincident Ac x rays, of delayed α particles (from ^{215}Ac and ^{216}Ac, with a ratio of 2:1), and on the level systematics of analogous levels in the lighter isotones ^{211}At and ^{213}Fr.

Eγ	E(level)	Mult.†	α
175.0 *5*	1796.0	E2	1.04
304.0 *5*	1621.0	E2	0.156
642.0 *5*	2438+x	E3	0.0711
1317.0 *5*	1317.0	E2	0.00572

† From measured A_2 angular distribution coefficients, and comparison with the corresponding transitions in ^{211}At and ^{213}Fr. All multipolarities are stretched.

$^{204}Pb(^{15}N,4n\gamma)$ 1983De08 (continued)

Level Scheme



$^{215}_{89}Ac_{126}$

Adopted Levels

Q(β⁻)=−6870 *140*; S(n)=7820 *SY*; S(p)=2790 *90*; Q(α)=7666 *6* 1995Au04.
Q(α): from Eα=7524 *8* to g.s. of ^{211}Ra (1968Va18).
1968Va18: activity was produced by ^{206}Pb(^{16}O,7n), E=90–160 MeV, and identified by excitation functions, genetic relationship to daughter nuclei, and by the agreement with α−particle energy decay systematics.
2000He17: activity was produced by ^{170}Er(^{51}V,p5n), E=214–286 MeV, and separated from the beam with a velocity filter. The activity was identified by excitation functions, and by its genetic relationship to daughter nuclei. Measured Eα, αγ coin. Detectors: germanium, semi.

^{215}Th Levels

Cross Reference (XREF) Flags

A ^{219}U α Decay

E(level)	Jπ	XREF	$T_{1/2}$	Comments
0.0	(1/2−)	A	1.2 s *2*	$T_{1/2}$: from 1968Va18. Jπ: from α−decay systematics of N=125, Jπ=1/2− isotones ^{209}Po, ^{211}Rn, and ^{213}Ra. These nuclei strongly populate a 5/2− g.s., and, 1/2− and 3/2− excited states. The hindrance factors for ^{215}Th α decay are: 7.0 (5/2−), 2.0 (1/2−), and 7.8 (3/2−), using $r_0(^{211}$Ra)=1.479, from adjacent even−even nuclei. configuration: expected shell−model configuration for the odd proton is p1/2. %α=100. No ε decay observed (lim 1.5%) (1968Va18).

^{219}U α Decay 1993An07,1994Ye08,1994AnZY

Parent ^{219}U: E=0.0; Jπ=?; $T_{1/2}$=42 μs *+34−13*; Q(g.s.)=9860 *50*; %α decay=100.

^{215}Th Levels

E(level)	Jπ†	$T_{1/2}$†
0.0	(1/2−)	1.2 s *2*

† From adopted levels.

α radiations

Eα	E(level)	Iα†
9680 *40*	0.0	100

† For α intensity per 100 decays, multiply by 1.0.

Adopted Levels

Q(β⁻)=9600 *180*; S(p)=170 *SY*; Q(α)=8240 *50* 1995Au04.

1979Sc09: ^{215}Pa activity was produced by ^{181}Ta(^{40}Ar,6n), E=165–202 MeV, and separated from the beam with a velocity filter. The activity was identified by excitation functions, and by its genetic relationship to daughter nuclei. Measured Eα. Detector: semi.

2000He17: ^{215}Pa activity was produced by ^{170}Er(^{51}V,6n), E=214–286 MeV, separated from the beam with a velocity filter, and implanted into a 16–strip semiconductor detector. The activity was identified by its genetic relationship to daughter nuclei. Measured Eα, half–life.

^{215}Pa Levels

E(level)	$T_{1/2}$	Comments
0.0	14 ms *2*	$T_{1/2}$: from 2000He17. Other value: 14 ms *+20–3* (1979Sc09). %α=100. %ε+%β⁺<6% (1997Mo25).

REFERENCES FOR A's=215,219,223,227,231

1939Pe01 M.Perey – Compt.Rend. 208, 97 (1939)
1939Pe02 M.Perey – J.Phys.Radium 10, 435 (1939)
1942Wa04 A.G.Ward – Proc.Roy.Soc.(London) 181A, 183 (1942)
1944Ka01 B.Karlik, T.Bernert – Z.Physik 123, 51 (1944)
1944Ka02 B.Karlik, T.Bernert – Naturwissenschaften 32, 44 (1944)
1949Os01 D.W.Osborne, R.C.Thompson, Q.Van Winkle – NNES 14B, 1397 (1949)
1949Pe03 S.Peterson, A.Ghiorso – NNES 14B, 1395 (1949)
1949Va02 Q.Van Winkle, R.G.Larson, L.I.Katzin – J.Am.Chem.Soc. 71, 2585 (1949)
1950Av61 P.Avignon – J.Phys.Radium 11, 521 (1950)
1950Cr28 W.W.T.Crane, I.Perlman – Priv.Comm., quoted by 1967Le24 unpublished (1950)
1950Ho79 J.M.Hollander, R.F.Leininger – Phys.Rev. 80, 915 (1950)
1950Le13 M.Lecoin, M.Perey, M.Riou, J.Teillac – J.Phys.Radium 11, 227 (1950)
1950Ma14 L.B.Magnusson, S.G.Thompson, G.T.Seaborg – Phys.Rev. 78, 363 (1950)
1951Me10 W.W.Meinke, A.Ghiorso, G.T.Seaborg – Phys.Rev. 81, 782 (1951)
1951To19 F.S.Tomkins, M.Fred, W.F.Meggers – Phys.Rev. 84, 168 (1951)
1952Me13 W.W.Meinke, A.Ghiorso, G.T.Seaborg – Phys.Rev. 85, 429 (1952)
1952Or03 D.A.Orth – Thesis, Univ.California (1952); UCRL–1059 (Rev.) (1952)
1952Se67 E.Segre – Phys.Rev. 86, 21 (1952)
1953Bu63 J.P.Butler, J.S.Adam – Phys.Rev. 91, 1219 (1953)
1953Cr67 W.W.T.Crane – Priv.Comm., quoted by 1958St50 unpublished (1953)
1953Hy83 E.K.Hyde, A.Ghiorso – Phys.Rev. 90, 267 (1953)
1954Ha60 G.R.Hagee, M.L.Curtis, G.R.Grove – Phys.Rev. 96, 817A (1954)
1954Hy26 E.K.Hyde – Phys.Rev. 94, 1221 (1954)
1955Ad09 M.Ader – Compt.Rend. 240, 2138 (1955)
1955Ad10 J.P.Adloff – Compt.Rend. 240, 1421 (1955)
1955Fr25 M.Frilley, S.Rosenblum, M.Valadares, G.Bouissieres – J.Phys.Radium 16, 378 (1955)
1955Fr26 M.Fred, F.S.Tomkins, W.F.Meggers – Phys.Rev. 98, 1514 (1955); Erratum Phys.Rev. 111, 1747 (1958)
1955To07 J.Tobailem – J.Phys.Radium 16, 48 (1955)
1956Ma01 C.W.Malich – Bull.Am.Phys.Soc. 1, No.1, 43, K12 (1956)
1956Pe27 M.Perey, J.P.Adloff – J.Phys.Radium 17, 545 (1956)
1956Sh43 N.S.Shimanskaya, E.A.Yashugina – At.Energ. 1, 133 (1956); J.Nuclear Energy 5, 161 (1957)
1957Pa07 H.Paul, H.Warhanek – Helv.Phys.Acta 30, 272 (1957)
1957Pi31 R.C.Pilger, Jr. – Thesis, Univ.California (1957); UCRL–3877 (1957)
1957Th10 T.D.Thomas, R.Vandenbosch, R.A.Glass, G.T.Seaborg – Phys.Rev. 106, 1228 (1957)
1958Ca19 M.J.Cabell – Can.J.Phys. 36, 989 (1958)
1958Fi10 I.I.Filimonov, B.V.Pshenichnikov – Zhur.Eksptl.I. Teoret.Fiz. 35, 548 (1958); Soviet Phys.JETP 8, 378 (1959)
1958Hi78 M.W.Hill – Thesis, Univ.California (1958); UCRL–8423 (1958)
1958St50 D.Strominger, J.M.Hollander, G.T.Seaborg – Revs.Modern Phys. 30, 585 (1958)
1958To25 P.A.Tove – Arkiv Fysik 13, 549 (1958)
1958Va29 H.Vartapetian – Compt.Rend. 246, 1680 (1958)
1959No41 G.I.Novikova, E.A.Volkova, L.I.Goldin, D.M.Ziv, E.F.Tretyakov – Zh.Eksp.Teor.Fiz. 37, 928 (1959); Sov.Phys.JETP 10, 663 (1960)
1959Ro51 J.Robert – Ann.Phys.(Paris) 4, 89 (1959)
1959St49 D.Strominger – Phys.Rev. 114, 502 (1959)
1960As02 F.Asaro, F.S.Stephens, J.M.Hollander, I.Perlman – Phys.Rev. 117, 492 (1960)
1960Gi03 J.E.Gindler, D.W.Engelkemeir – Phys.Rev. 119, 1645 (1960)
1960Pe13 G.Y.Petit – J.Phys.Radium 21, 447 (1960)
1960Ta19 K.Takahashi, H.Morinaga – Nuclear Phys. 21, 133 (1960)
1960Wa16 G.Walter, A.Coche – J.Phys.Radium 21, 477 (1960)
1961Ba42 S.A.Baranov, V.M.Kulakov, P.S.Samoilov, A.G.Zelenkov, Yu.F.Rodionov, S.V.Pirozhkov – Zhur.Eksptl.i Teoret.Fiz. 41, 1475 (1961); Soviet Phys.JETP 14, 1053 (1962)
1961Be28 A.V.Bellido – J.Inorg.Nuclear Chem. 19, 197 (1961)
1961Br32 F.Braganca Gil, G.Y.Petit – J.Phys.Radium 22, 680 (1961)
1961Br44 F.Braganca Gil, R.Foucher, G.Y.Petit – J.Phys.Radium 22, 289 (1961)
1961Fo08 R.Foucher – Thesis, University of Paris (1961)
1961Gr43 R.D.Griffioen, R.D.Macfarlane – UCRL–10023, p.50 (1961)
1961Ho29 J.M.Hollander, F.S.Stephens, F.Asaro, I.Perlman – Pric.Comm., quoted by 1964Hy02 unpublished (1961)
1961Ki05 H.W.Kirby – J.Inorg.Nuclear Chem. 18, 8 (1961)
1961Ro14 H.Rodenbusch, G.Herrmann – Z.Naturforsch 16a, 577 (1961)
1961Ry02 A.Rytz – Helv.Phys.Acta 34, 240 (1961)
1961Vo06 Yu.M.Volkov, A.P.Komar, G.A.Korolev, G.E.Kocharov – Izvest.Akad.Nauk SSSR, Ser.Fiz. 25, 1188 (1961); Columbia Tech.Transl. 25, 1193 (1962)
1962Gi04 M.Giannini, D.Prosperi, S.Sciuti – Nuovo Cimento 25, 1314 (1962)
1962Gr20 R.D.Griffioen, R.D.Macfarlane – Bull.Am.Phys.Soc. 7, No.8, 541, K5 (1962)
1962Pi06 R.C.Pilger, F.S.Stephens, F.Asaro, I.Perlman – Priv.Comm., quoted by 1964Hy02 unpublished (1962)
1962Wa18 R.J.Walen, V.Nedovesov, G.Bastin–Scoffier – Nuclear Phys. 35, 232 (1962)
1963Ab04 H.Abou–Leila, R.Foucher, A.G.De Pinho, N.Perrin, M.Valadares – J.Phys. 24, 857 (1963)
1963Ei10 J.F.Eichelberger, G.R.Grove, L.V.Jones, E.A.Rembold – MLM–1155, p.12 (1963)

REFERENCES FOR A's=215,219,223,227,231 (CONTINUED)

1963Su10 V.B.Subrahmanyam – Thesis, Univ.California (1963); UCRL–11082 (1963)
1964Ba33 G.Bastin–Scoffier, C.F.Leang, R.J.Walen – Compt.Rend. 258, 6397 (1964)
1964Bu02 F.D.S.Butement, V.J.Robinson – J.Inorg.Nucl.Chem. 26, 1 (1964)
1964Hy02 E.K.Hyde, I.Perlman, G.T.Seaborg – The Nuclear Properties of the Heavy Elements, Vol.II, Prentice–Hall, Inc., Englewood Cliffs, N.J. (1964)
1964Su04 V.Subrahmanyam, D.F.Mosier, F.Asaro, I.Perlman – UCRL–11213, p.19(1964)
1964Wa19 A.H.Wapstra – Nucl.Phys. 57, 48 (1964)
1964Yt01 C.Ythier, G.Mazzone, P.W.F.Louwrier – Physica 30, 2143 (1964)
1965Br23 C.Briancon – Compt.Rend. 260, 5764 (1965)
1965Cl05 S.Cluzeau – Thesis, University of Bordeaux (1965)
1965Co22 S.G.Cohen, D.Murnick, W.C.Schick – MIT–2098–251, p.50 (1965)
1965Ki05 H.W.Kirby, K.C.Jordan, J.Z.Braun, M.L.Curtis, M.L.Salutsky – J.Inorg.Nucl.Chem. 27, 1881 (1965)
1965Nu03 M.Nurmia, D.Giessing, W.Sievers, L.Varga – Ann.Acad.Sci.Fennicae, Ser.A VI, No.167 (1965)
1965PoZZ J.K.Poggenburg,Jr. – Thesis, Univ.California (1965); UCRL–16187 (1965)
1965Tr02 J.Treherne, C.Vieu – Compt.Rend. 261, 3100 (1965)
1965Va10 K.Valli, J.Aaltonen, G.Graeffe, M.Nurmia – Ann.Acad.Sci.Fenn., Ser.A VI, No.184 (1965)
1966Ba14 G.Bastin, C.F.Leang, R.J.Walen – Compt.Rend. 262B, 89 (1966)
1966Ba19 G.Bastin, C.–F.Leang, R.J.Walen – Compt.Rend. 262B, 370 (1966)
1966Ba29 E.Bashandy, S.G.Hanna – Nucl.Phys. 84, 577 (1966)
1966Fr07 M.Frilley – Priv.Comm. (1966); quoted by 67Vi04 unpublished (1966)
1966Gr07 G.Graeffe, P.Kauranen – J.Inorg.Nucl.Chem. 28, 933 (1966)
1966Hu20 J.B.Hursh – J.Inorg.Nucl.Chem. 28, 2771 (1966)
1966Ku13 V.I.Kuznetsov, N.K.Skobelev, G.N.Flerov – Yad.Fiz. 4, 279 (1966); Soviet J.Nucl.Phys. 4, 202 (1967)
1966La10 R.C.Lange, G.R.Hagee – MLM–1337J (1966)
1966Po02 P.Polak, A.H.Wapstra, C.Ythier – Priv.Comm. (1966)
1967Da20 J.Dalmasso, H.Maria – Compt.Rend. 265B, 822 (1967)
1967JoZX K.C.Jordan, B.C.Blanke – Proc.Symp.Standardization of Radionuclides, Vienna, Austria (1966), Intern.At.Energy Agency, Vienna, p.567 (1967); CONF–661012–4 (1967)
1967Le05 J.Letessier, D.Bertault, S.Cluzeau, G.Y.Petit – Nucl.Phys. A96, 689(1967)
1967Le24 C.M.Lederer, J.M.Hollander, I.Perlman – Table of Isotopes, Sixth Edition, John Wiley and Sons, Inc., New York (1967)
1967Li17 K.H.Lieser, E.Kluge – Radiochim.Acta 7, 3 (1967)
1967Ma19 H.Maria, C.Ythier, P.Polak, A.H.Wapstra – Physica 34, 571 (1967)
1967Po05 M.Poulet, A.Michalowicz, K.Kuroda, D.Cronenberger – Nucl.Phys. A99, 442(1967)
1967Vi04 C.Vieu, C.Briancon, G.Bastin, F.C.Leang, J.Treherne, R.J.Walen – Izv.Akad.Nauk SSSR, Ser.Fiz. 31, 85 (1967); Bull.Acad.Sci.USSR, Phys.Ser. 31, 90 (1967)
1968Ba25 S.A.Baranov, V.M.Kulakov, V.M.Shatinskii – Yadern.Fiz. 7, 727 (1968); Soviet J.Nucl.Phys. 7, 442 (1968)
1968Ba73 G.Bastin, C.F.Leang, R.J.Walen – J.Phys.(Paris), Suppl.No.1, Colloq.C1–181 (1968)
1968Br04 D.Brown, S.N.Dixon, K.M.Glover, F.J.G.Rogers – J.Inorg.Nucl.Chem. 30, 19(1968)
1968Br17 C.Briancon, C.F.Leang, R.Walen – Compt.Rend. 266B, 1533 (1968)
1968Br30 C.Briancon, C.Vieu – Compt.Rend. 267B, 651(1968)
1968Br37 C.Briancon, C.F.Leang – J.Phys.(Paris), Suppl.No.1, Colloq.C1–184 (1968)
1968Da10 W.F.Davidson, R.D.Connor – Nucl.Phys. A116, 342(1968)
1968Gr07 J.Graff, G.Chouraqui, M.Port, J.M.Thirion, S.Jang, T.Muller – J.Phys.(Paris) 29, 141 (1968)
1968Ha22 G.R.Hagee, R.C.Lange, A.G.Barnett, A.R.Campbell, C.R.Cothern, D.F.Griffing, H.J.Hennecke – Nucl.Phys. A115, 157(1968)
1968Va04 K.Valli, W.J.Treytl, E.K.Hyde – Phys.Rev. 167, 1094 (1968)
1968Va18 K.Valli, E.K.Hyde – Phys.Rev. 176, 1377 (1968)
1968Wa09 R.Walen, C.–F.Leang – Compt.Rend. 266B, 734 (1968)
1969Ba20 A.G.Barnett, A.R.Campbell, G.R.Hagee – J.Inorg.Nucl.Chem. 31, 1553 (1969)
1969Be67 D.Bertault, M.Vidal, G.Y.Petit – J.Phys.(Paris) 30, 909 (1969)
1969BoZF J.D.Bowman – Priv.Comm. (1969); Quoted by 74Ri01
1969Br27 C.Briancon, R.Walen – J.Phys.(Paris) 30, 753 (1969)
1969El03 T.W.Elze, T.v.Egidy, J.R.Huizenga – Nucl.Phys. A128, 564 (1969)
1969Ha32 R.L.Hahn, M.F.Roche, K.S.Toth – Phys.Rev. 182, 1329 (1969)
1969La04 R.C.Lange, G.R.Hagee – Nucl.Phys. A124, 412(1969)
1969LeZW C.–F.Leang – Thesis, Univ.Paris (1969)
1969Pe17 A.Peghaire – Nucl.Instr.Methods 75, 66 (1969)
1969Ro33 J.Robert, C.F.Miranda, R.Muxart – Radiochim.Acta 11, 104 (1969)
1970Bo13 J.Borggreen, K.Valli, E.K.Hyde – Phys.Rev. C2, 1841 (1970)
1970Bo31 J.S.Boyno, T.W.Elze, J.R.Huizenga – Nucl.Phys. A157, 263 (1970)
1970Da08 W.F.Davidson, R.D.Connor – Nucl.Phys. A149, 363 (1970)
1970Da09 W.F.Davidson, R.D.Connor – Nucl.Phys. A149, 385 (1970)
1970De19 A.G.de Pinho, E.F.da Silveira, N.L.da Costa – Phys.Rev. C2, 572 (1970)
1970Ge02 W.Gelletly, J.S.Geiger, J.S.Merritt – Can.J.Phys. 48, 993 (1970)
1970Ki12 H.W.Kirby – J.Inorg.Nucl.Chem. 32, 2823 (1970)
1970Ko05 A.P.Komar, A.A.Vorobiev, Y.K.Zalite, G.A.Korolev – Dokl.Akad.Nauk.SSSR 191, 61 (1970); Sov.Phys.Dokl. 15, 244 (1970)
1970Ko34 G.A.Korolev, A.A.Vorobev, Y.K.Zalite – Izv.Akad.Nauk SSSR, Ser.Fiz. 34, 2113 (1970); Bull.Acad.Sci. USSR, Phys.Ser. 34, 1884 (1971)

REFERENCES FOR A's=215,219,223,227,231 (CONTINUED)

1970Kr01 K.Krien, C.Gunther, J.D.Bowman, B.Klemme – Nucl.Phys. A141, 75 (1970)
1970Kr08 K.Krien, M.J.Canty, P.Herzog – Nucl.Phys. A157, 456 (1970)
1970Le11 C.F.Leang – J.Phys. (Paris) 31, 269 (1970)
1970Le13 M.Levanoni, F.C.Zawislak – Phys.Rev. C2, 672 (1970)
1970To08 H.Ton, W.Beens, S.Roodbergen, J.Blok – Nucl.Phys. A155, 235 (1970)
1970Va13 K.Valli, E.K.Hyde, J.Borggreen – Phys.Rev. C1, 2115 (1970)
1971Ar48 A.Artna–Cohen – Nucl.Data Sheets B6, 287 (1971)
1971Ar49 A.Artna–Cohen – Nucl.Data Sheets B6, 225 (1971)
1971Br27 T.H.Braid, R.R.Chasman, J.R.Erskine, A.M.Friedman – Phys.Rev. C4, 247 (1971)
1971Br28 C.Briancon, C.Vieu – J.Phys.(Paris) 32, 373 (1971)
1971Br29 C.Briancon, R.Walen – J.Phys.(Paris) 32, 381 (1971)
1971Er02 A.Erlik, J.Felsteiner, H.Lindeman, M.Tatcher – Nucl.Instrum.Methods 92, 45 (1971)
1971Gr17 B.Grennberg, A.Rytz – Metrologia 7, 65 (1971)
1971Ko37 G.A.Korolev, A.A.Vorobyov, Y.K.Zalite – Nucl.Instrum.Methods 97, 323 (1971)
1971Ko48 K.Kobayashi, T.Hashimoto, I.Kimura – J.Nucl.Sci.Technol. 8, 492 (1971)
1971KrZH L.A.Kroger, C.W.Reich, J.E.Cline – ANCR–1016, p.75 (1971)
1971Le10 C.F.Leang – J.Phys.(Paris) 32, 95 (1971)
1971Lo15 W.Lourens, B.O.Ten Brink, A.H.Wapstra – Nucl.Phys. A171, 337 (1971)
1972El21 Y.A.Ellis, M.R.Schmorak – Nucl.Data Sheets B8, 345 (1972)
1972Er03 J.R.Erskine – Phys.Rev. C5, 959 (1972)
1972Ga39 R.K.Garg, S.D.Chauhan, S.Sanyal, S.C.Pancholi, S.L.Gupta, N.K.Saha – Z.Phys. 257, 124 (1972)
1972GaZA R.Gaeta, J.A.Gonzalez, L.Gonzalez, C.Roldan – JEN–257 (1972)
1972Gr19 T.Grotdal, J.Limstrand, K.Nybo, K.Skar, T.F.Thorsteinsen – Nucl.Phys. A189, 592 (1972)
1972He18 W.H.A.Hesselink, A.H.Wapstra, J.G.Kromme, E.J.Haighton, M.Van Kampen, W.Hutjes, K.E.M.Dijkman – Nucl.Phys. A191, 283 (1972)
1972HeYM W.H.A.Hesselink – NP–19781 (1972)
1972Sc44 W.–D.Schmidt–Ott, J.C.McGeorge, R.W.Fink – Z.Phys. 255, 161 (1972)
1973Br12 E.Browne, F.Asaro – Phys.Rev. C7, 2545 (1973)
1973Ch24 K.Chayawattanangkur, G.Herrmann, N.Trautmann – J.Inorg.Nucl.Chem. 35, 3061 (1973)
1973Ha32 O.Hausser, W.Witthuhn, T.K.Alexander, A.B.McDonald, J.C.D.Milton, A.Olin – Phys.Rev.Lett. 31, 323 (1973)
1973HaZO O.Hausser, W.Witthuhn, T.K.Alexander, A.B.McDonald, J.C.D.Milton, A.Olin, S.J.Skorka – AECL–4595, p.19 (1973)
1973Ja06 U.Jager, H.Munzel, G.Pfennig – Z.Phys. 258, 337 (1973)
1973Ta30 K.Takahashi, M.Yamada, T.Kondoh – At.Data Nucl.Data Tables 12, 101 (1973)
1973Te06 W.Teoh – Nucl.Instrum.Methods 109, 509 (1973)
1973We08 R.Weiss–Reuter, H.Munzel, G.Pfennig – J.Inorg.Nucl.Chem. 35, 2145 (1973)
1974Bo11 J.D.Bowman, L.Ley, B.Richter – Nucl.Phys. A220, 367 (1974)
1974De11 A.G.de Pinho, L.T.Auler, A.G.da Silva – Phys.Rev. C9, 2056 (1974)
1974HeYW R.L.Heath – ANCR–1000–2 (1974)
1974Mo05 M.Monsecour, P.De Regge, A.Demildt, L.H.Baetsle – J.Inorg.Nucl.Chem. 36, 719 (1974)
1974No02 T.Nomura, K.Hiruta, M.Yoshie, O.Hashimoto – Phys.Rev. C9, 1168 (1974)
1974Ri01 B.Richter, V.Martini, W.–D.Schneider, L.Ley, V.Schoner – Nucl.Instrum.Methods 115, 401 (1974)
1974Ri05 B.Richter, M.J.Canty, L.Ley, M.V.Banaschik, A.Neskakis – Nucl.Phys. A223, 234 (1974)
1974Te03 W.Teoh, R.D.Connor, R.H.Betts – Nucl.Phys. A228, 432 (1974)
1975Er01 J.R.Erskine, G.Kyle, R.R.Chasman, A.M.Friedman – Phys.Rev. C11, 561 (1975)
1975Ho14 P.Hornshoj, P.Tidemand–Petersson, R.Kaczarowski, B.Kotlinska, J.Zylicz – Nucl.Phys. A248, 406 (1975)
1975Ra03 H.L.Ravn, S.Sundell, L.Westgaard, E.Roeckl – J.Inorg.Nucl.Chem. 37, 383 (1975)
1975Va11 E.Vano, R.Gaeta, L.Gonzalez, C.F.Liang – Nucl.Phys. A251, 225 (1975)
1975VyZS Ts.Vylov, V.M.Gorozhankin, N.A.Golovkov, Yu.V.Norseev, V.G.Chumin, B.S.Dzhelepov, R.B.Ivanov, M.A.Mikhailova – Proc.Symp.Nucl.Spectrosc.Nucl.Theory, 14th, Dubna, JINR–D6–8846, p.150 (1975)
1975We23 L.Westgaard, K.Aleklett, G.Nyman, E.Roeckl – Z.Phys. A275, 127 (1975)
1976Bl13 K.Blaton–Albicka, B.Kotlinska–Filipek, M.Matul, K.Stryczniewicz, M.Nowicki, E.Ruchowska–Lukasiak – Nukleonika 21, 935 (1976)
1976Bo50 G.L.Borchert – Z.Naturforsch. 31a, 102 (1976)
1976Li13 C.F.Liang, A.Peghaire – Nucl.Instrum.Methods 134, 553 (1976)
1976MaZW M.J.Martin – ORNL–5114 (1976)
1976SoZT L.P.Somerville, M.J.Nurmia, A.Ghiorso – LBL–5075, p.39 (1976)
1977Ba48 W.Bambynek, H.Behrens, M.H.Chen, B.Crasemann, M.L.Fitzpatrick, K.W.D.Ledingham, H.Genz, M.Mutterer, R.L.Intemann – Rev.Mod.Phys. 49, 77 (1977); Erratum Rev.Mod.Phys. 49, 961 (1977)
1977Ba72 S.A.Baranov, V.M.Shatinskii, A.G.Zelenkov, V.A.Pchelin – Yad.Fiz. 26, 921 (1977); Sov.J.Nucl.Phys. 26, 486 (1977)
1977Ch27 R.R.Chasman, I.Ahmad, A.M.Friedman, J.R.Erskine – Rev.Mod.Phys. 49, 833 (1977)
1977Ma30 C.Maples – Nucl.Data Sheets 22, 223 (1977)
1977Ma31 C.Maples – Nucl.Data Sheets 22, 243 (1977)
1977Ma32 C.Maples – Nucl.Data Sheets 22, 275 (1977)
1977MyZZ W.D.Myers – Droplet Model of Atomic Nuclei, IFI/Plenum Data Company, New York (1977)
1977Th04 R.C.Thompson, W.Wilcke, J.R.Huizenga, W.K.Hensley, D.G.Perry – Phys.Rev. C15, 2019 (1977)
1977Wi07 W.Wilcke, W.Feix, T.W.Elze, J.R.Huizenga, R.C.Thompson, R.M.Dreizler – Nucl.Phys. A286, 297 (1977)
1978Ke02 E.G.Kessler,Jr., R.D.Deslattes, A.Henins, W.C.Sauder – Phys.Rev.Lett. 40, 171 (1978)
1978Ro21 F.Rosel, H.M.Friess, K.Alder, H.C.Pauli – At.Data Nucl.Data Tables 21, 291 (1978)

REFERENCES FOR A's=215,219,223,227,231 (CONTINUED)

1979Bo30 H.G.Borner, G.Barreau, W.F.Davidson, P.Jeuch, T.von Egidy, J.Almeida, D.H.White – Nucl.Instrum.Methods 166, 251 (1979)

1979Sc09 K.–H.Schmidt, W.Faust, G.Munzenberg, H.–G.Clerc, W.Lang, K.Pielenz, D.Vermeulen, H.Wohlfarth, H.Ewald, K.Guttner – Nucl.Phys. A318, 253 (1979)

1979Te02 W.Teoh, R.D.Connor, R.H.Betts – Nucl.Phys. A319, 122 (1979)

1980Ry04 M.Rysavy, O.Dragoun – Comput.Phys.Commun. 19, 93 (1980)

1981Va28 S.K.Vasilev, B.S.Dzhelepov, R.B.Ivanov, M.A.Mikhailova, A.V.Mozzhukhin, B.I.Shestakov – Izv.Akad.Nauk SSSR, Ser.Fiz. 45, 1895 (1981)

1981Vo03 T.Von Egidy, G.Barreau, H.G.Borner, W.F.Davidson, J.Larysz, D.D.Warner, P.H.M.Van Assche, K.Nybo, T.F.Thorsteinsen, G.Lovhoiden, E.R.Flynn, J.A.Cizewski, R.K.Sheline, D.Decman, D.G.Burke, G.Sletten, N.Kaffrell, W.Kurcewicz, T.Bjornstad, G.Nyman – Nucl.Phys. A365, 26 (1981)

1982AlZL Yu.V.Aleksandrov, S.K.Vasilev, B.S.Dzhelepov, R.B.Ivanov, M.A.Mikhailova, A.V.Mozzhukhin, A.V.Saulsky, B.I.Shestakov – Program and Theses, Proc.32nd Ann.Conf.Nucl.Spectrosc.Struct.At.Nuclei, Kiev, p.135 (1982)

1982An02 I.Anicin, I.Bikit, C.Girit, H.Guven, W.D.Hamilton, A.A.Yousif – J.Phys.(London) G8, 369 (1982)

1982Ba56 G.Barreau, H.G.Borner, T.von Egidy, R.W.Hoff – Z.Phys. A308, 209 (1982)

1982Bo04 J.D.Bowman, R.E.Eppley, E.K.Hyde – Phys.Rev. C25, 941 (1982)

1982BrZF V.B.Brudanin, Ts.Vylov, N.A.Golovkov, I.I.Gromova, B.S.Dzhelepov, A.I.Ivanov, R.B.Ivanov, M.A.Mikhailova, Yu.V.Norseev – Program and Theses, Proc.32nd Ann.Conf.Nucl.Spectrosc.Struct.At.Nuclei, Kiev, p.134 (1982)

1982Li02 J.Libert, M.Meyer, P.Quentin – Phys.Rev. C25, 586 (1982)

1982Va04 R.Vaninbroukx, B.Denecke – Nucl.Instrum.Methods 193, 191 (1982)

1983Ah03 S.A.Ahmad, W.Klempt, R.Neugart, E.W.Otten, K.Wendt, C.Ekstrom, and the ISOLDE Collaboration – Phys.Lett. 133B, 47 (1983)

1983Ch06 H.Chatani – Nucl.Instrum.Methods 205, 501 (1983)

1983De08 D.J.Decman, H.Grawe, H.Kluge, K.H.Maier – Z.Phys. A310, 55 (1983)

1983Fu10 N.Fujiwara, S.Noguchi, E.Muraoka Kohriki, S.Yamashita – Nucl.Phys. A404, 509 (1983)

1983Lo06 M.P.Locher, M.E.Sainio – Phys.Lett. 121B, 227 (1983)

1983Lo16 T.Lonnroth, C.Baktash – Phys.Scr. 28, 459 (1983)

1983Ra28 I.Ragnarsson – Phys.Lett. 130B, 353 (1983)

1983Sh16 R.K.Sheline, G.A.Leander – Phys.Rev.Lett. 51, 359 (1983)

1984Al34 D.V.Aleksandrov, A.F.Belyatsky, Yu.A.Glukhov, E.Yu.Nikolsky, B.G.Novatsky, A.A.Ogloblin, D.N.Stepanov – Pisma Zh.Eksp.Teor.Fiz. 40, 152 (1984); JETP Lett.(USSR) 40, 909 (1984)

1984Bu21 P.A.Butler, D.Burrows, K.Connell, A.El–Lawindy, A.N.James, G.D.Jones, T.P.Morrison, J.Simpson, R.Wadsworth – ATOMKI Kozlem. 26, 58 (1984)

1984Bu38 J.D.Burrows, P.A.Butler, K.A.Connell, G.D.Jones, A.N.James, A.M.Y.El–Lawindy, T.P.Morrison, J.Simpson, R.Wadsworth – Nucl.Instrum.Methods 227, 259 (1984)

1984De16 D.J.Decman, H.Grawe, H.Kluge, K.H.Maier, A.Maj, M.Menningen, N.Roy, W.Wiegner – Nucl.Phys. A419, 163 (1984)

1984Ga38 S.Gales, E.Hourani, M.Hussonnois, J.P.Schapira, L.Stab, M.Vergnes – Phys.Rev.Lett. 53, 759 (1984)

1984Le04 G.A.Leander, R.K.Sheline – Nucl.Phys. A413, 375 (1984)

1984Po08 D.N.Poenaru, M.Ivascu, A.Sandulescu, W.Greiner – J.Phys.(London) G10, L183 (1984)

1984Ro30 H.J.Rose, G.A.Jones – Nature(London) 307, 245 (1984)

1984Sc25 N.Schulz, S.Khazrouni, A.Chevallier, J.Chevallier, L.Kraus, I.Linck, D.C.Radford, J.Dudek, W.Nazarewicz – J.Phys.(London) G10, 1201 (1984)

1985Al28 D.V.Aleksandrov, Yu.A.Glukhov, E.Yu.Nikolsky, B.G.Novatsky, A.A.Ogloblin, D.N.Stepanov – Izv.Akad.Nauk SSSR, Ser.Fiz. 49, 2111 (1985); Bull.Acad.Sci.USSR, Phys.Ser. 49, No.11, 26 (1985)

1985Be05 I.Bergstrom, B.Fant – Phys.Scr. 31, 26 (1985)

1985Co24 A.Coc, C.Thibault, F.Touchard, H.T.Duong, P.Juncar, S.Liberman, J.Pinard, J.Lerme, J.L.Vialle, S.Buttgenbach, A.C.Mueller, A.Pesnelle, and the ISOLDE Collaboration – Phys.Lett. 163B, 66 (1985)

1985Dr02 M.W.Drigert, J.A.Cizewski – Phys.Rev. C31, 1977 (1985)

1985Dr04 M.W.Drigert, J.A.Cizewski, M.S.Rosenthal – Phys.Rev. C32, 136 (1985)

1985Hi02 P.Hill, N.Kaffrell, W.Kurcewicz, G.Nyman – Z.Phys. A320, 531 (1985)

1985Is03 T.Ishii, I.Ahmad, J.E.Gindler, A.M.Friedman, R.R.Chasman, S.B.Kaufman – Nucl.Phys. A444, 237 (1985)

1985Kh01 S.Khazrouni, A.Chevallier, J.Chevallier, O.Helene, G.Ramanantsizehena, N.Schulz – Z.Phys. A320, 535 (1985)

1985Ku24 W.Kutschera, I.Ahmad, S.G.Armato III, A.M.Friedman, J.E.Gindler, W.Henning, T.Ishii, M.Paul, K.E.Rehm – Phys.Rev. C32, 2036 (1985)

1985Po11 D.N.Poenaru, M.Ivascu, A.Sandulescu, W.Greiner – Phys.Rev. C32, 572 (1985)

1985Pr01 P.B.Price, J.D.Stevenson, S.W.Barwick, H.L.Ravn – Phys.Rev.Lett. 54, 297 (1985)

1985Sa02 A.Sandulescu, D.N.Poenaru, W.Greiner, J.H.Hamilton – Phys.Rev.Lett. 54, 490 (1985)

1985Sa40 A.Sandulescu, Yu.S.Zamyatnin, I.A.Lebedev, B.F.Myasoedov, S.P.Tretyakova, D.Hasegan – Izv.Akad.Nauk SSSR, Ser.Fiz. 49, 2104 (1985); Bull.Acad.Sci.USSR, Phys.Ser. 49, No.11, 20 (1985)

1985Sh01 Y.–J.Shi, W.J.Swiatecki – Phys.Rev.Lett. 54, 300 (1985)

1985Sh07 Y.–J.Shi, W.J.Swiatecki – Nucl.Phys. A438, 450 (1985)

1985ZiZY W.L.Zijp – ECN FYS/RASA–85/19 (1985)

1986Bo35 M.J.G.Borge, D.G.Burke, F.Calaprice, O.C.Jonsson, G.Lovhoiden, R.A.Naumann, K.Nybo, G.Nyman, H.L.Ravn, T.F.Thorsteinsen, and the ISOLDE collaboration – Z.Phys. A325, 429 (1986)

1986Co05 P.D.Cottle, M.Gai, J.F.Ennis, J.F.Shriner, Jr., D.A.Bromley, C.W.Beausang, L.Hildingsson, W.F.Piel, Jr., D.B.Fossan, J.W.Olness, E.K.Warburton – Phys.Rev. C33, 1855 (1986)

1986De32 H.G.de Carvalho, J.B.Martins, O.A.P.Tavares – Phys.Rev. C34, 2261 (1986)

1986Dr07 M.W.Drigert, J.A.Cizewski – Phys.Rev. C33, 1344 (1986)

REFERENCES FOR A's=215,219,223,227,231 (CONTINUED)

1986Ek02 C.Ekstrom, L.Robertsson, A.Rosen – Phys.Scr. 34, 624 (1986)
1986Gi08 K.–L.Gippert, E.Runte, W.–D.Schmidt–Ott, P.Tidemand–Petersson, N.Kaffrell, P.Peuser, R.Kirchner, O.Klepper, W.Kurcewicz, P.O.Larsson, E.Roeckl, D.Schardt, K.Rykaczewski – Nucl.Phys. A453, 1 (1986)
1986Gr20 M.Greiner, W.Scheid – J.Phys.(London) G12, L229 (1986)
1986Ir01 M.Iriondo, D.Jerrestam, R.J.Liotta – Nucl.Phys. A454, 252 (1986)
1986Ka46 S.G.Kadmensky, V.I.Furman, Yu.M.Chuvilsky – Izv.Akad.Nauk SSSR, Ser.Fiz. 50, 1786 (1986); Bull.Acad.Sci.USSR, Phys.Ser. 50, No.9, 116 (1986)
1986LoZT A.Lorenz – IAEA Tech.Rept.Ser., No.261 (1986)
1986Pi11 G.A.Pik–Pichak – Yad.Fiz. 44, 1421 (1986)
1986Ru11 V.A.Rubchenya, V.P.Eismont, S.G.Yavshits – Izv.Akad.Nauk SSSR, Ser.Fiz. 50, 1016 (1986); Bull.Acad.Sci.USSR, Phys.Ser. 50, No.5, 184 (1986)
1986Ry04 A.Rytz, R.A.P.Wiltshire, M.King – Nucl.Instrum.Methods Phys.Res. A253, 47 (1986)
1986Sh02 R.K.Sheline – Phys.Lett. 166B, 269 (1986)
1986Tr10 S.P.Tretyakova, A.Sendulesku, V.L.Mikheev, Yu.S.Zamyatnin, I.A.Lebedev, B.F.Myasoedov, D.Kashegan, Yu.S.Korotkin – Izv.Akad.Nauk SSSR, Ser.Fiz. 50, 1925 (1986); Bull.Acad.Sci.USSR, Phys.Ser. 50, No.10, 52 (1986)
1987AdZU M.Adachi, T.Furusawa, M.Fukuda, M.Taya, F.Nakabeppu, H.Taketani – Inst.Nucl.Study, Univ.Tokyo, Ann.Rept., 1986, p.35 (1987)
1987Ar20 E.Arnold, W.Borchers, M.Carre, H.T.Duong, P.Juncar, J.Lerme, S.Liberman, W.Neu, R.Neugart, E.W.Otten, M.Pellarin, J.Pinard, G.Ulm, J.L.Vialle, K.Wendt, and the ISOLDE Collaboration – Phys.Rev.Lett. 59, 771 (1987)
1987Bl04 R.Blendowske, T.Fliessbach, H.Walliser – Nucl.Phys. A464, 75 (1987)
1987Bo04 M.J.G.Borge, D.G.Burke, H.Gietz, P.Hill, N.Kaffrell, W.Kurcewicz, G.Lovhoiden, S.Mattsson, R.A.Naumann, K.Nybo, G.Nyman, T.F.Thorsteinsen, and the ISOLDE Collaboration – Nucl.Phys. A464, 189 (1987)
1987Bo29 W.Borchers, R.Neugart, E.W.Otten, H.T.Duong, G.Ulm, K.Wendt, and the ISOLDE Collaboration – Hyperfine Interactions 34, 25 (1987)
1987Co19 A.Coc, C.Thibault, F.Touchard, H.T.Duong, P.Juncar, S.Liberman, J.Pinard, M.Carre, J.Lerme, J.L.Vialle, S.Buttgenbach, A.C.Mueller, A.Pesnelle, and the ISOLDE Collaboration – Nucl.Phys. A468, 1 (1987)
1987Co36 P.D.Cottle, M.Gai, J.F.Ennis, J.F.Shriner, Jr., D.A.Bromley, C.W.Beausang, L.Hildingsson, W.F.Piel, Jr., D.B.Fossan, J.W.Olness, E.K.Warburton – Phys.Rev. C36, 2286 (1987)
1987El02 A.M.Y.El–Lawindy, J.D.Burrows, P.A.Butler, J.R.Cresswell, V.Holliday, G.D.Jones, R.Tanner, R.Wadsworth, D.L.Watson, K.A.Connell, J.Simpson, C.Lauterbach, J.R.Mines – J.Phys.(London) G13, 93 (1987)
1987FaZS T.Faestermann, A.Gillitzer, K.Hartel, W.Henning, P.Kienle – Contrib.Proc. 5th Int.Conf.Nuclei Far from Stability, Rosseau Lake, Canada, K12 (1987)
1987Gu04 R.K.Gupta, S.Gulati, S.S.Malik, R.Sultana – J.Phys.(London) G13, L27 (1987)
1987Gu15 R.K.Gupta, S.S.Malik, R.Sultana – Fizika(Zagreb) 19, Supplement 1, 23 (1987)
1987Iv01 M.Ivascu, A.Sandulescu, I.Silisteanu – Rev.Roum.Phys. 32, 549 (1987)
1987Le05 G.A.Leander, Y.S.Chen – Phys.Rev. C35, 1145 (1987)
1987Mi10 G.J.Miller, J.C.McGeorge, I.Anthony, R.O.Owens – Phys.Rev. C36, 420 (1987)
1987Sh04 Y.–J.Shi, W.J.Swiatecki – Nucl.Phys. A464, 205 (1987)
1987Sh24 R.K.Sheline – Phys.Lett. 197B, 500 (1987)
1987We03 K.Wendt, S.A.Ahmad, W.Klempt, R.Neugart, E.W.Otten, H.H.Stroke, and the ISOLDE Collaboration – Z.Phys. D4, 227 (1987)
1987Wh01 D.H.White, H.G.Borner, R.W.Hoff, K.Schreckenbach, W.F.Davidson, T.von Egidy, D.D.Warner, P.Jeuch, G.Barreau, W.R.Kane, M.L.Stelts, R.E.Chrien, R.F.Casten, R.G.Lanier, R.W.Lougheed, R.T.Kouzes, R.A.Naumann, R.Dewberry – Phys.Rev. C35, 81 (1987)
1988Ah02 S.A.Ahmad, W.Klempt, R.Neugart, E.W.Otten, P.–G.Reinhard, G.Ulm, K.Wendt, and the ISOLDE Collaboration – Nucl.Phys. A483, 244 (1988)
1988Ba01 F.Barranco, R.A.Broglia, G.F.Bertsch – Phys.Rev.Lett. 60, 507 (1988)
1988Bl11 R.Blendowske, H.Walliser – Phys.Rev.Lett. 61, 1930 (1988)
1988Da15 M.Dahlinger, E.Kankeleit, D.Habs, D.Schwalm, B.Schwartz, R.S.Simon, J.D.Burrows, P.A.Butler – Nucl.Phys. A484, 337 (1988)
1988Fu10 Y.Fukuchi, T.Komatsubara, H.Sakamoto, T.Aoki, K.Furuno – J.Phys.Soc.Jpn. 57, 2976 (1988)
1988Iv02 M.Ivascu, I.Silisteanu – Nucl.Phys. A485, 93 (1988)
1988Le13 G.A.Leander, Y.S.Chen – Phys.Rev. C37, 2744 (1988)
1988Ma18 H.E.Martz, R.K.Sheline, R.G.Lanier, R.W.Hoff, G.L.Struble, D.J.Decman, D.G.Burke, R.R.Chasman, R.A.Naumann – Phys.Rev. C37, 1407 (1988)
1988NeZZ R.Neugart, E.Arnold, W.Borchers, W.Neu, G.Ulm, K.Wendt – Proc. 5th Int.Conf.Nuclei Far from Stability, Rosseau Lake, Canada 1987, Ed., I.S.Towner, p.126 (1988)
1988Sh02 Y.R.Shimizu, R.A.Broglia – Nucl.Phys. A476, 228 (1988)
1988Sh29 G.Shanmugam, B.Kamalaharan – Phys.Rev. C38, 1377 (1988)
1988Sh34 R.K.Sheline, Y.–S.Chen, G.A.Leander – Nucl.Phys. A486, 306 (1988)
1989Ah05 I.Ahmad, R.Holzmann, R.V.F.Janssens, P.Dendooven, M.Huyse, G.Reusen, J.Wauters, P.Van Duppen – Nucl.Phys. A505, 257 (1989)
1989An13 A.N.Andreev, D.D.Bogdanov, A.V.Eremin, A.P.Kabachenko, O.A.Orlova, G.M.Ter–Akopyan, V.I.Chepigin – Yad.Fiz. 50, 619 (1989)
1989Bo11 M.J.G.Borge, D.G.Burke, H.Gabelmann, P.Hill, O.C.Jonsson, N.Kaffrell, W.Kurcewicz, G.Lovhoiden, K.Nybo, G.Nyman, H.L.Ravn, J.Rogowski, T.F.Thorsteinsen, and the ISOLDE Collaboration – Z.Phys. A333, 109 (1989)
1989Br34 L.Brillard, A.G.Elayi, E.Hourani, M.Hussonnois, J.–F.Le Du, L.–H.Rosier, L.Stab – Compt.Rend.Acad.Sci., Ser.II 309, 1105 (1989)

REFERENCES FOR A's=215,219,223,227,231 (CONTINUED)

1989Bu06 B.Buck, A.C.Merchant – Phys.Rev. C39, 2097 (1989)

1989Bu09 D.G.Burke, H.Folger, H.Gabelmann, E.Hagebo, P.Hill, P.Hoff, O.Jonsson, N.Kaffrell, W.Kurcewicz, G.Lovhoiden, K.Nybo, G.Nyman, H.Ravn, K.Riisager, J.Rogowski, K.Steffensen, T.F.Thorsteinsen, and the ISOLDE Collaboration – Z.Phys. A333, 131 (1989)

1989Ci03 N.Cindro, M.Bozin – Phys.Rev. C39, 1665 (1989)

1989Dr02 G.D.Dracoulis, F.Riess, A.E.Stuchbery, R.A.Bark, S.L.Gupta, A.M.Baxter, M.Kruse – Nucl.Phys. A493, 145 (1989)

1989Ha26 E.D.Hackett, J.A.Kuehner, J.C.Waddington, G.D.Jones – Phys.Rev. C40, 1234 (1989)

1989Ma21 S.S.Malik, R.K.Gupta – Phys.Rev. C39, 1992 (1989)

1989Ma43 S.S.Malik, S.Singh, R.K.Puri, S.Kumar, R.K.Gupta – Pramana 15, 419 (1989)

1989Mi17 H.Miyatake, T.Nomura, S.Kubono, J.Tanaka, M.Oyaizu, H.Okawa, N.Ikeda, K.Sueki, H.Kudo, K.Morita, T.Shinozuka – Nucl.Phys. A501, 557 (1989)

1989Ne03 W.Neu, R.Neugart, E.–W.Otten, G.Passler, K.Wendt, B.Fricke, E.Arnold, H.J.Kluge, G.Ulm, and the ISOLDE Collaboration – Z.Phys. D11, 105 (1989)

1989Ra17 P.Raghavan – At.Data Nucl.Data Tables 42, 189 (1989)

1989Sh07 R.K.Sheline, A.K.Jain, K.Jain, I.Ragnarsson – Phys.Lett. 219B, 47 (1989)

1989Sh14 R.K.Sheline – Phys.Lett. 222B, 179 (1989)

1990An19 A.N.Andreev, D.D.Bogdanov, V.I.Chepigin, A.P.Kabachenko, S.Sharo, G.M.Ter–Akopian, A.V.Eremin – Z.Phys. A337, 229 (1990)

1990Ba23 F.Ballester, E.Casal, J.B.A.England – Nucl.Phys. A513, 61 (1990)

1990Br23 Ch.Briancon, S.Cwiok, S.A.Eid, V.Green, W.D.Hamilton, C.F.Liang, R.J.Walen – J.Phys.(London) G16, 1735 (1990)

1990Hu02 M.Hussonnois, J.F.Le Du, L.Brillard, G.Ardisson – J.Phys.(London) G16, L77 (1990)

1990Hu07 M.Hussonnois, J.F.Le Du, L.Brillard, G.Ardisson – Phys.Rev. C42, R495 (1990); Erratum Phys.Rev. C43 916 (1991)

1990Ja11 A.K.Jain, R.K.Sheline, P.C.Sood, K.Jain – Rev.Mod.Phys. 62, 393 (1990)

1990Jo08 J.Jove, G.Ionova – J.Radioanal.Nucl.Chem. 143, 73 (1990)

1990Ko40 K.Komura, M.Yamamoto, K.Ueno – Nucl.Instrum.Methods Phys.Res. A295, 461 (1990)

1990Li33 C.F.Liang, P.Paris, R.K.Sheline – Nucl.Phys. A520, 361c (1990)

1990Ni05 V.Ninov, F.P.Hessberger, P.Armbruster, S.Hofmann, G.Munzenberg, M.Leino, Y.Fujita, D.Ackermann, W.Morawek, A.Luttgen – Z.Phys. A336, 473 (1990)

1990Po14 Yu.S.Popov, I.B.Makarov, D.Kh.Srurov, E.A.Erin – Radiokhimiya 32, 2 (1990); Sov.J.Radiochemistry 32, 425 (1990)

1990Ru02 E.Ruchowska, J.Zylicz, C.F.Liang, P.Paris, Ch.Briancon – J.Phys.(London) G16, 255 (1990)

1990Sh01 G.Shanmugam, B.Kamalaharan – Phys.Rev. C41, 1184 (1990)

1990Sh15 R.K.Sheline, C.F.Liang, P.Paris – Int.J.Mod.Phys. A5, 2821 (1990)

1990Sh16 R.K.Sheline, P.C.Sood, C.F.Liang, P.Paris, R.W.Hoff – Int.J.Mod.Phys. A5, 2833 (1990)

1990We01 D.Weselka, P.Hille, A.Chalupka – Phys.Rev. C41, 778 (1990)

1991An10 A.N.Andreev, D.D.Bogdanov, V.I.Chepigin, A.P.Kabachenko, O.N.Malyshev, G.M.Ter–Akopian, A.V.Yeremin – Z.Phys. A338, 363 (1991)

1991An13 A.N.Andreev, D.D.Bogdanov, A.V.Eremin, A.P.Kabachenko, O.N.Malyshev, G.M.Ter–Akopyan, V.I.Chepigin – Yad.Fiz. 53, 895 (1991); Sov.J.Nucl.Phys. 53, 554 (1991)

1991Ho05 T.H.Hoare, P.A.Butler, G.D.Jones, M.Loiselet, O.Naviliat–Cuncic, J.Vervier, M.Dahlinger, A.M.Y.El–Lawindy, R.Wadsworth, D.L.Watson – J.Phys.(London) G17, 145 (1991)

1991Ho15 E.Hourani, L.Rosier, G.Berrier–Ronsin, A.Elayi, A.C.Mueller, G.Rappenecker, G.Rotbard, G.Renou, A.Liebe, L.Stab, H.L.Ravn – Phys.Rev. C44, 1424 (1991)

1991Jo05 G.D.Jones, T.H.Hoare, P.A.Butler, C.A.White – J.Phys.(London) G17, 713 (1991)

1991Li19 C.F.Liang, P.Paris, J.Kvasil, R.K.Sheline – Phys.Rev. C44, 676 (1991)

1991Ry01 A.Rytz – At.Data Nucl.Data Tables 47, 205 (1991)

1992Br10 E.Browne – Nucl.Data Sheets 65, 669 (1992)

1992Ch23 H.Chatani, I.Kimura – Ann.Nucl.Energy 19, 425 (1992)

1992De51 J.de Boer, N.Gollwitzer, A.Losch, H.J.Maier, H.Muller, M.Rohn, B.Ackermann, T.Bihn, V.Grafen, C.Gunther, M.Marten–Tolle, N.Singh, R.Tolle – Z.Phys. A344, 41 (1992)

1992Ku03 W.Kurcewicz, G.Lovhoiden, T.F.Thorsteinsen, M.J.G.Borge, D.G.Burke, M.Cronqvist, H.Gabelmann, H.Gietz, P.Hill, N.Kaffrell, R.A.Naumann, K.Nybo, G.Nyman, J.Rogowski, and the ISOLDE Collaboration – Nucl.Phys. A539, 451 (1992)

1992Li09 C.F.Liang, P.Paris, A.Gizon, V.Barci, D.Barneoud, R.Beraud, J.Blachot, Ch.Briancon, J.Genevey, R.K.Sheline – Z.Phys. A341, 401 (1992)

1992Pr05 P.B.Price, R.Bonetti, A.Guglielmetti, C.Chiesa, R.Matheoud, C.Migliorino, K.J.Moody – Phys.Rev. C46, 1939 (1992)

1992Sc26 P.Schuurmans, J.Wouters, P.De Moor, N.Severijns, W.Vanderpoorten, J.Vanhaverbeke, L.Vanneste – Hyperfine Interactions 75, 423 (1992)

1992Wi02 M.Wieland, J.Fernandez Niello, F.Riess, M.Aiche, A.Chevallier, J.Chevallier, N.Schulz, J.C.Sens, Ch.Briancon, R.Kulessa, E.Ruchowska – Phys.Rev. C45, 1035 (1992)

1992Wo14 J.Wouters, P.De Moor, P.Schuurmans, N.Severijns, W.Vanderpoorten, L.Vanneste – Hyperfine Interactions 75, 381 (1992)

1993Ab01 A.Abdul–Hadi, V.Barci, B.Weiss, H.Maria, G.Ardisson, M.Hussonnois, O.Constantinescu – Phys.Rev. C47, 94 (1993)

1993Ab03 W.Abfalterer, R.W.Finlay, S.M.Grimes, V.Mishra – Phys.Rev. C47, 1033 (1993)

1993An07 A.N.Andreyev, D.D.Bogdanov, V.I.Chepigin, A.P.Kabachenko, O.N.Malyshev, R.N.Sagaidak, G.M.Ter–Akopian, M.Veselsky, A.V.Yeremin – Z.Phys. A345, 247 (1993)

1993AnZS A.N.Andreyev, D.D.Bogdanov, V.I.Chepigin, M.Florek, A.P.Kabachenko, O.N.Malyshev, S.Sharo, G.M.Ter–Akopian, M.Veselsky, A.V.Yeremin – Proc.6th Intern.Conf.on Nuclei Far from Stability + 9th Intern.Conf.on Atomic Masses and Fundamental Constants, Bernkastel–Kues, Germany, 19–24 July, 1992, R.Neugart, A.Wohr, Eds., p.759 (1993)

1993Go18 M.Goncalves, S.B.Duarte – Phys.Rev. C48, 2409 (1993)

1993Gu10 P.Guazzoni, M.Jaskola, L.Zetta, C.–Y.Kim, T.Udagawa, G.Bohlen – Nucl.Phys. A564, 425 (1993)

REFERENCES FOR A's=215,219,223,227,231 (CONTINUED)

1993Gu11 R.K.Gupta, M.Horoi, A.Sandulescu, M.Greiner, W.Scheid – J.Phys.(London) G19, 2063 (1993)
1993Li07 C.F.Liang, P.Paris, R.K.Sheline – Phys.Rev. C47, 1801 (1993)
1994AnZY A.N.Andreev, D.D.Bogdanov, A.V.Eremin, A.P.Kabachenko, O.N.Malyshev, A.G.Popeko, R.N.Sagaidak, G.M.Ter–Akopyan, V.I.Chepigin – Program and Thesis, Proc.44th Ann.Conf.Nucl.Spectrosc.Struct.At.Nuclei, Kharkov, p.85 (1994)
1994Au05 N.Auerbach – Phys.Rev. C50, 1606 (1994)
1994Be30 T.Berggren – Phys.Rev. C50, 2494 (1994)
1994Br36 E.Browne, I.Ahmad, K.E.Gregorich, S.A.Kreek, D.M.Lee, D.C.Hoffman – Nucl.Instrum.Methods Phys.Res. A339, 209 (1994)
1994Bu07 B.Buck, A.C.Merchant, S.M.Perez, P.Tripe – J.Phys.(London) G20, 351 (1994)
1994Cr01 F.Cristancho, J.X.Saladin, M.P.Metlay, W.Nazarewicz, C.Baktash, M.Halbert, I.–Y.Lee, D.F.Winchell, S.M.Fischer, M.K.Kabadiyski – Phys.Rev. C49, 663 (1994)
1994Du03 O.Dumitrescu – Phys.Rev. C49, 1466 (1994)
1994Li12 C.F.Liang, R.K.Sheline, P.Paris, M.Hussonois, J.F.Ledu, D.B.Isabelle – Phys.Rev. C49, 2230 (1994)
1994Po18 D.N.Poenaru, W.Greiner, E.Hourani, M.Hussonnois – Z.Phys. A349, 307 (1994)
1994Sh02 R.K.Sheline, C.F.Liang, P.Paris, A.Gizon, V.Barci – Phys.Rev. C49, 725 (1994)
1994Ye08 A.V.Yeremin, A.N.Andreyev, D.D.Bogdanov, G.M.Ter–Akopian, V.I.Chepigin, V.A.Gorshkov, A.P.Kabachenko, O.N.Malyshev, A.G.Popeko, R.N.Sagaidak, S.Sharo, E.N.Voronkov, A.V.Taranenko, A.Yu.Lavrentjev – Nucl.Instrum.Methods Phys.Res. A350, 608 (1994)
1995AnZY A.N.Andreev, D.D.Bogdanov, A.V.Eremin, A.P.Kabachenko, O.N.Malyshev, G.M.Ter–Akopyan, V.I.Chepigin – Program and Thesis, Proc.45th Ann.Conf.Nucl.Spectrosc.Struct.At.Nuclei, St.Petersburg, p.109 (1995)
1995Ar33 G.Ardisson, M.Hussonnois – Radiochim.Acta 70/71, 123 (1995)
1995Au04 G.Audi, A.H.Wapstra – Nucl.Phys. A595, 409 (1995)
1995Au05 T.Aumann, K.Summerer, H.Geissel, B.Blank, T.Brohm, H.–G.Clerc, S.Czajkowski, C.Donzaud, A.Grewe, E.Hanelt, A.Heinz, H.Irnich, M.de Jong, A.Junghans, J.V.Kratz, A.Magel, G.Munzenberg, F.Nickel, M.Pfutzner, A.Piechaczek, C.Rohl, C.Scheidenberger, K.–H.Schmidt, W.Schwab, S.Steinhauser, W.Trinder, B.Voss – Z.Phys. A352, 163 (1995)
1995Du05 O.Dumitrescu, C.Cioaca – Phys.Rev. C51, 3264 (1995)
1995Ho11 E.Hourany, G.Berrier–Ronsin, A.Elayi, P.Hoffmann–Rothe, A.C.Mueller, L.Rosier, G.Rotbard, G.Renou, A.Liebe, D.N.Poenaru, H.L.Ravn – Phys.Rev. C52, 267 (1995)
1995Li04 C.F.Liang, P.Paris, R.K.Sheline, D.Nosek, J.Kvasil – Phys.Rev. C51, 1199 (1995)
1995Sh03 R.K.Sheline, C.F.Liang, P.Paris, J.Kvasil, D.Nosek – Phys.Rev. C51, 1708 (1995)
1995Si05 I.Silisteanu, W.Scheid – Phys.Rev. C51, 2023 (1995)
1996Aa01 A.J.Aas, H.Mach, M.J.G.Borge, B.Fogelberg, I.S.Grant, K.Gulda, E.Hagebo, W.Kurcewicz, J.Kvasil, A.Lindroth, T.Martinez, D.Nosek, B.Rubio, J.F.Smith, K.Steffensen, J.L.Tain, O.Tengblad, T.F.Thorsteinsen, and the ISOLDE Collaboration – Nucl.Phys. A611, 281 (1996)
1996Le01 A.I.Levon, J.de Boer, G.Graw, J.Kvasil, M.Loewe, B.D.Valnion, M.Wurkner, H.Baltzer, C.Gunther, J.Manns, U.Muller, T.Weber – Nucl.Phys. A598, 11 (1996)
1996Mi09 M.Mirea – Phys.Rev. C54, 302 (1996)
1996Ru11 H.Ruellan, M.C.Lepy, M.Etcheverry, J.Plagnard, J.Morel – Nucl.Instrum.Methods Phys.Res. A369, 651 (1996)
1996Sc06 E.Schonfeld, H.Janssen – Nucl.Instrum.Methods Phys.Res. A369, 527 (1996)
1996Si20 I.Silisteanu, W.Scheid – Roum.J.Phys. 41, 43 (1996)
1996St14 T.L.Stewart, M.W.Kermode, D.J.Beachey, N.Rowley, I.S.Grant, A.T.Kruppa – Phys.Rev.Lett. 77, 36 (1996)
1997Ku20 W.Kurcewicz, I.S.Grant, K.Gulda, A.J.Aas, J.Billowes, M.J.G.Borge, D.G.Burke, P.A.Butler, J.F.C.Cocks, B.Fogelberg, S.J.Freeman, G.D.Jones, E.Hagebo, P.Hoff, J.Honsi, A.Lindroth, G.Lovhoiden, H.Mach, T.Martinez, R.A.Naumann, K.Nybo, G.Nyman, H.Ravn, B.Rubio, J.Simpson, A.G.Smith, J.F.Smith, K.Steffensen, J.L.Tain, O.Tengblad, T.F.Thorsteinsen, and the ISOLDE Collaboration – Nucl.Phys. A621, 827 (1997)
1997Mi30 M.Mirea, G.Popovici – Roum.J.Phys. 42, 461 (1997)
1997Mo25 P.Moller, J.R.Nix, K.–L.Kratz – At.Data Nucl.Data Tables 66, 131 (1997)
1997Mu08 U.Muller, P.Sevenich, K.Freitag, C.Gunther, P.Herzog, G.D.Jones, C.Kliem, J.Manns, T.Weber, B.Will, and the ISOLDE Collaboration – Phys.Rev. C55, 2267 (1997)
1997Sc16 K.A.Scaldeferri, D.R.Phillips, C.–W.Kao, T.D.Cohen – Phys.Rev. C56, 679 (1997)
1997Wu04 M.Wurkner, J.De Boer, M.Loewe, H.Steffens, H.Maier, J.Srebrny, P.J.Napiorkowski, J.Iwanicki, A.Kordyasz, M.Kisielinski, M.Kowalczyk, J.Choinski, T.Czosnyka, A.I.Levon, J.Kvasil, C.Gunther, G.Sletten – Acta Phys.Pol. B28, 97 (1997)
1998Ak04 Y.A.Akovali – Nucl.Data Sheets 84, 1 (1998)
1998Br10 C.R.Brune, W.H.Geist, H.J.Karwowski, E.J.Ludwig, K.D.Veal – Phys.Rev. C57, 3437 (1998)
1998Dr01 D.Drechsel, G.Knochlein, A.Yu.Korchin, A.Metz, S.Scherer – Phys.Rev. C57, 941 (1998)
1998Jo08 G.D.Jones, P.A.Butler, T.H.Hoare, P.M.Jones – Eur.Phys.J. A 2, 129 (1998)
1998Ma83 J.Manns, J.Groger, C.Gunther, U.Muller, T.Weber, J.de Boer – Eur.Phys.J. A 3, 263 (1998)
1998Mi11 M.Mirea – Phys.Rev. C57, 2484 (1998)
1998Sh02 R.K.Sheline, C.F.Liang, P.Paris – Phys.Rev. C57, 104 (1998)
1998St24 A.E.Stuchbery, G.D.Dracoulis, T.Kibedi, A.P.Byrne, B.Fabricius, A.R.Poletti, G.J.Lane, A.M.Baxter – Nucl.Phys. A641, 401 (1998)
1999Aa03 A.J.Aas, H.Mach, J.Kvasil, M.J.G.Borge, B.Fogelberg, I.S.Grant, K.Gulda, E.Hagebo, P.Hoff, W.Kurcewicz, A.Lindroth, G.Lovhoiden, A.Machova, T.Martinez, B.Rubio, M.Sanchez–Vega, J.F.Smith, J.L.Tain, R.B.E.Taylor, O.Tengblad, T.F.Thorsteinsen, and the ISOLDE Collaboration – Nucl.Phys. A654, 499 (1999)
1999Br17 R.Broda, B.Fornal, P.J.Daly, C.T.Zhang, P.Bhattacharyya, Z.W.Grabowski, J.F.C.Cocks, P.A.Butler, P.T.Greenlees, G.D.Jones, P.M.Jones, R.Julin, I.Y.Lee, A.O.Macchiavelli, J.Blomqvist – Phys.Rev. C59, 3071 (1999)
1999Ch12 H.Chatani – Nucl.Instrum.Methods Phys.Res. A425, 277 (1999)
1999He28 H.Heiselberg, R.Mattiello – Phys.Rev. C60, 044902 (1999)

REFERENCES FOR A's=215,219,223,227,231 (CONTINUED)

1999Ho28 F.Hoellinger, B.J.P.Gall, N.Schulz, N.Amzal, P.A.Butler, P.T.Greenlees, D.Hawcroft, J.F.C.Cocks, K.Helariutta, P.M.Jones, R.Julin, S.Juutinen, H.Kankaanpaa, H.Kettunen, P.Kuusiniemi, M.Leino, M.Muikku, A.Savelius – Phys.Rev. C60, 057301 (1999)

1999La14 C.A.Laue, K.E.Gregorich, R.Sudowe, M.B.Hendricks, J.L.Adams, M.R.Lane, D.M.Lee, C.A.McGrath, D.A.Shaughnessy, D.A.Strellis, E.R.Sylwester, P.A.Wilk, D.C.Hoffman – Phys.Rev. C59, 3086 (1999)

1999Li05 C.F.Liang, P.Paris, R.K.Sheline – Phys.Rev. C59, 648 (1999)

1999Sc17 P.Schuurmans, J.Camps, P.De Moor, K.Freitag, P.Herzog, M.Huyse, R.Paulsen, N.Severijns, A.Van Geert, P.Van Duppen, B.Will, and the NICOLE and ISOLDE Collaborations – Phys.Rev.Lett. 82, 4787 (1999)

1999Wu05 M.Wurkner, J.De Boer, J.Choinski, T.Czosnyka, C.Droste, C.Gunther, J.Iwanicki, M.Kisielinski, A.Kordyasz, M.Kowalczyk, H.Kusakari, J.Kvasil, A.I.Levon, M.Loewe, P.J.Napiorkowski, T.Shizuma, G.Sletten, J.Srebrny, M.Sugawara, T.Weber, Y.Yoshizawa – Acta Phys.Pol. B30, 1313 (1999)

1999Yu01 H.Yuki, K.Nakazawa, T.Ohtsuki, J.Kasagi, T.Mitsugashira – J.Radioanal.Nucl.Chem. 239, 151 (1999)

2000He17 F.P.Hessberger, S.Hofmann, D.Ackermann, V.Ninov, M.Leino, S.Saro, A.Andreyev, A.Lavrentev, A.G.Popeko, A.V.Yeremin – Eur.Phys.J. A 8, 521 (2000); Erratum Eur.Phys.J. A 9, 433 (2000)

2000JaZY R.V.F.Janssens, I.Ahmad, J.Caggiano, M.P.Carpenter, J.P.Greene, A.Heinz, T.L.Khoo, F.G.Kondev, T.Lauritsen, C.J.Lister, D.Seweryniak, A.Sonzogni, I.Wiedenhover, H.Amro, K.Abu Saleem, G.Hackman, P.Chowdhury, D.Cline, A.O.Machiavelli, C.Wu – ANL–00/20 (Physics Division Ann.Rept., 1999), p.48 (2000)

2000Ni02 K.Nishio, H.Ikezoe, S.Mitsuoka, J.Lu – Phys.Rev. C61, 034309 (2000)

2000Ri12 L.A.Riley, P.D.Cottle, M.Fauerbach, V.S.Griffin, B.N.Guy, K.W.Kemper, G.S.Rajbaidya, O.J.Tekyi–Mensah – Phys.Rev. C62, 021301 (2000)

2001Fr05 L.M.Fraile, M.J.G.Borge, H.Mach, R.Boutami, A.J.Aas, B.Fogelberg, L.M.Garcia–Raffi, I.S.Grant, K.Gulda, E.Hagebo, W.Kurcewicz, J.Kvasil, M.J.Lopez, G.Lovhoiden, T.Martinez, B.Rubio, J.L.Tain, O.Tengblad, and the ISOLDE Collaboration – Nucl.Phys. A686, 71 (2001)

2001FrZZ S.Franchoo – Priv.Comm. (2001)