Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, M. S. Basunia, Murray Martin et al. ,	NDS 160, 405 (2019)	30-Oct-2019

Q(β^-)=408 *12*; S(n)=5327 *8*; S(p)=3888 *6*; Q(α)=8014.0 *20* 2017Wa10
S(2n)=12054 *6*, S(2p)=9775 *6* (2017Wa10).
Additional information 1.
Isotopic assignment: 1951Me10 (from ^{226}Pa α-decay chain, also 1949Me54, as listed in 2013Fr09). Later studies: 1964Mc21, 1968Ha14, 1972Es03.
Theory references: consult NSR database (www.nndc.bnl.gov/nsr/) for 14 primary references for calculations of half-lives of radioactive decay modes, and three for nuclear structure.

^{218}Fr Levels

Shell-model calculations were carried out by the evaluators to compare the low-lying negative-parity structures up to 10^- and excitation energy of 1 MeV using NuShellX@MSU code with jj67pn interaction, and ^{208}Pb core with 5 valence protons in $1h_{9/2}$ and $2f_{7/2}$ orbitals, and 5 valance neutrons in $1i_{11/2}$ and $2g_{9/2}$ orbitals.

Cross Reference (XREF) Flags

A ^{222}Ac α decay (4.9 s)
B ^{222}Ac α decay (64 s)
C ^{209}Bi(^{18}O,2αnγ)

E(level)†	J$^\pi$#	$T_{1/2}$	XREF	Comments
0.0	1^-	1.1 ms *+5–4*	AB	%α=100 Only α decay has been observed by 1964Mc21 and 1982Ew01. Additional information 2. J$^\pi$: favored α decay to 1^- ^{214}At g.s. Evaluators′ shell-model calculations also predict 1^- g.s. $T_{1/2}$: from α-decay curve. Weighted average of 0.7 ms *6* (1964Mc21) and 1.3 ms *+5–4* (1982Ew01).
0+x&	(9^-)		C	2014Bu06 suggested that this level may be the same as the 86-keV level with $J^\pi=(8^-)$ from 1999Sh03 due to similar configuration as reported by 2000De36.
46‡ *11*			AB	
86 *8*	(8^-,9^-)	21.9 ms *5*		%$\alpha\approx$100 μ=+2.68 *4* (2014Bu06) μ: from hyperfine structure using collinear resonance ionization spectroscopy at ISOLDE-CERN. The value corresponds to $J^\pi=8^-$. For 9^-, 2014Bu06 give μ=+2.70 *4*. Only the α-decay mode has been observed. The isomeric decay mode may be possible if intermediate levels of appropriate spins exist between this level and the ground state. Measured $\delta\langle r^2\rangle(^{218}Fr,^{221}Fr)=-0.401$ fm^2 *5* (stat) *6* (syst) (2014Bu06, hyperfine structure using collinear resonance ionization spectroscopy at ISOLDE-CERN). Measured $\delta\nu(^{218}Fr,^{221}Fr)$=+8.24 GHz *10* (2014Bu06, hyperfine structure using collinear resonance ionization spectroscopy at ISOLDE-CERN). E(level): from Eα=7868 *5* and 7952 *5* of 1.1-ms and 21.9-ms α decays, respectively, if they both populate the g.s. in ^{214}At. J$^\pi$: (8^-) tentative assignment from 1982Ew01 and 1999Sh03, based on weak population (HF=510) of 9^- isomer at 232 keV in ^{214}At, and fairly strong population (HF=6.8) of an (8^-) state at 728 keV in ^{214}At, from α decay of

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{218}Fr Levels (continued)

E(level)[†]	Jπ[#]	XREF	Comments
			21.9-ms activity of ^{218}Fr. On the basis of similar configurations, 2014Bu06 suggest that this level may be the same as the 0+x, (9$^-$) in in-beam γ-ray work (2000De36). Evaluators′ shell-model calculations predict 7$^-$ at 82 keV, 8$^-$ at 194 keV, and two 9$^-$ states at 283 and 313 keV.
			$T_{1/2}$: from α-decay curve; weighted average of 21 ms *2* (2014Bu06) and 22.0 ms *5* (1982Ew01).
112[‡] *28*		B	
163[‡] *28*		B	
193[‡] *28*		B	
255[‡] *28*		B	
272.9+x[&]	(11$^-$)	C	
295[‡] *28*		B	
450.0+x[@]	(10$^-$)	C	Evaluators′ shell-model calculations predict 10$^-$ levels at 463 and 492 keV.
550[‡] *28*		B	
586.8+x[a]	(12$^+$)	C	
596.0+x[&]	(13$^-$)	C	
776.6+x[@]	(12$^-$)	C	
862.7+x[a]	(14$^+$)	C	
940.0+x	(13$^+$)	C	
973.1+x[&]	(15$^-$)	C	
1143.8+x[@]	(14$^-$)	C	
1192.1+x[a]	(16$^+$)	C	
1421.7+x[&]	(17$^-$)	C	
1572.4+x[a]	(18$^+$)	C	
1582.9+x[@]	(16$^-$)	C	
1921.7+x[&]	(19$^-$)	C	
2035.1+x[a]	(20$^+$)	C	
2065.1+x[@]	(18$^-$)	C	
2477.9+x[&]	(21$^-$)	C	
2527.5+x[a]	(22$^+$)	C	
3045.1+x[a]	(24$^+$)	C	

[†] From least-squares fit to Eγ data from (^{18}O,2αnγ), unless otherwise noted.

[‡] Level energies are from Eα values measured in 4.9- and 64-s ^{222}Ac decays. The relative energies of the α decaying levels in ^{222}Ac have not been determined. The Eα=7000 *20* from the 64-s isomer and Eα=7008.6 *20* from the 4.9-s g.s. determine the excitation energies of the connecting levels to be very similar: E(level in ^{218}Fr fed from 64-s ^{222}Ac)- E(64-s parent ^{222}Ac level)=9 *21*.

[#] From probable (reflection asymmetric) band assignments for states above the ground state.

[@] Band(A): s=−1 band, π=−. Probable configuration=$\pi h_{9/2}\otimes\nu g_{9/2}$.

[&] Band(B): s=+1 band, π=−. Probable configuration=$\pi h_{9/2}\otimes\nu g_{9/2}$. Average D_0/Q_0=0.00036 fm^{-1} 7, from the γ-ray branching ratios and rotational model, where D_0 and Q_0 are intrinsic electric dipole moment and quadrupole moment, respectively.

[a] Band(b): s=+1 band, π=+. See comments for the π=− partner of s=+1 band.

Adopted Levels, Gammas (continued)

$\gamma(^{218}Fr)$

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.[‡]
272.9+x	(11^-)	272.9	100	0+x	(9^-)	
450.0+x	(10^-)	177.1	100	272.9+x	(11^-)	(M1)
586.8+x	(12^+)	314.0	100	272.9+x	(11^-)	
596.0+x	(13^-)	323.0	100	272.9+x	(11^-)	
776.6+x	(12^-)	326.6	100	450.0+x	(10^-)	
862.7+x	(14^+)	266.5	100	596.0+x	(13^-)	
		275.9	≈10	586.8+x	(12^+)	
940.0+x	(13^+)	163.5	100	776.6+x	(12^-)	
973.1+x	(15^-)	110.3	≈20	862.7+x	(14^+)	(E1)
		377.2	100	596.0+x	(13^-)	
1143.8+x	(14^-)	203.8	≈30	940.0+x	(13^+)	
		367.1	100	776.6+x	(12^-)	
1192.1+x	(16^+)	219.0	100	973.1+x	(15^-)	
		329.4	≈20	862.7+x	(14^+)	
1421.7+x	(17^-)	229.5	100	1192.1+x	(16^+)	
		448.7	100	973.1+x	(15^-)	
1572.4+x	(18^+)	150.6	≈45	1421.7+x	(17^-)	(E1)
		380.5	100	1192.1+x	(16^+)	
1582.9+x	(16^-)	439.1	100	1143.8+x	(14^-)	
1921.7+x	(19^-)	500.0	100	1421.7+x	(17^-)	
2035.1+x	(20^+)	462.7	100	1572.4+x	(18^+)	
2065.1+x	(18^-)	482.2	100	1582.9+x	(16^-)	
2477.9+x	(21^-)	556.2[#]	100	1921.7+x	(19^-)	
2527.5+x	(22^+)	492.4	100	2035.1+x	(20^+)	
3045.1+x	(24^+)	517.5	100	2527.5+x	(22^+)	

[†] From $^{209}Bi(^{18}O,2\alpha n\gamma)$.
[‡] From intensity balance in $(^{18}O,2\alpha n\gamma)$.
[#] Placement of transition in the level scheme is uncertain.

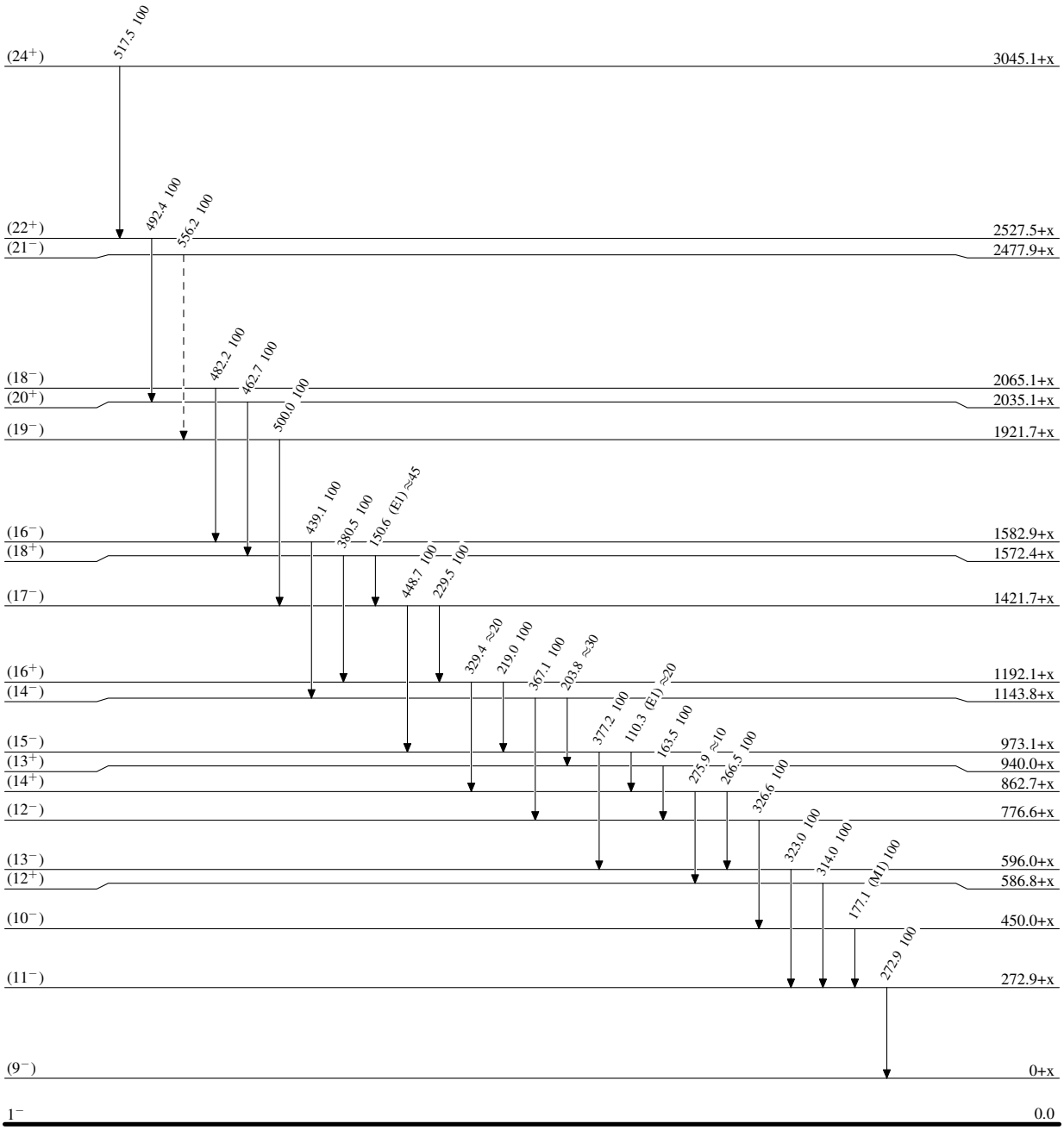
Adopted Levels, Gammas

Legend

Level Scheme

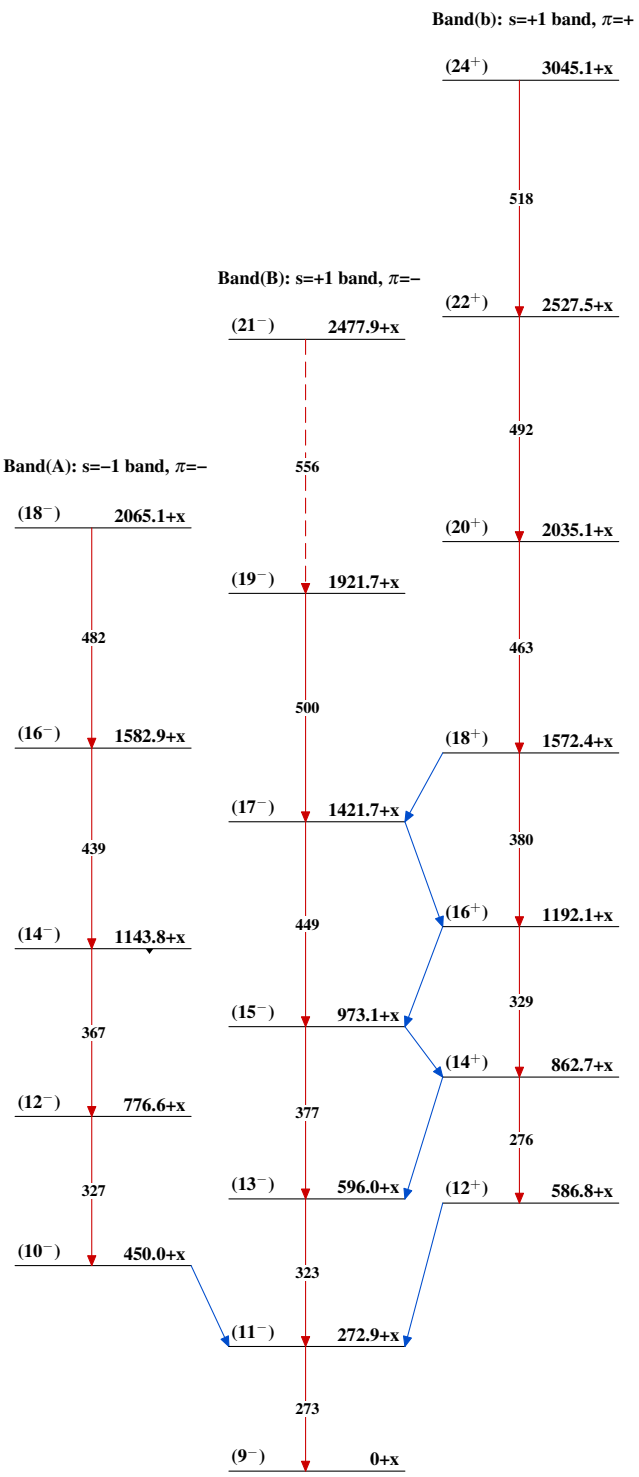
Intensities: Relative photon branching from each level

– – – – – – ► γ Decay (Uncertain)



$^{218}_{87}Fr_{131}$

Adopted Levels, Gammas



$^{218}_{87}Fr_{131}$