Adopted Levels

History			
Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	ENSDF	17-Feb-2014

Q(β^-)=560 *5*; S(n)=5795 *4*; S(p)=4701 *4*; Q(α)=5439.4 *7* 2012Wa38
Q(ε)=1310.5 *28*, S(2n)=12892 *5*, S(2p)=11300 *3* (2012Wa38).
Additional information 1.
1948St42: ^{230}Pa produced and identified in Th(d,F) at E(d)=19 MeV; and Th(α,F) at E(α)=38 MeV using cyclotron at Berkeley laboratory; measured half-life from beta-decay curve. Later the isotope was confirmed by 1949Os01 and several other studies dealing with γ rays and conversion electrons, see decay dataset for ^{230}Pa to ^{230}Th.
See 1976Ga11, 1980Ku14 and 1981Re06 for calculations of fission-barrier heights based on fission probability deduced in (^{3}He,tF) reaction by 1976Ga11.
See also:
Calculated Half-lives and Q(α): 2011Sa40.
Cluster radioactivity: 2011Sh13.
2010Su15, 2008Mo11: ^{232}Th(p,3n), deduced $\sigma(\theta$,E).
All configurations are from 2013Ko11.

^{230}Pa Levels

Cross Reference (XREF) Flags

A ^{230}Th(^{3}He,t):IAS
B ^{231}Pa(pol d,t)

E(level)	J$^\pi$‡	T$_{1/2}$	XREF	Comments
0.0#	2$^-$	17.4 d *5*	B	%α=0.0032 *1*; %β^-=7.8 *7*; %ε+%β^+=92.2 *7* μ=2.00 *29* (1989He07,2011StZZ) %α=0.0032 *1* (1966Ba14); 0.0031 *5* (1965Br32); 0.0043 *7* (1964Mc21); 0.003 (1950Me08). %β^- and %ε branchings have been deduced by evaluators using γ-ray data and decay schemes given in 1994Ac02 and 1972Va24. See also ^{230}Pa ε Decay. Other values: %β^-=10.4 *5* (1966Ba14); 9.6 *8* (1970Lo02); 8.4 *13* (1971Ku25); 7.9 *10* from ε and β^- decay schemes. Other measurements: 1948St42, 1955On07. T$_{1/2}$: average of 17.0 d *5* (1948St42) and 17.7 d *5* (1949Os01). μ: Static nuclear orientation with γ-ray detection (1989He07). J$^\pi$: β feedings to 1$^-$ and 3$^+$ states in ^{230}Th; finger-print method in (pol d,t). Analogy to ^{231}Pa and to ^{229}Th would suggest that the odd proton and odd neutron in ^{230}Pa are in the 1/2[530] and 5/2[633] orbits, respectively. From the Gallagher-Moszkowski coupling rule, these states would be expected to couple to J^π=2$^-$. 1989He07 suggests octupole deformation in ^{230}Pa ground state with a proton in the 5/2[642] and a neutron in the 1/2[631] orbitals by comparing measured and calculated μ values for various Nilsson states. μ(^{231}Pa g.s.)=1.98, μ(^{233}Pa g.s.)=3.4 *8*; the odd protons are in 3/2$^-$, 1/2[530] state for both isotopes. μ=−0.4038 *24* for ^{227}Ra in 3/2[631] neutron state, and μ=+0.45 *4* for its isotone ^{229}Th in 5/2[633] neutron state.
28# *1*	(3$^-$)		B	
48@ *1*	(2$^-$)		B	
66# *1*	(4$^-$)		B	
69@ *2*	(3$^-$)		B	
104@ *1*	(4$^-$)		B	
112# *1*	(5$^-$)		B	
146@ *1*	(5$^-$)		B	

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Adopted Levels (continued)

^{230}Pa Levels (continued)

E(level)	J^{π}‡	XREF
157& *1*	(3^-)	B
170# *1*	(6^-)	B
199& *1*	(4^-)	B
202[a] *1*	(0^-)	B
223 *1*		B
237[a] *1*	(2^-)	B
247& *1*	(5^-)	B
259[b] *1*	(1^-)	B
284[b] *1*	(2^-)	B
297[a] *1*	(1^-)	B
312†& *1*	(6^-)	B
312†[b] *1*	(3^-)	B
322[a] *1*	(4^-)	B
341[c] *1*	(1^-)	B
350[b] *1*	(4^-)	B
357[a] *1*	(3^-)	B
373[c] *1*	(2^-)	B
401[b] *1*	(5^-)	B
409 *1*		B
423[c] *1*	(3^-)	B
437 *1*		B
455[a] *1*	(6^-)	B
465†[a] *1*	(5^-)	B
465†[b] *1*	(6^-)	B
488†[c] *1*	(4^-)	B
488†[d] *1*	(0^+)	B
497 *1*		B
506 *1*		B
518[d] *1*	(2^+)	B
532 *1*		B
538 *1*		B
559[d] *1*	(1^+)	B
580 *1*		B
594[d] *1*	(4^+)	B
605 *1*		B
618[d] *1*	(3^+)	B
634 *1*		B
641 *1*		B
662 *1*		B
689[e] *1*	(1^+)	B
713[e] *1*	(2^+)	B
735[f] *1*	(2^+)	B
747[e] *1*	(3^+)	B
755 *1*		B
772[f] *1*	(3^+)	B
795[e] *1*	(4^+)	B
807 *1*		B
828[f] *1*	(4^+)	B
865 *1*		B

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Adopted Levels (continued)

^{230}Pa Levels (continued)

E(level)	J^{π}‡	$T_{1/2}$	XREF	Comments
873[g] *1*	(1^+)		B	
887[h] *1*	(2^+)		B	
906[g] *1*	(2^+)		B	
921[h] *1*	(3^+)		B	
944 *1*			B	
958[g] *1*	(3^+)		B	
969[h] *1*	(4^+)		B	
992 *1*			B	
1012 *1*			B	
1026†[g] *1*	(4^+)		B	
1026†[h] *1*	(5^+)		B	
1035[i] *1*	(3^+)		B	
1057 *1*			B	
1092[i] *1*	(4^+)		B	
1112[g] *1*	(5^+)		B	
1129 *1*			B	
1145 *1*			B	
1163[i] *1*	(5^+)		B	
1173 *1*			B	
1195 *1*			B	
1211[g] *1*	(6^+)		B	
1218 *1*			B	
1243 *1*			B	
1256 *1*			B	
1318 *1*			B	
1336 *1*			B	
1349 *1*			B	
1361 *1*			B	
17763 *18*	0^+	210 keV *11*	A	%p=56 *6* (1991Ja04) Γ_p=118 keV *14* (1991Ja04) Spreading width (neutron and fission decays)=92 keV *14* (1991Ja04). Deduced Coulomb displacement energy=19856 keV *17* (1991Ja04). J^{π}: IAS of ^{230}Th g.s. Γ from 1991Ja04.

† 312, 465, 488 and 1026 are interpreted as doublets from analysis of measured cross sections and comparison with theoretical values for assigned configurations.

‡ From fingerprint method (2013Ko11) in (pol d,t), unless otherwise specified.

Band(A): $K^{\pi}=2^-$, $\pi 1/2[530]+\nu 3/2[631]$. While configuration=$\pi 1/2[530]+\nu 3/2[631]$, p=$2^-$ is more probable, $\pi 1/2[530]-\nu 5/2[633]$, $K^{\pi}=2^-$ cannot be ruled out.

@ Band(B): $K^{\pi}=2^-$, $\pi 1/2[530]-\nu 5/2[633]$. While configuration=$\pi 1/2[530]-\nu 5/2[633]$, p=$2^-$ is more probable, $\pi 1/2[530]+\nu 3/2[631]$, $K^{\pi}=2^-$ cannot be ruled out.

& Band(C): $K^{\pi}=3^-$, $\pi 1/2[530]+\nu 5/2[633]$.

a Band(D): $K^{\pi}=0^-$, $\pi 1/2[530]-\nu 1/2[631]$.

b Band(E): $K^{\pi}=1^-$, $\pi 1/2[530]-\nu 3/2[631]$.

c Band(F): $K^{\pi}=1^-$, $\pi 1/2[530]+\nu 1/2[631]$.

d Band(G): $K^{\pi}=0^+$, $\pi 1/2[530]-\nu 1/2[501]$.

e Band(H): $K^{\pi}=1^+$, $\pi 1/2[530]+\nu 1/2[501]$.

f Band(I): $K^{\pi}=2^+$, $\pi 1/2[530]+\nu 3/2[501]$.

g Band(J): $K^{\pi}=1^+$, $\pi 1/2[530]-\nu 3/2[501]$.

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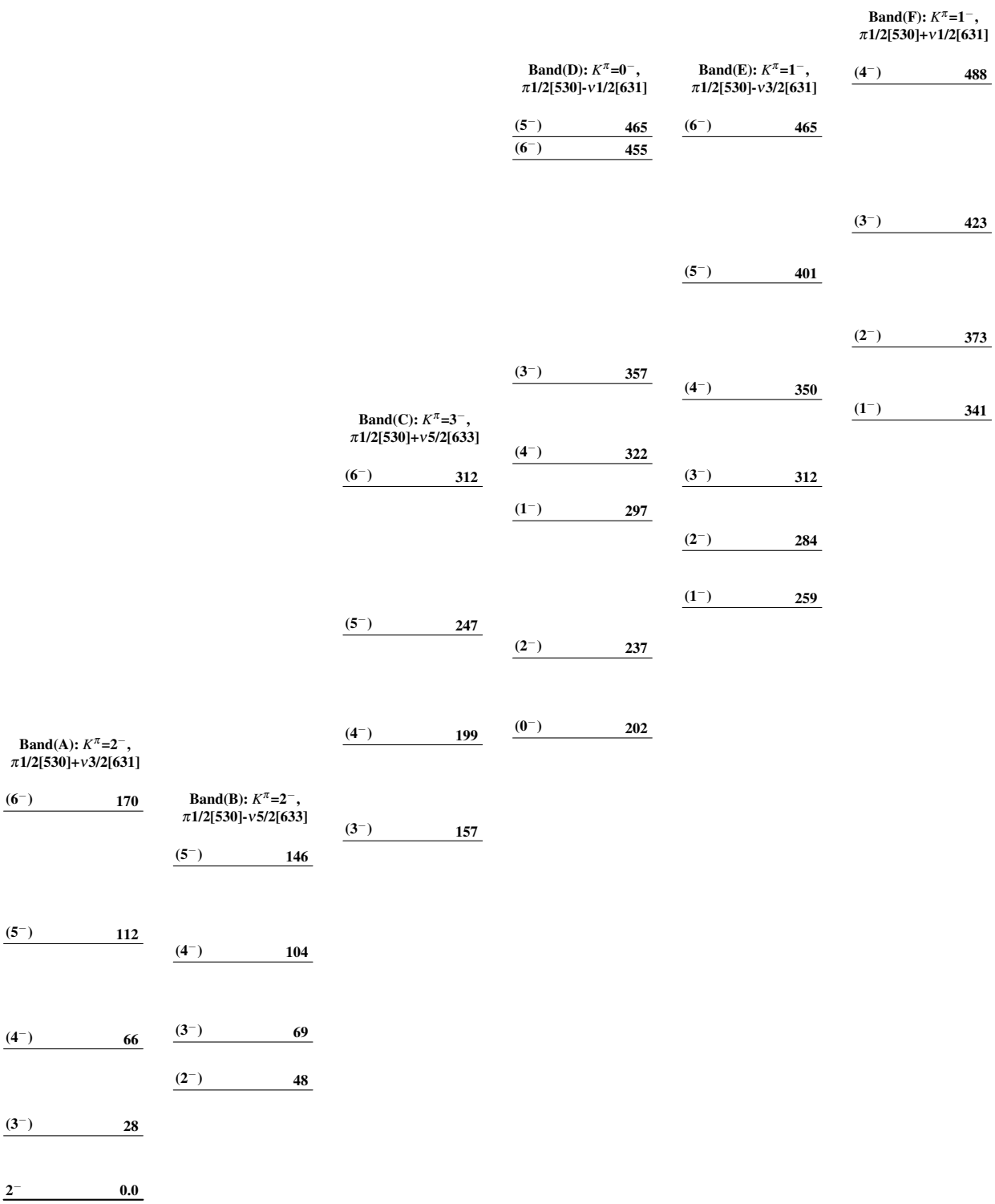
Adopted Levels (continued)

^{230}Pa Levels (continued)

[h] Band(K): $K^{\pi}=2^{+}$, $\pi 1/2[530]$-$\nu 5/2[503]$.
[i] Band(L): $K^{\pi}=3^{+}$, $\pi 1/2[530]$+$\nu 5/2[503]$.

Adopted Levels



$^{230}_{91}Pa_{139}$

Adopted Levels (continued)

Band(J): $K^{\pi}=1^{+}$, $\pi 1/2[530]$-$\nu 3/2[501]$

(6^{+})	1211
(5^{+})	1112
(4^{+})	1026
(3^{+})	958
(2^{+})	906
(1^{+})	873

Band(K): $K^{\pi}=2^{+}$, $\pi 1/2[530]$-$\nu 5/2[503]$

(5^{+})	1026
(4^{+})	969
(3^{+})	921
(2^{+})	887

Band(L): $K^{\pi}=3^{+}$, $\pi 1/2[530]$+$\nu 5/2[503]$

(5^{+})	1163
(4^{+})	1092
(3^{+})	1035

Band(I): $K^{\pi}=2^{+}$, $\pi 1/2[530]$+$\nu 3/2[501]$

(4^{+})	828
(3^{+})	772
(2^{+})	735

Band(H): $K^{\pi}=1^{+}$, $\pi 1/2[530]$+$\nu 1/2[501]$

(4^{+})	795
(3^{+})	747
(2^{+})	713
(1^{+})	689

Band(G): $K^{\pi}=0^{+}$, $\pi 1/2[530]$-$\nu 1/2[501]$

(3^{+})	618
(4^{+})	594
(1^{+})	559
(2^{+})	518
(0^{+})	488

$^{230}_{91}Pa_{139}$