Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 146, 1 (2017)	30-Sep-2017

Q(β^-)=1052 *4*; S(n)=7450 *4*; S(p)=6087 *3*; Q(α)=−2053 *3* 2017Wa10
S(2n)=16620 *50*, S(2p)=14758 *4* (2017Wa10).
First identification of ^{138}La nuclide by Inghram et al.: Phys Rev 72, (1947) 967.
Other measurements:
2015Kh02: ^{139}La(^{3}He,X) E=38 MeV. Measured Eγ, Iγ. Deduced γ-ray strength functions, level densities.
2007By02: ^{138}Ba(^{3}He,t) E=420 MeV. Measured triton spectra. Deduced Gamow-Teller strength distributions. Total B(GT)=5.8 *16* up to the neutron threshold.
Theoretical calculations:
2014Ac01: calculated ground state and excited state magnetic moments.
2009Ka16: calculated hyperfine structure.
2008Ha20: calculated levels, J, π.

^{138}La Levels

Cross Reference (XREF) Flags

A	^{137}Ba(^{3}He,d)	E	^{139}La(d,t)
B	^{137}Ba(α,t)	F	^{140}Ce(d,α)
C	^{138}Ba(p,nγ)	G	^{238}U(^{12}C,Fγ)
D	^{139}La(p,d)		

E(level)[†]	J$^\pi$	T$_{1/2}$	XREF	Comments
0.0	5$^+$	1.03×10^{11} y *1*	ABCDEFG	%β^-=34.5 *4*; %ε+%β^+=65.5 *4* μ=+3.713646 *7* (1977Kr12,2014StZZ) Q=+0.39 *3* (2003Ii03,2016St14) J$^\pi$: spin from NMR spectroscopy (1955So31,1972Fi14); parity from L(p,d)=L(d,t)=2 from 7/2$^+$, L(^{3}He,d)=4 from 3/2$^+$. T$_{1/2}$: average of 1.07×10^{11} y *6* (2005Be73), 1.01×10^{11} y *1* (1997Ni12), 1.14×10^{11} y *5* (Appl Rad Isot 45, 388 (1994)), 1.06×10^{11} y *3* (1983No02), 1.03×10^{11} y *2* (1981Sa42), 1.040×10^{11} y *14* (1966De04), 1.13×10^{11} y *4* (1957Gl20), 1.0×10^{11} y *1* (1956Tu17). Others: 1.28×10^{11} y *12* (1979Ta21), 1.29 y *2* (1977Ce04), 1.27×10^{11} y *18* (1972Ma31), 1.56×10^{11} y *30* (1972El02). μ: from 2014StZZ based on data in 1977Kr12 and 1955So31 measured using NMR. Q: re-evaluated in 2016St14 from data in 2003Ii03 measured using laser spectroscopy. Others: +0.45 *2* (1979Ch39, laser spectroscopy), 0.43 *2* (1977Kr12, nuclear magnetic resonance), without reporting hyperfine anomaly. With the Adopted value of T$_{1/2}$, the deduced λ_{β^-}=(2.34 *4*)×10^{-12}y^{-1}, compared with the measured value λ_{β^-}=(2.37 *10*)×10^{-12}y^{-1} from 2000Ta24, obtained using a geophysical method. %ε+%β^+ from weighted average of 65.0 *4* (1997Ni12), 66.8 *16* (1983No02), 66.2 *4* (1981Sa42), 64.9 *9* (1977Ce04), 66.2 *18*, (1979Ta21), 63.0 *10* (1966De04, original uncertainty=0.5), 67.8 *13* (1972Ma31). Values of ε+%β^+ are deduced from Iγ(788.66 in ^{138}Ce)/Iγ(1435.70 in ^{138}Ba) or ratio of partial half-lives for β^- and ε decays given in the references. Δ<r^2> (^{138}La-^{139}La)=0.064 *7* (2001Ji03). Evaluated nuclear charge radius <r^2>$^{1/2}$=4.847 fm *5* (2013An02). Additional information 1. Configuration=$\pi g_{7/2}\otimes\nu d_{3/2}$ (1975IsZY).
72.57 *3*	(3)$^+$	116 ns *5*	ABCDEF	μ=+2.89 *5* (1979Bo11,2014StZZ)

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Adopted Levels, Gammas (continued)

^{138}La Levels (continued)

E(level)[†]	J^π	$T_{1/2}$	XREF	Comments
				J^π: L(p,d)=2+0 from $7/2^+$, L(d,t)=0+2 from $7/2^+$, L(^{3}He,d)=2+4 from $3/2^+$; 72.57γ (E2) to 5^+. $T_{1/2}$: from neutron-γ(t) in (p,nγ) (1975IsZY). μ: from measured g-factor in 1979Bo11 using TDPAD. Configuration=$\pi g_{7/2}\otimes\nu d_{3/2}$ (1975IsZY).
116.17 *6*	$(2)^+$		ABCDEF	J^π: L(d,t)=L(p,d)=2 from $7/2^+$, L(^{3}He,d)=2+4 from $3/2^+$; 43.6γ to $(3)^+$; $(2)^+$ is proposed by 1973He02 in (p,d) and 1972La20 and 1975IsZY in (d,t) based on comparisons of measured spectroscopic strength with shell-model predictions.
161.19 *6*	$(3)^+$		ABCDEF	J^π: L(d,t)=0+2, L(^{3}He,d)=2+4; 88.62γ to $(3)^+$, 45.0γ to $(2)^+$. 1972La20 and 1973He02 suggest J=2, inconsistent with L(d,t)=0 component.
192.18 *5*	$(2,3)^+$		ABCDE	J^π: L(p,d)=2+0 and L(d,t)=2 from $7/2^+$, L(^{3}He,d)=2+4 from $3/2^+$; 1972La20 and 1973He02 suggest J=3; 76.01γ to $(2)^+$.
230.40 *7*	$(4)^+$		ABCDEF	J^π: L(p,d)=L(d,t)=2 from $7/2^+$, L(^{3}He,d)=4; 157.8γ to $(3)^+$, 230.4γ to to 5^+.
292.96 *7*	$(1)^+$		ABC F	J^π: L(^{3}He,d)=2 from $3/2^+$; 176.83γ to $(2)^+$; $(1)^+$ is proposed by 1975IsZY in (^{3}He,d) based on comparison of measured $\sigma(\theta)$ with shell-model prediction.
413.30 *6*	$3^+,4^+$		ABCDEF	J^π: L(d,t)=L(p,d)=0+2, 297.2γ to $(2)^+$. 1972La20 in (d,t) and 1973He02 in (p,d) suggest J=4, 1975IsZY in (d,t) suggest J=3.
479.25 *13*	$3^+,4^+$		ABCDEF	XREF: D(493). J^π: L(p,d)=2+0 and L(d,t)=0 from $7/2^+$, L(^{3}He,d)=2 from $3/2^+$. 1972La20 in (d,t) and 1973He02 in (p,d) suggest J=3, 1975IsZY suggest J=4 based 479.3γ to 5^+.
510.44 *6*	$3^+,4^+$		bC EF	J^π: L(d,t)=0 from $7/2^+$.
518.68 *15*	$3^+,4^+$		AbCDE	XREF: D(530). J^π: L(d,t)=0 and L(p,d)=2+0 from $7/2^+$, L(^{3}He,d)=2+4 from $3/2^+$.
642.35 *9*	$(2)^+$		ABC F	J^π: L(^{3}He,d)=0 from $3/2^+$, 229.3γ and 131.9γ to $3^+,4^+$.
737.67 *9*	$(2)^-$		C e	J^π: L(d,t)=5 from $7/2^+$ for 738+739 doublet, 444.7γ to $(1)^+$, 576.4γ to $(3)^+$.
738.80[#] *20*	$(7)^-$	2.0 μs *3*	C eFG	%IT=100 J^π: L(d,t)=5 from $7/2^+$ for 738+739 doublet; 738.8γ (M2) to 5^+. $(4)^-$ is proposed by 1975IsZY. $T_{1/2}$: from 2104As02 in ^{238}U(^{12}C,Fγ), deduced from measured imbalance in intensity using a time window of 300 ns.
770.5?			F	E(level): observed in (d,α) only.
823.33 *12*	$(1,2,3)^-$		C EF	J^π: L(d,t)=5 from $7/2^+$, 85.68γ to $(2)^-$, 535.5γ from $1^+,2^+$.
836.6[#] *6*	(8^-)[‡]		E G	J^π: L(d,t)=5 from $7/2^-$; 1975IsZY in (d,t) suggest that one of the two states at 836 and 1067 has J=7 and the other has J=8.
842.79 *16*			C F	
888 *2*			E	
900.5 *3*	$(4,5)^-$		C EF	J^π: L(d,t)=5 from $7/2^+$, 900.8γ to 5^+, 670.0γ to $(4)^+$.
915.3?			F	E(level): observed in (d,α) only.
929 *3*			E	
936.30 *19*	$(4,5)^-$		C EF	J^π: L(d,t)=5 from $7/2^+$, 936.2γ to 5^+, 706.5γ to $(4)^+$.
947.79 *17*			C	
961.4 *5*	$(4,5,6)^-$		C EF	J^π: L(d,t)=5 from $7/2^+$, 961.4γ to 5^+.
1033 *2*			E	
1057.77 *16*	$1^+,2^+$		ABC	J^π: L(^{3}He,d)=0 from $3/2^+$.
1067 *2*	$(7,8)^-$		E	J^π: L(d,t)=5 from $7/2^-$; 1975IsZY in (d,t) suggest that one of the two states at 836 and 1067 has J=7 and the other has J=8.
1096 *2*	$1^+,2^+$		A E	E(level): weighted average of 1096 *2* from (^{3}He,d) and 1095 *3* from (d,t). J^π: L(^{3}He,d)=0 from $3/2^+$.
1102.54 *22*			C E	
1150 *3*			ab E	E(level): from (d,t). Others: 1154 *2* from (^{3}He,d), 1160 *4* from (α,t).
1155 *5*			ab E	E(level): from (d,t). Others: 1154 *2* from (^{3}He,d), 1160 *4* from (α,t).
1178 *5*	$1^+,2^+$		A	J^π: L(^{3}He,d)=0 from $3/2^+$.
1200.3 *3*			C E	
1228.87 *16*	$1^+,2^+$		A C E	J^π: L(^{3}He,d)=0 from $3/2^+$.

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Adopted Levels, Gammas (continued)

^{138}La Levels (continued)

E(level)[†]	J^π	XREF	Comments
1243.0 *3*	$(4,5,6)^-$	ABC	J^π: L(^{3}He,d)=5 from $7/2^+$, 1243.0γ to 5^+.
1257.0[#] *7*	$(9)^-$	E G	J^π: L(d,t)=5 from $7/2^+$, 420.3γ to (8^-), band structure.
1267 *1*	$-$	AB	J^π: L(^{3}He,d)=5 from $3/2^+$.
1302 *2*		E	
1344 *3*		E	
1358.8 *3*	$1^+,2^+$	ABC	J^π: L(^{3}He,d)=0 from $3/2^+$, 621.0γ to $(2)^-$.
1375 *2*		E	
1385.1 *3*		C E	
1425 *2*	$1^+,2^+$	AB E	J^π: L(^{3}He,d)=0 from $3/2^+$. E(level): from (d,t). Others: 1426 *3* from (^{3}He,d), 1426 *4* from (α,t).
1455 *2*	$1^+,2^+$	AB	J^π: L(^{3}He,d)=0 from $3/2^+$. E(level): from (^{3}He,d). Other: 1456 *2* from (α,t).
1466 *2*		E	
1490.5 *3*		C E	
1520 *3*		E	
1531 *2*	$1^+,2^+$	AB	J^π: L(^{3}He,d)=0 from $3/2^+$. E(level): weighted average of 1532 *2* in (^{3}He,d) and 1530 *2* in (α,t).
1545 *3*		E	
1570 *2*	$1^+,2^+$	AB E	J^π: L(^{3}He,d)=0 from $3/2^+$. E(level): weighted average of 1568 *3* in (^{3}He,d), 1565 *5* in (α,t) and 1571 *2* in (d,t).
1581 *2*	$-$	AB E	J^π: L(^{3}He,d)=5 from $3/2^+$. E(level): weighted average of 1580 *3* in (^{3}He,d), 1579 *3* in (α,t) and 1583 *2* in (d,t).
1599 *2*		E	
1624 *4*	$1^+,2^+$	AB	J^π: L(^{3}He,d)=0 from $3/2^+$.
1645 *2*	$-$	AB E	E(level): weighted average of 1645 *2* in (^{3}He,d), 1644 *2* in (α,t) and 1646 *2* in (d,t). J^π: L(^{3}He,d)=5 from $3/2^+$.
1656 *3*		E	
1676 *3*		E	
1687 *2*	$1^+,2^+$	AB E	E(level): weighted average of 1685 *3* in (^{3}He,d), 1686 *2* in (α,t) and 1690 *2* in (d,t). J^π: L(^{3}He,d)=0 from $3/2^+$.
1707 *2*		E	
1713 *2*	$+$	AB	E(level): from (α,t). Other: 1715 *4* from (^{3}He,d). J^π: L(^{3}He,d)=2 from $3/2^+$.
1722.4 *4*		C	
1733.45 *23*	$1^+,2^+$	ABC E	XREF: B(1728)E(1726). J^π: L(^{3}He,d)=0 from $3/2^+$.
1739 *2*		E	
1756 *4*	$+$	AB	E(level): weighted average of 1757 *4* in (^{3}He,d), 1755 *4* in (α,t). J^π: L(^{3}He,d)=2 from $3/2^+$.
1788.4 *4*	$+$	ABC E	
2001.6[#] *6*	(10^-)[‡]	G	
2352.8[#] *7*	(11^-)[‡]	G	
2476.2[#] *8*	(12^-)[‡]	G	
2938.6[#] *9*	(13^-)[‡]	G	
3190.0[#] *9*	(14^-)[‡]	G	
3514.8[@] *9*	(13^+)[‡]	G	
3574.5 *9*	(14^-)[‡]	G	
3725.8 *10*	(14^+)[‡]	G	
3771.7[@] *10*	(14^+)[‡]	G	
3960.8 *10*	(15^+)[‡]	G	
4099.1 *10*	(15^-)[‡]	G	

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Adopted Levels, Gammas (continued)

^{138}La Levels (continued)

E(level)†	Jπ	XREF
4152.5@ *11*	(15+)‡	G
4467.9# *10*	(16−)‡	G

† From a least-squares fit to γ-ray energies where applicable, unless otherwise noted.
‡ Proposed by 2014As02 in (^{12}C,Fγ) based on band structures and comparisons with shell-model predictions.
# Band(A): γ cascade based on 7−. Members of $\pi g_{7/2}\otimes\nu h_{11/2}$ and/or $\pi d_{5/2}\otimes\nu h_{11/2}$ multiplet.
@ Band(B): γ cascade based on (13+).

γ(^{138}La)

E_i(level)	J_i^π	Eγ‡	Iγ‡	E_f	J_f^π	Mult.	α†	Comments
72.57	(3)+	72.57 *3*	100	0.0	5+	(E2)	6.33	B(E2)(W.u.)=7.8 *4* α(K)=3.00 *5*; α(L)=2.61 *4*; α(M)=0.581 *9* α(N)=0.1229 *18*; α(O)=0.01723 *25*; α(P)=0.0001543 *22* Mult.: from 1975We16 in (p,nγ) based on RUL. Mult=M1 would require a half-life less than 0.1 ns.
116.17	(2)+	43.6 *1*	100	72.57	(3)+			
161.19	(3)+	45.0 *1*	13 *5*	116.17	(2)+			
		88.62 *5*	100 *8*	72.57	(3)+			
192.18	(2,3)+	76.01 *8*	100 *9*	116.17	(2)+			
		119.64 *5*	41 *3*	72.57	(3)+			
230.40	(4)+	157.8 *1*	4.6 *6*	72.57	(3)+			
		230.4 *2*	100 *9*	0.0	5+			
292.96	(1)+	100.78 *6*	22 *2*	192.18	(2,3)+			
		176.83 *6*	100	116.17	(2)+			
413.30	3+,4+	182.9 *1*	4.4 *5*	230.40	(4)+			
		221.13 *5*	34 *3*	192.18	(2,3)+			
		297.2 *3*	8.4 *8*	116.17	(2)+			
		340.78 *20*	100 *8*	72.57	(3)+			
479.25	3+,4+	248.7 *2*	7.7 *8*	230.40	(4)+			
		406.8 *2*	100 *8*	72.57	(3)+			
		479.3 *3*	21 *3*	0.0	5+			
510.44	3+,4+	280.0 *1*	7.7 *16*	230.40	(4)+			
		318.3 *1*	98 *7*	192.18	(2,3)+			
		394.3 *1*	43 *4*	116.17	(2)+			
		437.9 *1*	100 *9*	72.57	(3)+			
518.68	3+,4+	357.6 *2*	17 *2*	161.19	(3)+			
		445.9 *3*	100 *9*	72.57	(3)+			
		518.5 *4*	15 *2*	0.0	5+			
642.35	(2)+	131.9 *1*	9.7 *9*	510.44	3+,4+			
		229.3 *2*	43 *4*	413.30	3+,4+			
		450.2 *2*	33 *3*	192.18	(2,3)+			
		481.0 *3*	100 *15*	161.19	(3)+			
		526.2 *3*	11.8 *9*	116.17	(2)+			
		569.5 *2*	58 *6*	72.57	(3)+			
737.67	(2)−	227.3 *1*	25 *2*	510.44	3+,4+			
		324.4 *2*	6.0 *6*	413.30	3+,4+			
		444.7 *3*	49 *5*	292.96	(1)+			
		545.4 *2*	23 *2*	192.18	(2,3)+			
		576.4 *2*	100 *8*	161.19	(3)+			

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Adopted Levels, Gammas (continued)

γ(^{138}La) (continued)

E_i(level)	J^{π}_i	E_{γ}‡	I_{γ}‡	E_f	J^{π}_f	Mult.	α†	Comments
738.80	(7)⁻	738.8 *2*	100	0.0	5⁺	(M2)	0.01513	B(M2)(W.u.)=0.0026 +*5*−*4* α(K)=0.01288 *18*; α(L)=0.001781 *25*; α(M)=0.000372 *6* α(N)=8.18×10⁻⁵ *12*; α(O)=1.331×10⁻⁵ *19*; α(P)=1.037×10⁻⁶ *15* E_{γ}: weighted average of 738.8 *2* from (p,nγ) and 739.2 *5* from (^{12}C,Fγ). Mult.: proposed by 2014As02 in (^{12}C,Fγ) based on transition energy and $T_{1/2}$.
823.33	(1,2,3)⁻	85.68 *8*	100	737.67	(2)⁻			
836.6	(8⁻)	97.8# *5*		738.80	(7)⁻			
842.79		612.7 *4*	19 *3*	230.40	(4)⁺			
		842.7 *2*	100 *9*	0.0	5⁺			
900.5	(4,5)⁻	670.0 *3*	56 *7*	230.40	(4)⁺			
		900.8 *5*	100 *10*	0.0	5⁺			
936.30	(4,5)⁻	706.5 *5*	100 *10*	230.40	(4)⁺			
		936.2 *2*	≤233	0.0	5⁺			
947.79		105.0 *1*	28 *3*	842.79				
		717.4 *3*	100 *10*	230.40	(4)⁺			
961.4	(4,5,6)⁻	961.4 *5*	100	0.0	5⁺			
1057.77	1⁺,2⁺	765.0 *3*	36 *4*	292.96	(1)⁺			
		865.6 *3*	33 *3*	192.18	(2,3)⁺			
		941.3 *3*	≤45	116.17	(2)⁺			
		985.3 *3*	100 *9*	72.57	(3)⁺			
1102.54		910.4 *3*	100 *10*	192.18	(2,3)⁺			
		941.3 *3*	≤94	161.19	(3)⁺			
1200.3		681.5 *3*	100 *10*	518.68	3⁺,4⁺			
		1200.5 *5*	78 *13*	0.0	5⁺			
1228.87	1⁺,2⁺	936.2 *2*	≤127	292.96	(1)⁺			
		1067.5 *3*	92 *9*	161.19	(3)⁺			
		1112.2 *3*	100 *9*	116.17	(2)⁺			
1243.0	(4,5,6)⁻	295.2 *3*	100 *9*	947.79				
		1243.0 *5*	89 *21*	0.0	5⁺			
1257.0	(9)⁻	420.3# *4*	100	836.6	(8⁻)			
1358.8	1⁺,2⁺	535.5 *3*	34 *9*	823.33	(1,2,3)⁻			
		621.0 *4*	100 *18*	737.67	(2)⁻			
1385.1		874.6 *3*	100 *11*	510.44	3⁺,4⁺			
		971.8 *5*	≤57	413.30	3⁺,4⁺			
1490.5		971.8 *5*	≤27	518.68	3⁺,4⁺			
		1077.2 *3*	100 *10*	413.30	3⁺,4⁺			
1722.4		1309.1 *5*		413.30	3⁺,4⁺			
		1429.5 *5*		292.96	(1)⁺			
1733.45	1⁺,2⁺	910.4 *3*	≤122	823.33	(1,2,3)⁻			
		1090.8 *3*	100 *10*	642.35	(2)⁺			
1788.4	⁺	827.0 *6*	90 *14*	961.4	(4,5,6)⁻			
		1270 *1*	100 *17*	518.68	3⁺,4⁺			
		1309.1 *5*	≤124	479.25	3⁺,4⁺			
2001.6	(10⁻)	744.6# *3*	25# *6*	1257.0	(9)⁻			
		1165.0# *3*	100# *13*	836.6	(8⁻)			
2352.8	(11⁻)	351.2# *3*	100	2001.6	(10⁻)			
2476.2	(12⁻)	123.4# *3*	100	2352.8	(11⁻)	M1	0.595	α(K)=0.509 *8*; α(L)=0.0687 *11*; α(M)=0.01429 *23* α(N)=0.00314 *5*; α(O)=0.000511 *8*; α(P)=3.96×10⁻⁵ *7*

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Adopted Levels, Gammas (continued)

γ(^{138}La) (continued)

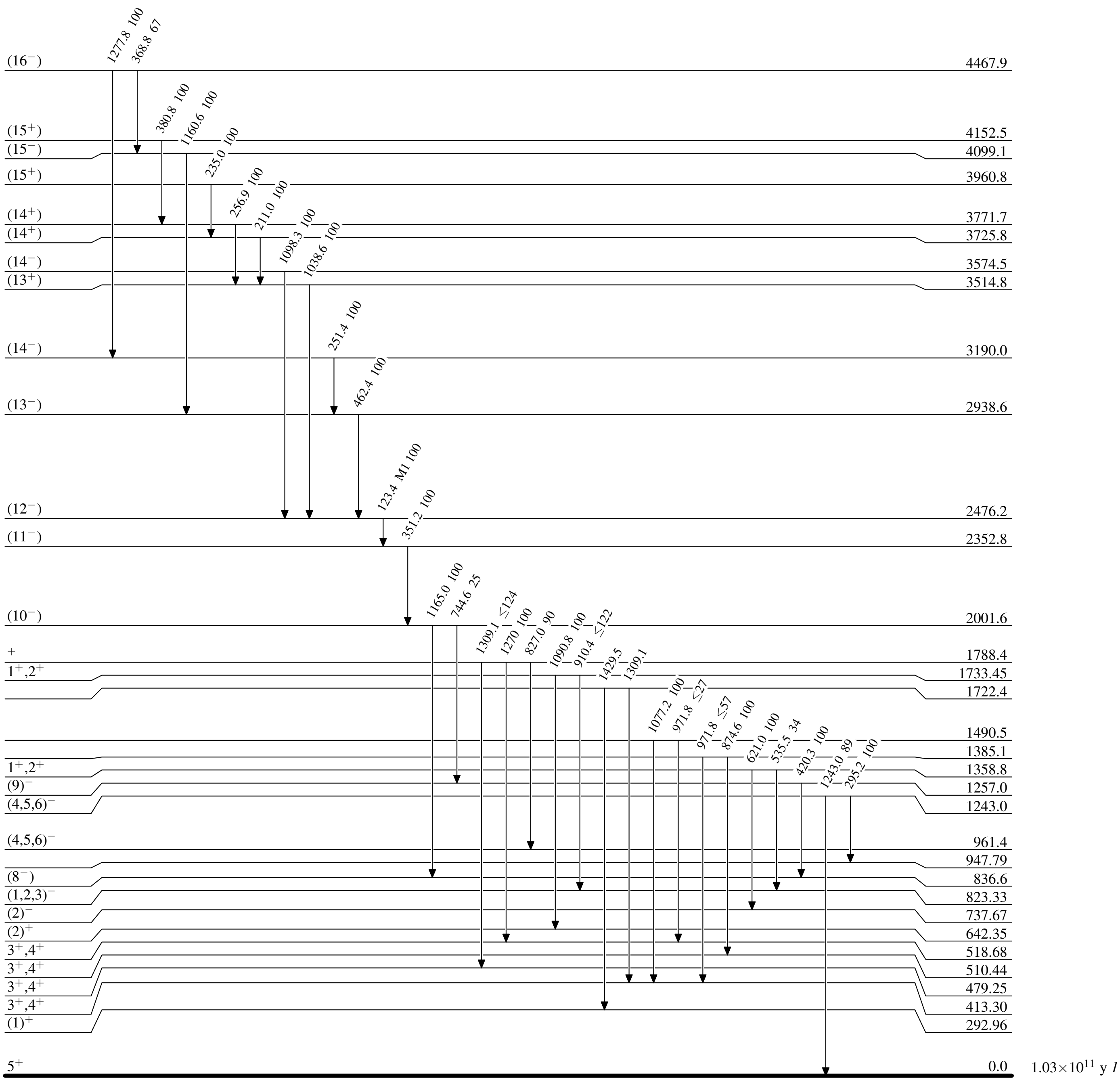
E_i(level)	J^π_i	E_γ‡	I_γ‡	E_f	J^π_f	Comments
						Mult.: from (^{12}C,Fγ) based on measured α(exp)=0.5 *2* (2014As02).
2938.6	(13⁻)	462.4# *4*	100	2476.2	(12⁻)	
3190.0	(14⁻)	251.4# *3*	100	2938.6	(13⁻)	
3514.8	(13⁺)	1038.6# *5*	100	2476.2	(12⁻)	
3574.5	(14⁻)	1098.3# *5*	100	2476.2	(12⁻)	
3725.8	(14⁺)	211.0# *3*	100	3514.8	(13⁺)	
3771.7	(14⁺)	256.9# *4*	100	3514.8	(13⁺)	
3960.8	(15⁺)	235.0# *3*	100	3725.8	(14⁺)	
4099.1	(15⁻)	1160.6# *5*	100	2938.6	(13⁻)	
4152.5	(15⁺)	380.8# *5*	100	3771.7	(14⁺)	
4467.9	(16⁻)	368.8# *5*	67# *33*	4099.1	(15⁻)	
		1277.8# *5*	100# *50*	3190.0	(14⁻)	

† Additional information 2.
‡ From (p,nγ), unless otherwise noted.
# From (^{12}C,Fγ).

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level

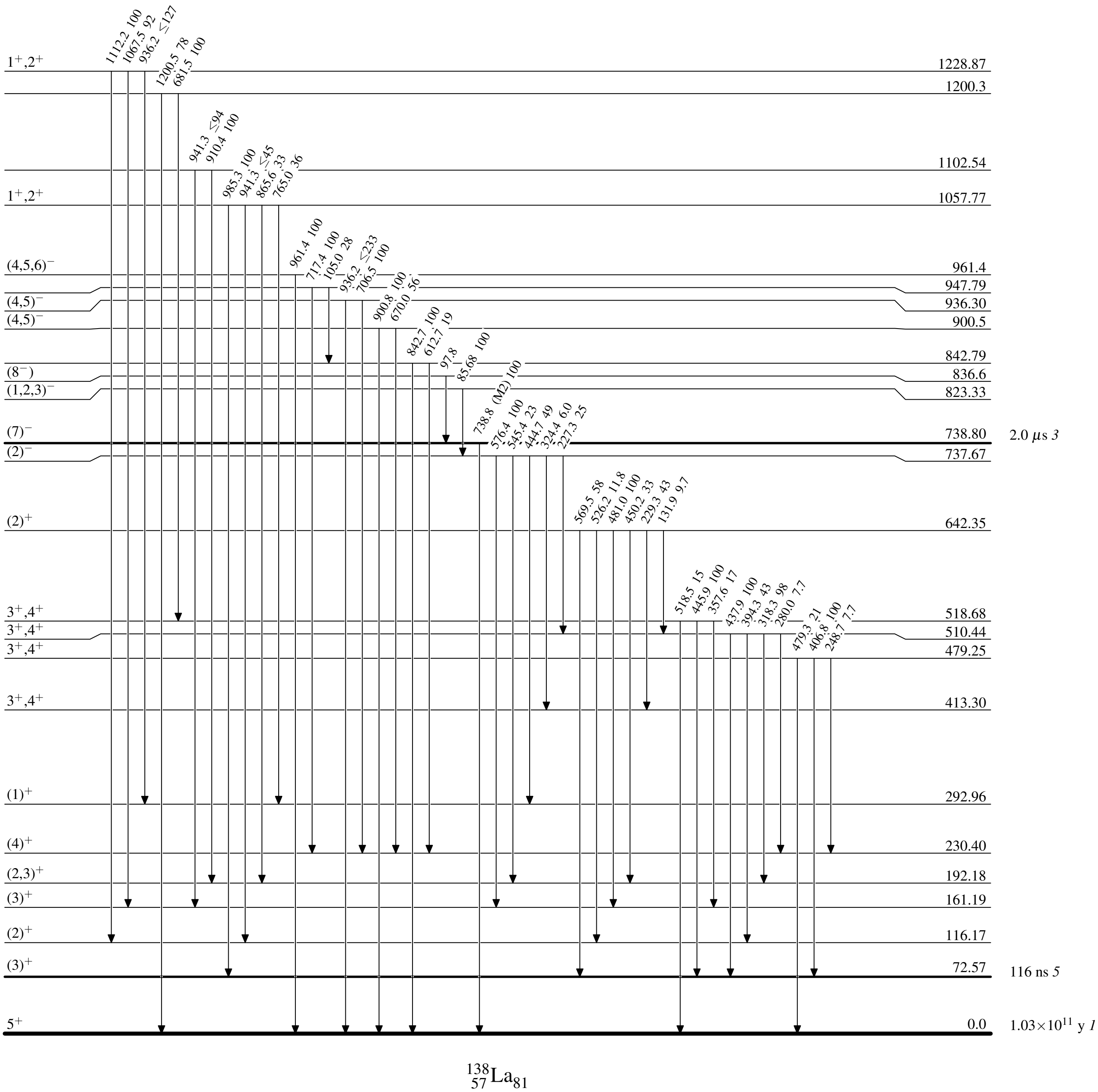


$^{138}_{57}La_{81}$

Adopted Levels, Gammas

Level Scheme (continued)

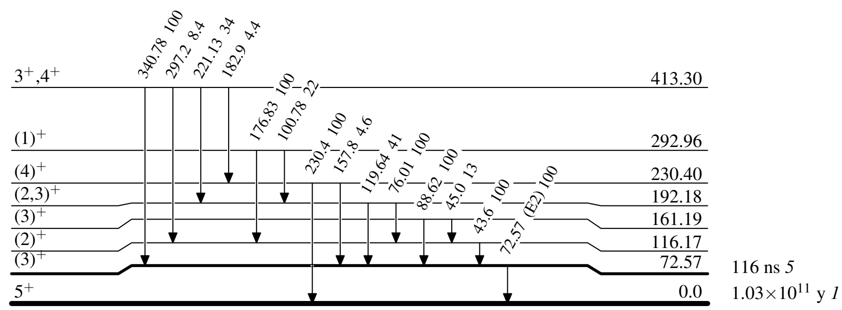
Intensities: Relative photon branching from each level



Adopted Levels, Gammas

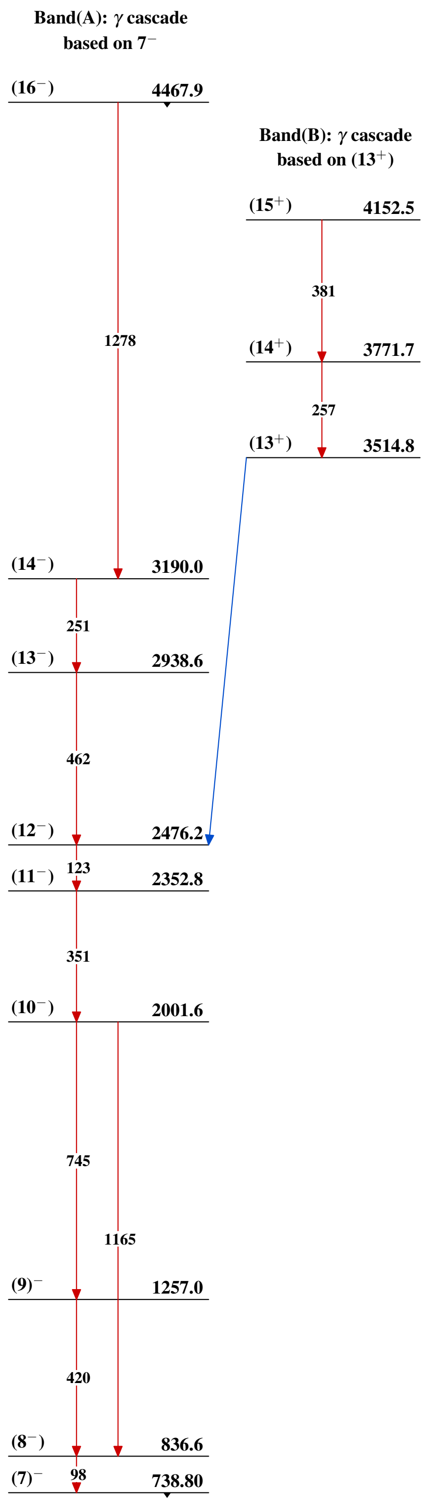
Level Scheme (continued)

Intensities: Relative photon branching from each level



$^{138}_{57}La_{81}$

Adopted Levels, Gammas



$^{138}_{57}La_{81}$