Adopted Levels, Gammas

History			
Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	ENSDF	07-June-2023

Q(β^-)=5653 *12*; S(n)=5520 *10*; S(p)=10008 *10*; Q(α)=−3564 *20* 2021Wa16
Q(β^-n)=626 *11*, S(2n)=10400 *12*, S(2p)=22697 *11* (2021Wa16).
Q(β^-)=5.66 MeV *10*, measured by 2003ShZU (also 2007Ha57) from total-absorption γ spectroscopy using a BGO detector.
1998IcZZ, 2000IcZZ, 2001AsZY, 2003ShZU, 2005Ic02, 2006HaZT, 2007Ha57, 2010Ha32 (all from the same experimental group): ^{159}Pm produced and identified in proton-induced fission of ^{238}U with E(p)≈15 MeV and identified through mass separation and the genetic relationship to ^{159}Sm at the Tokai-ISOL facility. Measured $T_{1/2}$ of the decay of ^{159}Pm and Q(β^-) value.
2017Wu04: ^{159}Pm nuclide produced at the RIBF-RIKEN facility in ^{9}Be(^{238}U,F),E=345 MeV/nucleon reaction. The identification of nuclide of interest was made in the BigRIPS separator by determining the atomic number and the A/Q ratio using the TOF-Bρ-ΔE method. The reaction products were transported through the ZeroDegree Spectrometer and implanted into the beta-counting system WAS3ABi, surrounded by the EURICA array with 84 HPGe detectors. Measured $T_{1/2}$ of the g.s. of ^{159}Pm from (implants)β^--, (implants)$\beta^-\gamma$-, and (implants)γ-correlations.
2022Ki23: ^{159}Pm nuclide was produced at the RIBF-RIKEN facility using the ^{9}Be(^{238}U,F),E(^{238}U)=345 MeV/nucleon, followed by separation of fission fragments by measuring the energy loss (ΔE), magnetic rigidity (Bρ) and time-of-flight (TOF) of the ions using the BigRIPS separator, multisampling ionization chambers (MUSIC), and parallel-plate avalanche counters (PPACs), and plastic scintillators. The radioactive ions were implanted in the Advanced Implantation Detector Array (AIDA) consisting of a stack of six double-sided silicon strip detectors (DSSSDs), and centered in the BRIKEN neutron detector consisting of 140 ^{3}He-filled proportional counters embedded in a large polyethylene moderator matrix. For γ and nγ-coin detection, two CLARION-type clover HPGe detectors were used, but γ data were not analyzed in the present experiment. Measured (implanted ions)(β^-) correlations, and (implanted ions)(β^-)(neutron) correlations. Deduced half-life and %β^-n for the decay of ^{159}Pm.
2012Va02: measured mass of the g.s. from cyclotron frequency ratios using the Canadian Penning Trap mass spectrometer at the CARIBU-ANL facility.
2020Ra13: theory: calculated levels, J^π, band, B(E2), B(M1) using projected shell model.
Additional information 1.

^{159}Pm Levels

Cross Reference (XREF) Flags

A ^{159}Pm IT decay (4.97 μs)

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$	XREF	Comments
0.0[#]	(5/2$^-$)	1.634 s *42*	A	%β^-=100; %β^-n≤0.6 (2022Ki23) Only the β^- decay mode has been detected and expected, followed by possible β^--delayed neutron decay. $T_{1/2}$: weighted average of 1.648 s *+43−42* (2022Ki23, binned maximum likelihood fitting of the (implants)β-correlated decay curve, using Bateman equations to account for the activities of the parent, daughter, grand-daughter, and great-grand-daughter, and the β^--delayed neutron branch of the decay chain); 1.48 s *18* (2017Wu04, fit to the (implants)β^--correlated spectrum using the least-squares and maximum-likelihood methods, including contributions from the parent, daughter and grand-daughter decays); and 1.5 s *2* (2005Ic02, from 1.6 s *2*, 1.5 s *4*, 1.4 s *3* for decay curves for Sm K_α x rays and the 71.8γ and 261.3γ, respectively; also 1.47 s *15* in 2001AsZY, and 2 s *1* in 1998IcZZ, 2000IcZZ). %β^-n deduced from neutron-gated β^--decay events, fitted by an exponential function of the background subtracted time distribution of (implants)(β^-)(neutron)-correlations (2022Ki23). For further details of the analysis method, consult 2020ToZY thesis.
62.9[#] *2*	(7/2$^-$)		A	
144.4[#] *2*	(9/2$^-$)		A	

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Adopted Levels, Gammas (continued)

^{159}Pm Levels (continued)

E(level)[†]	J$^{\pi}$[‡]	T$_{1/2}$	XREF	Comments
243.7[#] *3*	(11/2$^-$)		A	
313.5[@] *3*	(5/2$^+$)		A	
363.0[#] *3*	(13/2$^-$)		A	
383.1[@] *2*	(7/2$^+$)		A	
473.6[@] *6*	(9/2$^+$)		A	
495.4[#] *3*	(15/2$^-$)		A	
580.0[@] *3*	(11/2$^+$)		A	
654.1[#] *4*	(17/2$^-$)		A	
706.6[@] *8*	(13/2$^+$)		A	
850.6[@] *4*	(15/2$^+$)		A	
933.2 *3*	(11/2,9/2)		A	
1164.8 *3*	(15/2,13/2)		A	
1495.0 *3*	(17/2$^+$)	4.97 μs *12*	A	%IT=100 T$_{1/2}$: from (270.6γ+330.3γ+644.4+801.7γ+921.2γ)(t) (2021Yo08). Proposed configuration=π5/2[532]$\otimes\nu$7/2[633]$\otimes\nu$5/2[523] (2021Yo08).

[†] From ^{159}Pm IT decay (4.97 μs).
[‡] As assigned by 2021Yo08, based on shell-model calculations, and systematics of neighboring nuclei.
[#] Band(A): π5/2[532] band. Band assignment from 2021Yo08.
[@] Band(B): π5/2[413] band. Band assignment from 2021Yo08.

γ(^{159}Pm)

E$_i$(level)	J$_i^{\pi}$	E$_{\gamma}$[‡]	I$_{\gamma}$[‡]	E$_f$	J$_f^{\pi}$	Mult.[†]	α[#]
62.9	(7/2$^-$)	62.8 *3*	100	0.0	(5/2$^-$)	[M1+E2]	9 *4*
144.4	(9/2$^-$)	81.2 *3*	100 *25*	62.9	(7/2$^-$)	[M1+E2]	3.8 *11*
		144.3 *3*	22 *6*	0.0	(5/2$^-$)	[E2]	0.617 *10*
243.7	(11/2$^-$)	99.0 *3*	100 *19*	144.4	(9/2$^-$)	[M1+E2]	2.0 *4*
		180.9 *3*	23 *5*	62.9	(7/2$^-$)	[E2]	0.284 *4*
313.5	(5/2$^+$)	313.4 *3*	100	0.0	(5/2$^-$)		
363.0	(13/2$^-$)	119.2 *3*	100 *18*	243.7	(11/2$^-$)	[M1+E2]	1.07 *14*
		218.2	28 *5*	144.4	(9/2$^-$)	[E2]	0.1513 *21*
383.1	(7/2$^+$)	(69.6)		313.5	(5/2$^+$)	[M1+E2]	6.5 *22*
		320.2 *3*	93 *49*	62.9	(7/2$^-$)		
		383.4 *3*	100 *31*	0.0	(5/2$^-$)		
473.6	(9/2$^+$)	159		313.5	(5/2$^+$)		
		330		144.4	(9/2$^-$)		
495.4	(15/2$^-$)	132.5 *3*	100 *23*	363.0	(13/2$^-$)	[M1+E2]	0.76 *7*
		251.7 *3*	68 *15*	243.7	(11/2$^-$)	[E2]	0.0948 *14*
580.0	(11/2$^+$)	106.4		473.6	(9/2$^+$)	[M1+E2]	1.6 *3*
		197.2 *3*	100 *16*	383.1	(7/2$^+$)	[E2]	0.212 *3*
		435.2 *3*	28 *7*	144.4	(9/2$^-$)		
654.1	(17/2$^-$)	158.7 *3*	100 *18*	495.4	(15/2$^-$)	[M1+E2]	0.432 *14*
		291.1		363.0	(13/2$^-$)		
706.6	(13/2$^+$)	233.0		473.6	(9/2$^+$)		
850.6	(15/2$^+$)	144.0		706.6	(13/2$^+$)		
		270.6 *3*	100 *9*	580.0	(11/2$^+$)	[E2]	0.0751 *11*
933.2	(11/2,9/2)	788.8 *3*		144.4	(9/2$^-$)		
		870.5 *3*	100 *19*	62.9	(7/2$^-$)		
1164.8	(15/2,13/2)	231.8 *3*	23 *7*	933.2	(11/2,9/2)		

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Adopted Levels, Gammas (continued)

γ(^{159}Pm) (continued)

E_i(level)	J_i^π	E_γ[‡]	I_γ[‡]	E_f	J_f^π	Mult.[†]	α[#]	Comments
1164.8	(15/2,13/2)	669.4 *3*	37 *4*	495.4	(15/2$^-$)			
		801.7 *3*	100 *7*	363.0	(13/2$^-$)			
		921.2 *3*	90 *7*	243.7	(11/2$^-$)			
1495.0	(17/2$^+$)	330.2 *3*	100 *5*	1164.8	(15/2,13/2)	[D,E2]	0.035 *23*	If M1, B(M1)(W.u.)= 8.20×10^{-8} *28*; if E2, B(E2)(W.u.)=3.82×10^{-4} *13*; if E1, B(E1)(W.u.)=8.85×10^{-10} *30*.
		644.4 *3*	30.1 *19*	850.6	(15/2$^+$)	[M1+E2]	0.0085 *21*	If E2, reduced hindrance factor (f_ν)=22 *2* (2021Yo08). If M1, B(M1)(W.u.)= 3.34×10^{-9} *22*; if E2, B(E2)(W.u.)=4.04×10^{-6} *27*.
		841.0 *3*	8.2 *14*	654.1	(17/2$^-$)	[E1]	1.37×10^{-3} *2*	B(E1)(W.u.)=4.3×10^{-12} *7*
		999.6 *3*	5.9 *12*	495.4	(15/2$^-$)	[E1]	9.83×10^{-4} *14*	B(E1)(W.u.)=1.84×10^{-12} *37*

[†] Assumed based on J^π assignments in 2021Yo08.

[‡] From ^{159}Pm IT decay (4.97 μs).

[#] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

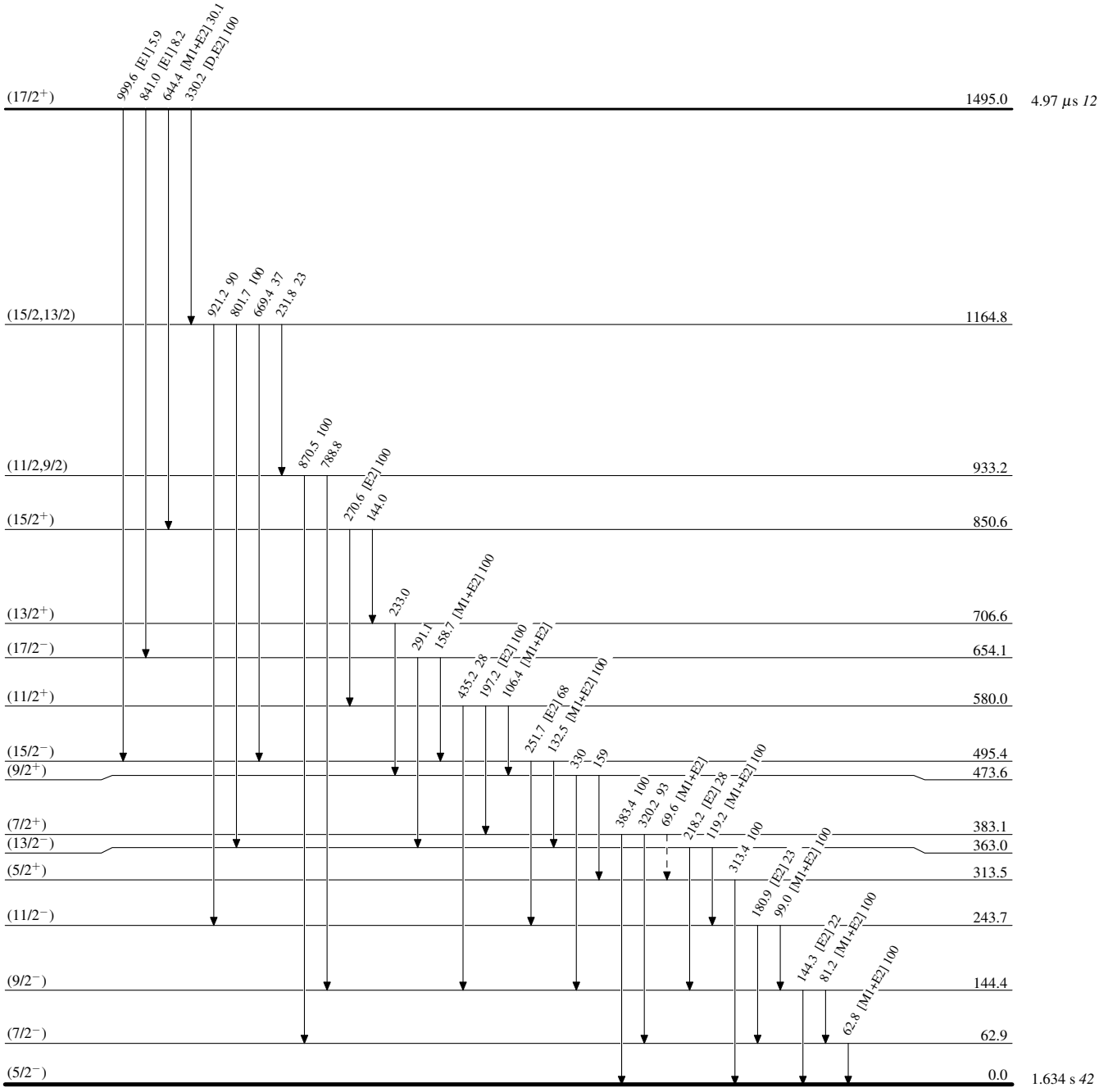
Adopted Levels, Gammas

Legend

Level Scheme

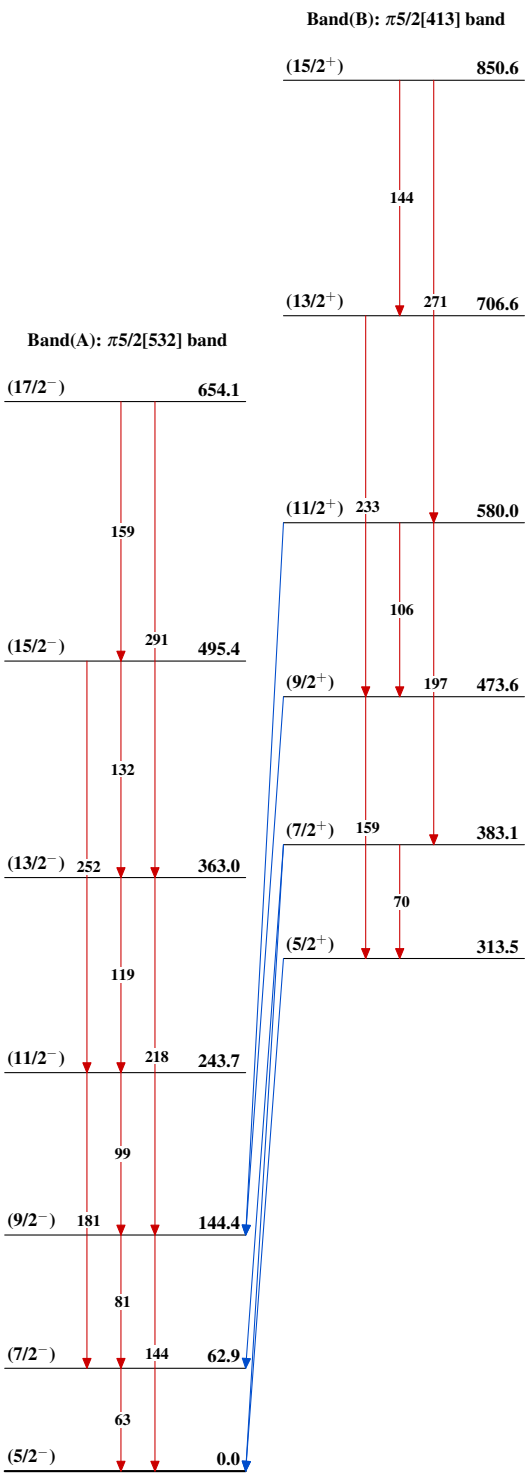
Intensities: Relative photon branching from each level

- - - - - - ► γ Decay (Uncertain)



$^{159}_{61}Pm_{98}$

Adopted Levels, Gammas



$^{159}_{61}Pm_{98}$