Adopted Levels, Gammas

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

Q(β^-)=2518 *4*; S(n)=6844 *5*; S(p)=8081 *6*; Q(α)=−1528 *6* 2021Wa16
S(2n)=12727 *4*, S(2p)=18324 *8* (2021Wa16).

1951Bu25: ^{159}Eu produced and identified in Gd(γ,p),E=23 MeV using synchrotron facility at AERE, Harwell. Measured half-life of the decay of an activity assigned to the decay of ^{149}Eu or an isomer in one of the stable Gd isotopes, but the measured production yield was consistent with that expected for ^{159}Eu. In addition, half-life of 20 min in this work agrees with that from later measurements, and there is no known isomer of long half-life in any of the stable Gd isotopes.

1961Ku10: ^{159}Eu produced in ^{160}Gd(γ,p),E=25 MeV, probably using natural Gd target at the Tohoku University, Japan. Measured half-life of the decay of the g.s. of ^{159}Eu, β-radiation, β-endpoint energy, and γ rays using GM counters and NaI(Tl) detector.

1990Al34: measured hfs, isotope shifts; deduced hyperfine constants, magnetic dipole moment, quadrupole moment, rms charge radii.

2012Va02: measured mass of the g.s. from cyclotron frequency ratios using the Canadian Penning Trap mass spectrometer at the CARIBU-ANL facility.

Theoretical calculations:

2022Mi14: calculated β^--decay $T_{1/2}$, partial $T_{1/2}$ for Gamow-Teller decays, Q values, isoscalar spin-triplet strength using proton-neutron quasiparticle random-phase approximation (pnQRPA), proton-neutron quasiparticle Tamm-Dancoff approximation (pnQTDA), with Skryme energy density functional, and Bayesian neural network (BNN).

2019Ni05: calculated neutron and proton pairing residual interaction strength, binding energy, moments of inertia using self-consistent Hartree-Fock plus BCS framework, with self-consistent blocking using Skyrme parametrization.

2017Pa44: calculated energy levels, J^π, bands, B(E2), B(M1), and deformation versus angular momentum using the projected shell model framework.

2000Va03: calculated levels, J^π, B(E2) using shell model, with pseudo-SU(3) symmetry.

1997As06: calculated isotope shifts, hfs anomaly using shell model.

1990Na14: calculated equilibrium deformations using Shell correction method with average Woods-Saxon potential, and monopole pairing residual interaction.

1984Al30: calculated quadrupole and hexadecapole moments, ground-state energy.

^{159}Eu Levels

Cross Reference (XREF) Flags

A ^{159}Sm β^- decay (11.37 s)
B ^{160}Gd(pol t,α)

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$	XREF	Comments
0.0[#]	5/2$^+$	18.1 min *1*	AB	%β^-=100 μ=+1.38 *2* (1990Al34,2019StZV) Evaluated rms charge radius (R)=5.1498 fm *84* (2013An02). Evaluated δ<r^2>(^{159}Eu−^{145}Eu)=+1.852 fm^2 *8* (2013An02). Measured δ<r^2>(^{159}Eu−^{151}Eu)=+0.922 fm^2 *7* and by subtraction of values δ<r^2>(^{159}Eu−^{158}Eu)=+0.083 fm^2 *8* (1990Al34). Isotope shift $\delta\nu$(^{151}Eu-^{159}Eu)=−5967 MHz *45* (1990Al34). J$^\pi$: spin from hyperfine structure measurements (1990Al34); parity from π5/2[413] Nilsson assignment based on measured μ value and comparison with theoretical values of ≈+1.5 for π5/2[413], and ≈+2.7 for an alternative assignment of π5/2[532], as for ^{153}Eu and ^{155}Eu in 1989Be04. $T_{1/2}$: weighted average of 18.07 min *9* (1965Mu16), 17.9 min *8* (1966Da19), 19.0 min *5* (1965Iw01) and 19.0 min *10* (1961Ku10). Other: 20 min (1951Bu25). Additional information 1. μ: hyperfine structure using laser resonance ionization spectroscopy method (1990Al34).
75.41[#] *4*	7/2$^+$		AB	

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Adopted Levels, Gammas (continued)

^{159}Eu Levels (continued)

E(level)†	Jπ‡	XREF	Comments
172.00# *6*	9/2+	AB	
189.80@ *5*	5/2−	AB	
254.54@ *5*	7/2−	AB	
291# *4*	(11/2+)	B	
333.61& *12*	3/2+	AB	XREF: B(337). E(level): 337 is a doublet in (pol t,α) with J^π=9/2− and 3/2+.
337@ *4*	9/2−	B	E(level): doublet in (pol t,α) with J^π=9/2− and 3/2+.
392& *4*	5/2+	B	
442@ *4*	11/2−	B	
571& *4*	9/2+&(13/2−)	B	E(level): doublet.
704@ *4*	(15/2−)	B	
806c *4*	(3/2+)	B	
887 *4*		B	
1051.8b *2*	7/2−	A	Jπ: γ rays to 5/2+, 5/2−, 7/2−, and 9/2+ levels and allowed-unhindered (au) β− decay (log *ft*=5.0) from the parent, which is interpreted as the ν5/2,5/2[523] → π7/2,7/2[523] transition, which is the only available 'au' transition in this mass region.
1076a *4*	1/2+	B	
1140a	5/2+&(3/2+)	B	E(level): doublet.
≈1260		B	
≈1287		B	
≈1310a	(7/2+)	B	
1488		B	Jπ: L+1/2 from $A_y(\theta)$ in (pol t,α).
1635		B	Jπ: L+1/2 from $A_y(\theta)$ in (pol t,α).
≈1670		B	
≈1690		B	
1765		B	Jπ: L+1/2 from $A_y(\theta)$ in (pol t,α).
≈1803		B	
≈1825		B	
1905		B	
1954		B	
≈2460		B	

† From least-squares fit to γ energies.
‡ From measured angular distributions and analyzing powers in (pol t,α) (1979Bu05), except as noted for the ground state and 1051 level.
# Band(A): π5/2[413] band. Band parameters: A=10.83 keV, B=−2.5 eV.
@ Band(B): π5/2[532] band. Band parameter: A=9.25 keV.
& Band(C): π3/2[411] band. Band parameters: A=11.7 keV.
a Band(D): π1/2[420] band. Band parameters: A=10.7 keV, a=+1.0.
b Band(E): π7/2[523].
c Band(F): π1/2[411].

γ(^{159}Eu)

E_i(level)	J_i^π	E_γ†	I_γ†	E_f	J_f^π	Mult.	δ	α‡	Comments
75.41	7/2+	75.44 *4*	100	0.0	5/2+	(M1+E2)	0.50 *18*	4.7 *4*	Mult.,δ: from ^{159}Sm β− decay (1987Wi14, constancy of the ratio of intrinsic M1 matrix element within the rotational band to its intrinsic quadrupole moment and δ(96)).

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Adopted Levels, Gammas (continued)

$\gamma(^{159}Eu)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.	δ	α[‡]	Comments
172.00	$9/2^+$	96.65 *8*	53 *12*	75.41	$7/2^+$	(M1+E2)	0.48 *18*	2.17 *9*	δ: from ^{159}Sm β^- decay (1987Wi14, deduced from calculation of E2 portion from Alaga rules and Iγ(172)).
		172.00 *6*	100 *12*	0.0	$5/2^+$	[E2]			
189.80	$5/2^-$	114.42 *6*	7.9 *4*	75.41	$7/2^+$				
		189.79 *9*	100	0.0	$5/2^+$				
254.54	$7/2^-$	64.76 *6*	11.8 *14*	189.80	$5/2^-$				
		82.58 *5*	8.0 *14*	172.00	$9/2^+$				
		179.09 *9*	59.0 *28*	75.41	$7/2^+$				
		254.43 *8*	100 *4*	0.0	$5/2^+$				
333.61	$3/2^+$	143.90 *12*	84 *12*	189.80	$5/2^-$				
		333.20 *26*	100 *16*	0.0	$5/2^+$				
1051.8	$7/2^-$	797.2 *5*	33 *6*	254.54	$7/2^-$				
		861.97 *14*	100 *6*	189.80	$5/2^-$				
		879.78 *29*	12.6 *18*	172.00	$9/2^+$				
		976.65 *32*	14.4 *20*	75.41	$7/2^+$				
		1051.7 *3*	15 *4*	0.0	$5/2^+$				

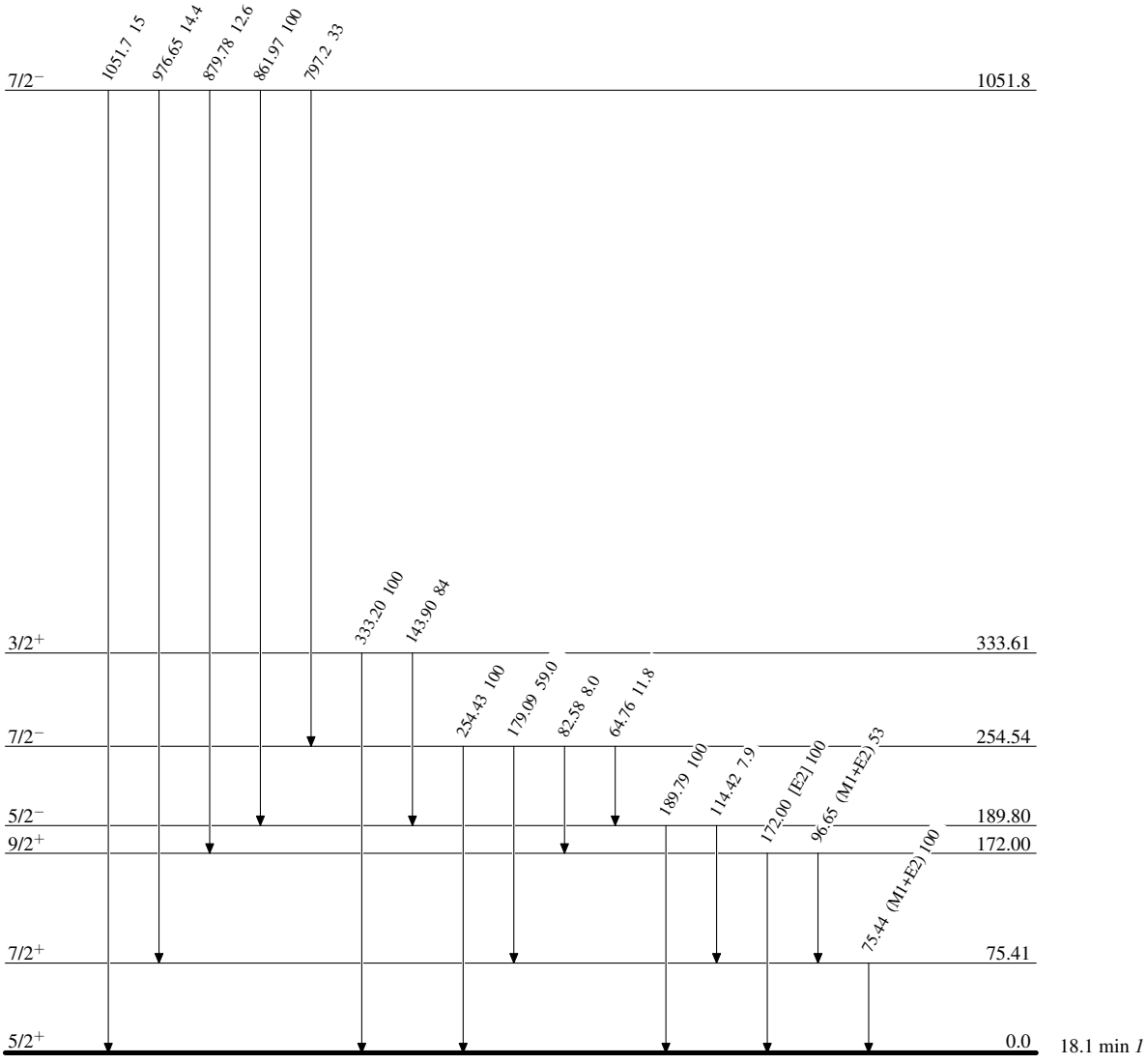
[†] From ^{159}Sm β^- decay (1987Wi14).

[‡] 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

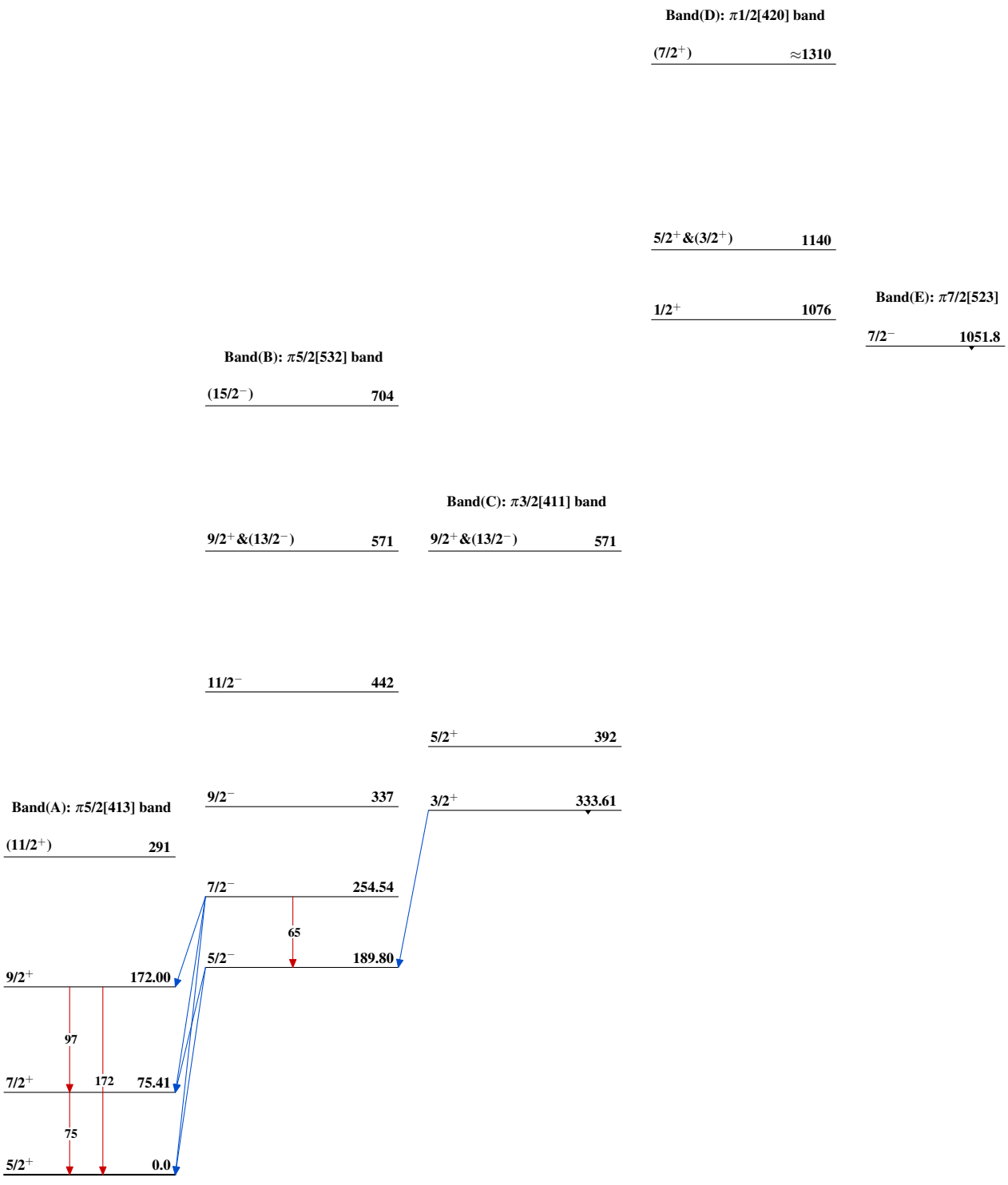
Level Scheme

Intensities: Relative photon branching from each level



$^{159}_{63}Eu_{96}$

Adopted Levels, Gammas



$^{159}_{63}Eu_{96}$

Adopted Levels, Gammas (continued)

Band(F): π1/2[411]

$(3/2^+)$ **806**

$^{159}_{63}Eu_{96}$