Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 191,1 (2023)	22-Aug-2023

Q(β^-)=1010 *5*; S(n)=7280 *5*; S(p)=6984 *5*; Q(α)=−109 *7* 2021Wa16
S(2n)=13524 *5*, S(2p)=16269 *5* (2021Wa16).
1955Ha45: ^{167}Ho produced and identified in ^{170}Er(p,α),E(p)=22.4 MeV, and ^{167}Er(n,p) reactions using natural erbium target, followed by ion-exchange method at the ORNL cyclotron facility. Measured half-life of the decay of ^{167}Ho, β and γ radiations. Deduced β-end-point energies of 1.0 MeV *1* and 0.28 MeV. Gamma rays of 0.35 and 0.70 MeV were observed.
1960Wi10: ^{167}Ho produced in ^{167}Er(n,p),E(n)=14 MeV, followed by chemical separation at the University of Arkansas Cockcroft-Walton 400-kV accelerator. Measured half-life of the decay of ^{167}Ho.
Theoretical structure calculations:
2017Ta12: calculated ground-state band, moments of inertia and gyromagnetic ratios, B(M1), magnetic moments, deformations using quasiparticle phonon nuclear model (QPNM).
1970Ri02: calculated levels, J^π using Hartree-Fock-Bogolyubov theory.
Other theory references for structure: nine references retrieved from from the NSR database listed in this dataset as 'document' records.
Additional information 1.

^{167}Ho Levels

Three neutron resonances at 0.27 eV, 8.5 eV and 57.4 eV, each with J^π=13/2$^-$,15/2$^-$ are known from 2018MuZZ evaluation. See ^{166}Ho(n,γ),(n,n):resonances dataset for details.
A brief dataset is included for continuum γ-ray spectroscopy from ^{164}Dy(α,pγ) reaction studied by 2023Po08 for determination of nuclear level density (NLD) and γ-strength function (GSF).

Cross Reference (XREF) Flags

A	^{167}Dy β^- decay (6.20 min)	D	^{168}Er(pol t,α)
B	^{164}Dy(α,pγ)	E	^{170}Er(p,α)
C	^{166}Ho(n,γ),(n,n):resonances		

E(level)†	J$^\pi$‡	$T_{1/2}$	XREF	Comments
0.0&	7/2$^-$	2.98 h *3*	A DE	%β^-=100 J$^\pi$: angular distribution and analyzing power in ^{168}Er(pol t,α). $T_{1/2}$: from 2002Ka45, decay curves for 321γ and 347γ. 2002Ka45 give weighted average of 3.003 h *18* from the following eight measurements, four for each of the two γ rays: 2.952 h *5*, 2.961 h *32*, 3.035 h *3*, 2.948 h *11*, 2.947 h *3*, 2.932 h *15*, 3.0253 h *20*, and 3.002 h *23*, uncertainties being statistical only. However, evaluators find that the dataset of $T_{1/2}$ values in 2002Ka45 is highly discrepant, with reduced χ^2=106 as compared to critical χ^2=2.0. Evaluators adopt unweighted average of 2.98 h *3*, where the uncertainty has been doubled to account for systematic uncertainties. Others: 3.1 h *1* (1960Wi10, β counting), 3.0 h (1955Ha45, from γ decay).
100& *4*	9/2$^-$		DE	
221& *4*	11/2$^-$		DE	
259.34a *11*	3/2$^+$	6.0 μs *10*	A DE	%IT=100 J$^\pi$: M2 γ to 7/2$^-$; angular distribution and analyzing power in ^{168}Er(pol t,α). $T_{1/2}$: $\beta\gamma$(t) in ^{167}Dy β^- decay (1977Tu01).
319.75a *12*	5/2$^+$		A DE	J$^\pi$: M1 γ to 3/2$^+$; angular distribution and analyzing power in ^{168}Er(pol t,α).
392.48b *13*	(1/2$^+$)		A	J$^\pi$: γ to 3/2$^+$ and position of level relative to 3/2$^+$ 1/2[411] state consistent with 1/2[411] bandhead assignment.

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Adopted Levels, Gammas (continued)

^{167}Ho Levels (continued)

E(level)[†]	Jπ[‡]	XREF	Comments
409.97[b] *12*	3/2+	A DE	XREF: E(403).
507[a] *4*	(9/2+)[#]	DE	
541[b] *4*	(7/2+)[#]	DE	
569.69 *12*	(3/2−)	A	Jπ: log *ft*=5.45 from (1/2−); γ to 7/2−. Configuration=π7/2[523]⊗2+ (1977Tu01).
702 *4*		D	
804 *4*		D	
922.0? *2*		A	
974[c] *4*	7/2+	D	
1006[d] *4*	(9/2−)[@]	D	
1092 *4*	(7/2+)[#@]	D	Jπ: possible 7/2 member of a γ-vibration band built on the 1/2+, π1/2[411] state.
1099.5 *2*		A	
1149.0 *3*		A	
1165[f] *4*	7/2+	D	
1168.8? *2*		A	
1240.6 *4*		A	
1275[f] *4*	(9/2+)[#]	D	
1403[e] *4*	(5/2+)[#@]	D	
1464[g] *4*	7/2−	D	
1664.9 *4*		A	
1666[g] *4*	11/2−	D	
1707 *4*		D	
1775 *4*		D	
1858[h] *4*	(1/2+)[@]	D	
1919.0? *3*		A	
1938[h] *4*	5/2+	D	E(level): doublet from a wider peak than normal, although σ(θ) and $A_y(\theta)$ distributions consistent with 5/2+ for most of the peak (1979Lo02).

[†] From ^{167}Dy β− decay for levels decaying by γ rays, and from (pol t,α) for levels populated only in transfer reactions.

[‡] From Nilsson-model interpretation (including pairing and Coriolis-coupling effects) of angular-distribution and analyzing-power data in ^{168}Er(pol t,α) (1979Lo02), except where noted.

[#] Assignment by 1979Lo02 considered tentative because of poor fit to $A_y(\theta)$ for a weakly populated level.

[@] Possible assignment to a band (1979Lo02) of weak population and poor fit to $A_y(\theta)$ in (pol t,α).

[&] Band(A): π7/2[523] band.

[a] Band(B): π3/2[411] band. The 7/2+ member is not seen in (pol t,α), as it is probably obscured by the strongly excited 1/2[411] state at 409 keV (1979Lo02).

[b] Band(C): π1/2[411] band. The 1/2+ bandhead in (pol t,α) is not seen as it would be obscured by a strong α-particle group, and the 5/2+ member would be populated weakly (1979Lo02).

[c] Band(D): π7/2[404]. 9/2+ member is expected to be populated weakly, and would be obscured by larger peaks in the spectrum (1979Lo02).

[d] Band(E): π1/2[541]. Tentative assignment.

[e] Band(F): π5/2[402]. Tentative assignment.

[f] Band(G): π5/2[413] band.

[g] Band(H): π5/2[532] band.

[h] Band(I): π1/2[420] band.

Adopted Levels, Gammas (continued)

γ(^{167}Ho)

E_i(level)	J_i^π	E_γ †	I_γ †	E_f	J_f^π	Mult. †	δ †	α ‡	Comments
259.34	3/2+	259.33 *13*	100	0.0	7/2−	M2		0.827 *12*	B(M2)(W.u.)=0.080 *14* α(K)=0.661 *9*; α(L)=0.1286 *18*; α(M)=0.0294 *4* α(N)=0.00685 *10*; α(O)=0.000980 *14*; α(P)=5.11×10^{-5} *7*
319.75	5/2+	60.44 *8*	100	259.34	3/2+	M1(+E2)	≤1.25	14.1 *30*	α(K)=7.2 *22*; α(L)=5 *4*; α(M)=1.3 *10* α(N)=0.29 *21*; α(O)=0.035 *24*; α(P)=4.5×10^{-4} *14*
392.48	(1/2+)	72.67# *10*	≈4.6	319.75	5/2+	[E2]		9.73 *15*	α(K)=2.061 *29*; α(L)=5.89 *9*; α(M)=1.425 *22* α(N)=0.321 *5*; α(O)=0.0376 *6*; α(P)=9.32×10^{-5} *13*
		133.19 *7*	100 *8*	259.34	3/2+	[M1+E2]		1.07 *8*	α(K)=0.74 *23*; α(L)=0.25 *11*; α(M)=0.059 *28* α(N)=0.013 *6*; α(O)=0.0017 *7*; α(P)=4.1×10^{-5} *19*
409.97	3/2+	90.26 *8*	64 *9*	319.75	5/2+	[M1+E2]		3.83 *33*	α(K)=2.2 *8*; α(L)=1.3 *8*; α(M)=0.30 *21* α(N)=0.07 *5*; α(O)=0.008 *5*; α(P)=1.2×10^{-4} *6*
		150.58 *8*	100 *14*	259.34	3/2+	[M1+E2]		0.73 *9*	α(K)=0.53 *16*; α(L)=0.16 *6*; α(M)=0.037 *14* α(N)=0.0083 *31*; α(O)=0.00108 *32*; α(P)=2.9×10^{-5} *13*
569.69	(3/2−)	159.71 *8*	≈1.0	409.97	3/2+	[E1]		0.0910 *13*	α(K)=0.0764 *11*; α(L)=0.01141 *16*; α(M)=0.002509 *35* α(N)=0.000575 *8*; α(O)=7.96×10^{-5} *11*; α(P)=3.72×10^{-6} *5*
		250.03 *13*	19.9 *11*	319.75	5/2+	[E1]		0.0282 *4*	α(K)=0.02385 *34*; α(L)=0.00344 *5*; α(M)=0.000756 *11* α(N)=0.0001740 *24*; α(O)=2.449×10^{-5} *34*; α(P)=1.223×10^{-6} *17*
		310.26 *12*	52.0 *30*	259.34	3/2+	[E1]		0.01643 *23*	α(K)=0.01390 *20*; α(L)=0.001981 *28*; α(M)=0.000435 *6* α(N)=0.0001001 *14*; α(O)=1.419×10^{-5} *20*; α(P)=7.27×10^{-7} *10*
		569.7 *2*	100.0	0.0	7/2−	[E2]		0.01135 *16*	
922.0?		352.2 *2*	100 *10*	569.69	(3/2−)				
		662.9# *3*	33 *4*	259.34	3/2+				
1099.5		689.4# *3*	≈25	409.97	3/2+				
		707.1 *2*	100 *20*	392.48	(1/2+)				
1149.0		579.4 *3*	39 *7*	569.69	(3/2−)				
		738.8 *4*	100 *25*	409.97	3/2+				
1168.8?		599.2 *2*	100 *12*	569.69	(3/2−)				

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Adopted Levels, Gammas (continued)

$\gamma(^{167}Ho)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π
1168.8?		909.1[#] *5*	≈47	259.34	$3/2^+$	1664.9		1094.6 *6*	77 *31*	569.69	$(3/2^-)$
1240.6		830.8 *5*	≈70	409.97	$3/2^+$			1272.9 *6*	100 *12*	392.48	$(1/2^+)$
		848.3 *10*	≈100	392.48	$(1/2^+)$			1405.6 *5*	74 *11*	259.34	$3/2^+$
		920.5[#] *5*	≈50	319.75	$5/2^+$	1919.0?		997.0[#] *2*	100	922.0?	
		981.4 *8*	≈50	259.34	$3/2^+$						

[†] From ^{167}Dy β^- decay.

[‡] 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.

[#] Placement of transition in the level scheme is uncertain.

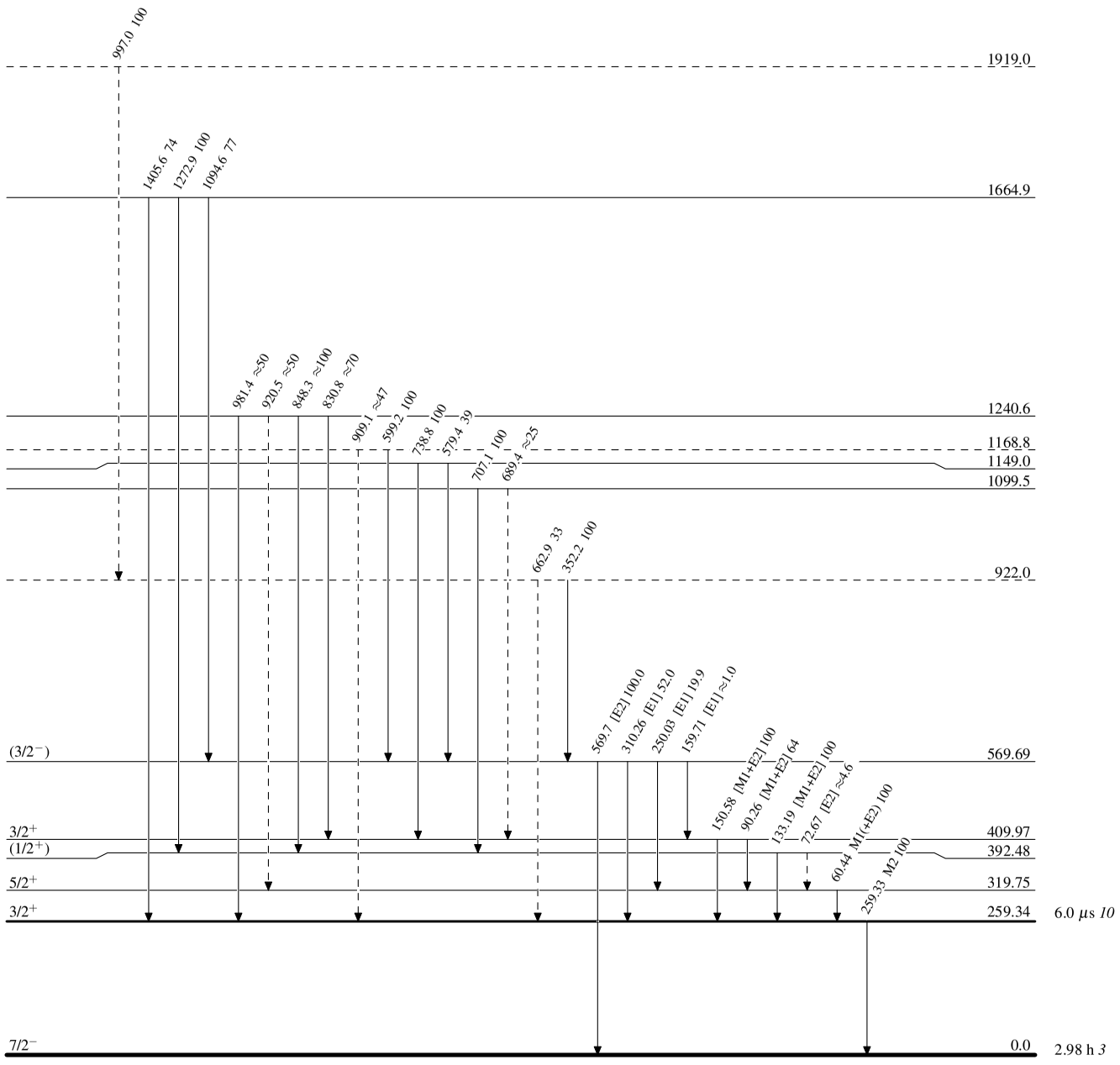
Adopted Levels, Gammas

Legend

Level Scheme

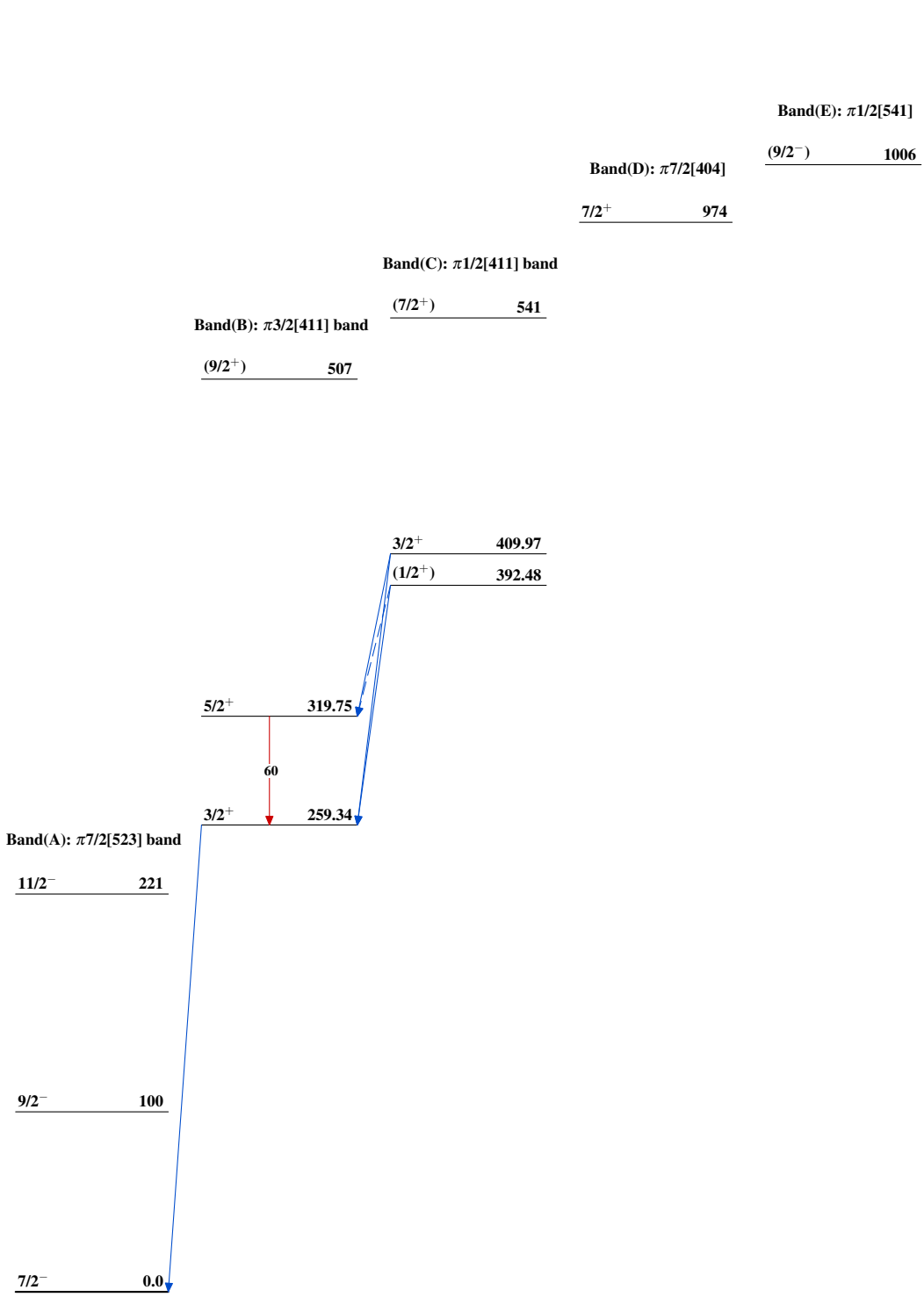
Intensities: Relative photon branching from each level

γ Decay (Uncertain)



$^{167}_{67}Ho_{100}$

Adopted Levels, Gammas



$^{167}_{67}Ho_{100}$

Adopted Levels, Gammas (continued)

Band(I): π1/2[420] band

5/2$^+$ 1938

(1/2$^+$) 1858

Band(H): π5/2[532] band

11/2$^-$ 1666

7/2$^-$ 1464

Band(G): π5/2[413] band

(9/2$^+$) 1275

7/2$^+$ 1165

$^{167}_{67}Ho_{100}$