^{163}Dy(d,2nγ),(p,nγ) 1972Fu09

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	C. W. Reich, Balraj Singh	NDS 111, 1211 (2010)	12-Apr-2010

Additional information 1.

1972Fu09: (d,2nγ) E= 13.5 MeV; (p,nγ) E= 6.7 MeV. Measured γ, $\gamma(\theta)$, $\gamma\gamma$-coin, ce.

Others:

1976Sc19: (p,nγ) E= 8 MeV. Measured $\gamma\gamma$(t), deduced $T_{1/2}$.

1972Sh36, 1971GoZU: (p,2nγ) E=15, 18 MeV. Measured γ, $\gamma\gamma$, $\gamma\gamma$(t).

^{163}Ho Levels

Bands: see Adopted Levels for details of assignments. See 1976Sc19 and 1972Fu09 for values derived using least-squares adjustment procedures including Coriolis and pairing effects.

E(level)	J^{π}[†]	$T_{1/2}$[‡]
0[@]	7/2$^-$	
100.04[@] *6*	9/2$^-$	
222.23[@] *7*	11/2$^-$	
297.88[&] *8*	1/2$^+$	
307.64[&] *9*	3/2$^+$	
360.37[a] *10*	3/2$^+$	
366.66[@] *9*	13/2$^-$	
392.09[&] *11*	5/2$^+$	
431.18[&] *7*	7/2$^+$	0.37 ns *15*
439.97[b] *8*	7/2$^+$	0.35 ns *15*
440.51[a] *9*	5/2$^+$	
471.26[c] *11*	(1/2)$^-$	≤0.2 ns
500.38[c] *14*	(5/2)$^-$	
528.25[a] *9*	7/2$^+$	
531.80[@] *10*	(15/2$^-$)	
552.06[b] *8*	(9/2$^+$)	
578.23[c] *13*	(3/2)$^-$	
587.56[&] *7*	(9/2$^+$)	
612.80[c] *10*	9/2$^-$	≤0.3 ns
614.5?[#] *2*	(5/2)$^-$	
652.07[&] *9*	(11/2$^+$)	
664.02[a] *9*	(9/2$^+$)	
688.09[b] *22*	(11/2$^+$)	
719.56[@] *11*	(17/2$^-$)	
795.45[a] *14*	(11/2$^+$)	
810.34[c] *10*	(13/2$^-$)	
844.7[b] *3*	(13/2$^+$)	
876.1?[#] *3*	5/2$^+$	
881.93?[&] *13*	(13/2$^+$)	
924.44[@] *12*	(19/2$^-$)	
964.77[&] *11*	(15/2$^+$)	
978.97[a] *13*	(13/2$^+$)	
1025.6[b] *4*	(15/2$^+$)	
1092.82[c] *15*	(17/2$^-$)	
1154.01 *13*	(21/2$^-$)	
1154.66?[a] *22*	(15/2$^+$)	
1220.1?[b] *3*	(17/2$^+$)	
1266.3?[&] *4*	(17/2$^+$)	
1363.8[&] *3*	(19/2$^+$)	
1393.53?[@] *22*	(23/2$^-$)	
1457.3[c] *3*	(21/2$^-$)	

† From the Adopted Levels, consistent with those proposed by 1972Fu09.

‡ From $\gamma\gamma$(t) (1976Sc19).

\# Level based on ε decay data.

@ Band(A): π7/2[523] band.

& Band(B): π1/2[411] band.

a Band(C): π3/2[411] band.

b Band(D): π7/2[404] band.

c Band(E): π1/2[541] band.

^{163}Dy(d,2nγ),(p,nγ) 1972Fu09 (continued)

γ(^{163}Ho)

See 1977Sc22, 1976An03, and 1973Wi02 for a comparison of experimental B(E1) values with calculated values from hexadecapole deformations.

E_γ [†]	I_γ [‡]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [#]	α [&]	Comments
(9.8)		307.64	3/2+	297.88	1/2+			
52.74 10	≈3	360.37	3/2+	307.64	3/2+			
x57.80[@] 10	1.8 6							
59.25[b] 10	1.7 5	587.56	(9/2+)	528.25	7/2+			
62.48 10	2.4 7	360.37	3/2+	297.88	1/2+			
80.16 10	3.7 11	440.51	5/2+	360.37	3/2+			
84.45 10	3.4 10	392.09	5/2+	307.64	3/2+			A_2=− 0.03 7.
87.71 10	3.1 9	528.25	7/2+	440.51	5/2+			A_2=− 0.07 9.
97.03 10	3.2 10	528.25	7/2+	431.18	7/2+			A_2=+ 0.11 7.
100.04 10	62.0 31	100.04	9/2−	0	7/2−			A_2=+ 0.03 1.
112.4[b] 3	≤0.2	612.80	9/2−	500.38	(5/2)−			
122.14 10	57.5 29	222.23	11/2−	100.04	9/2−			A_2=+ 0.03 1.
123.52 10	6.0 9	431.18	7/2+	307.64	3/2+			A_2=+ 0.25 10.
131.44 10	2.1 6	795.45	(11/2+)	664.02	(9/2+)			A_2=− 0.06 7.
135.72 10	3.0 9	664.02	(9/2+)	528.25	7/2+			A_2=+ 0.09 4 for 135.7+136.17.
136.17 10	2.4 7	528.25	7/2+	392.09	5/2+			A_2=+ 0.09 4 for 136.17+135.7.
142.62 10	1.0 3	440.51	5/2+	297.88	1/2+			A_2=+ 0.17 6.
144.41 10	41.4 21	366.66	13/2−	222.23	11/2−			A_2=+ 0.05 1.
154.40 10	1.1 3	964.77	(15/2+)	810.34	(13/2−)			A_2=− 0.25 15.
158.27 10	7.9 12	810.34	(13/2−)	652.07	(11/2+)			A_2=− 0.15 4.
x159.38[@] 10	1.6 5							A_2=+ 0.06 8 for 159.38+160.24.
x160.24[@] 10	1.7 5							
163.61 10	3.3 10	471.26	(1/2)−	307.64	3/2+			
165.14 10	25.3 13	531.80	(15/2−)	366.66	13/2−			A_2=+ 0.06 5.
168.0 3	≈2	528.25	7/2+	360.37	3/2+			
173.38 10	1.9 6	471.26	(1/2)−	297.88	1/2+			
175.7[b] 3	0.7 2	1154.66?	(15/2+)	978.97	(13/2+)			
181.59 10	14.7 22	612.80	9/2−	431.18	7/2+			A_2=− 0.10 3.
183.5[b] 3	≤0.5	978.97	(13/2+)	795.45	(11/2+)			
187.76 10	12.6 19	719.56	(17/2−)	531.80	(15/2−)			A_2=+ 0.03 3.
192.74 10	8.0 12	500.38	(5/2)−	307.64	3/2+			A_2=− 0.04 3.
195.53[b] 10	2.4 7	587.56	(9/2+)	392.09	5/2+			
197.51 10	4.0 12	810.34	(13/2−)	612.80	9/2−			
204.87 10	6.4 10	924.44	(19/2−)	719.56	(17/2−)			A_2=+ 0.02 4.
220.85 10	20.3 10	652.07	(11/2+)	431.18	7/2+			A_2=+ 0.14 3.
222.27 10	8.5 13	222.23	11/2−	0	7/2−			A_2=+ 0.14 6.
223.54 10	6.2 9	664.02	(9/2+)	440.51	5/2+			A_2=+ 0.28 7.
229.57 10	2.8 8	1154.01	(21/2−)	924.44	(19/2−)			A_2=+ 0.04 9.
232.86 10	2.5 8	664.02	(9/2+)	431.18	7/2+			A_2=− 0.24 17.
239.6[b] 3	0.6 2	1393.53?	(23/2−)	1154.01	(21/2−)			
254.1[b] 3	1.0 3	614.5?	(5/2)−	360.37	3/2+			
x263.0[@] 3	11.0 17							A_2=− 0.05 2.
266.62 10	13.0 20	366.66	13/2−	100.04	9/2−	E2	0.0961	α(K)=0.0693 10; α(L)=0.0207 3; α(M)=0.00484 7; α(N+..)=0.001247 18 α(N)=0.001102 16; α(O)=0.0001416 20; α(P)=3.50×10^{-6} 5 A_2=+ 0.20 2 for 266.6+267.2. α(K)exp= 0.10 4.

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^{163}Dy(d,2nγ),(p,nγ) 1972Fu09 (continued)

γ(^{163}Ho) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[&]	Comments
267.20 *10*	3.8 *11*	795.45	(11/2$^+$)	528.25	7/2$^+$			A_2=+ 0.20 *2* for 266.6+267.2.
280.35 *10*	3.1 *9*	578.23	(3/2)$^-$	297.88	1/2$^+$			A_2=+ 0.09 *14*.
282.48 *10*	7.4 *11*	1092.82	(17/2$^-$)	810.34	(13/2$^-$)			A_2=+ 0.18 *7*.
294.37[b] *10*	8.9 *13*	881.93?	(13/2$^+$)	587.56	(9/2$^+$)			A_2=+ 0.08 *3*.
297.88 *10*	100 *5*	297.88	1/2$^+$	0	7/2$^-$	E3	0.287	α(K)=0.1521 *22*; α(L)=0.1030 *15*; α(M)=0.0251 *4*; α(N+..)=0.00641 *9* α(N)=0.00570 *8*; α(O)=0.000704 *10*; α(P)=8.92$\times10^{-6}$ *13* Mult.: from adopted gammas.
309.58 *10*	15.0 *8*	531.80	(15/2$^-$)	222.23	11/2$^-$	(E2)	0.0607	α(K)=0.0452 *7*; α(L)=0.01194 *17*; α(M)=0.00277 *4*; α(N+..)=0.000716 *10* α(N)=0.000631 *9*; α(O)=8.24$\times10^{-5}$ *12*; α(P)=2.36$\times10^{-6}$ *4* A_2=+ 0.17 *2*. α(K)exp(309.6γ+312.7γ+315.0γ)= 0.029 *15*.
312.73 *10*	7.3 *11*	964.77	(15/2$^+$)	652.07	(11/2$^+$)			A_2=+ 0.13 *5*.
314.96 *10*	5.6 *8*	978.97	(13/2$^+$)	664.02	(9/2$^+$)			A_2=+ 0.11 *5*.
326.8 *3*	1.6 *5*	978.97	(13/2$^+$)	652.07	(11/2$^+$)			
331.12 *10*	6.9 *10*	431.18	7/2$^+$	100.04	9/2$^-$			A_2=− 0.06 *5*.
339.95 *10*	2.0 *6*	439.97	7/2$^+$	100.04	9/2$^-$			
352.90 *10*	8.9 *13*	719.56	(17/2$^-$)	366.66	13/2$^-$			A_2=+ 0.22 *6*.
359.2[b] *3*	2.1 *6*	1154.66?	(15/2$^+$)	795.45	(11/2$^+$)			
364.9 *3*	2.4 *7*	1457.3	(21/2$^-$)	1092.82	(17/2$^-$)			
384.4[b] *3*	2.9 *9*	1266.3?	(17/2$^+$)	881.93?	(13/2$^+$)			
392.65 *10*	5.6 *8*	924.44	(19/2$^-$)	531.80	(15/2$^-$)	E2	0.0303	α(K)=0.0236 *4*; α(L)=0.00524 *8*; α(M)=0.001202 *17*; α(N+..)=0.000313 *5* α(N)=0.000275 *4*; α(O)=3.68$\times10^{-5}$ *6*; α(P)=1.275$\times10^{-6}$ *18* A_2=+ 0.27 *5*. α(K)exp= 0.034 *15*.
399.0 *3*	2.4 *7*	1363.8	(19/2$^+$)	964.77	(15/2$^+$)			
[x]417.2[@] *3*	2.2 *7*							
431.16 *10*	46.0 *23*	431.18	7/2$^+$	0	7/2$^-$	E1	0.00749	α(K)=0.00636 *9*; α(L)=0.000889 *13*; α(M)=0.000195 *3*; α(N+..)=5.17$\times10^{-5}$ *8* α(N)=4.49$\times10^{-5}$ *7*; α(O)=6.42$\times10^{-6}$ *9*; α(P)=3.41$\times10^{-7}$ *5* A_2=+ 0.10 *2*. α(K)exp= 0.007 *3*, α(L)exp≈0.002.
434.45 *10*	2.9 *9*	1154.01	(21/2$^-$)	719.56	(17/2$^-$)			A_2=+ 0.18 *15*.
436.1[b] *3*	1.6 *5*	876.1?	5/2$^+$	439.97	7/2$^+$			
439.94 *10*	10.8 *16*	439.97	7/2$^+$	0	7/2$^-$	E1	0.00715	α(K)=0.00607 *9*; α(L)=0.000848 *12*; α(M)=0.000186 *3*; α(N+..)=4.93$\times10^{-5}$ *7* α(N)=4.29$\times10^{-5}$ *6*; α(O)=6.13$\times10^{-6}$ *9*; α(P)=3.26$\times10^{-7}$ *5* A_2=+ 0.08 *4*. α(K)exp= 0.007 *4*.
452.00 *10*	5.0 *8*	552.06	(9/2$^+$)	100.04	9/2$^-$			A_2=+ 0.11 *6*.
465.9 *3*	2.2 *7*	688.09	(11/2$^+$)	222.23	11/2$^-$			A_2=+ 0.24 *24*.
469.0[b] *3*	1.2 *4*	1393.53?	(23/2$^-$)	924.44	(19/2$^-$)			
478.0 *3*	≈1	844.7	(13/2$^+$)	366.66	13/2$^-$			
[x]514.5[@] *3*	≈8							

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^{163}Dy(d,2nγ),(p,nγ) 1972Fu09 (continued)

γ(^{163}Ho) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J^π_i	E_f	J^π_f	Comments
552.07[a] *10*	4.0[a] *12*	552.06	(9/2$^+$)	0	7/2$^-$	I_γ: equal intensity assigned, arbitrarily, in two places. A_2=− 0.04 *5* for doublet.
552.07[a] *10*	4.0[a] *12*	652.07	(11/2$^+$)	100.04	9/2$^-$	A_2=− 0.04 *5* for doublet.
[x]558.7[@] *3*	7.6 *11*					A_2=+ 0.03 *5*.
[x]568.5[@] *3*	3.0 *9*					A_2=+ 0.19 *15*.
[x]585.7[@] *3*	2.0 *6*					
588.0 *3*	4.0 *12*	688.09	(11/2$^+$)	100.04	9/2$^-$	A_2=− 0.30 *15*.
[x]590.4 *3*	3.2 *10*					A_2= 0.00 *12*.
[x]611.6[@] *3*	3.0 *9*					A_2=− 0.06 *10*.
614.6[b] *3*	5.7 *9*	614.5?	(5/2)$^-$	0	7/2$^-$	A_2=+ 0.01 *5*.
622.5 *3*	4.0 *12*	844.7	(13/2$^+$)	222.23	11/2$^-$	A_2=− 0.14 *7*.
[x]652.5[@] *3*	4.7 *14*					
658.9 *3*	3.7 *11*	1025.6	(15/2$^+$)	366.66	13/2$^-$	
688.3[@b] *3*	≈5	1220.1?	(17/2$^+$)	531.80	(15/2$^-$)	

[†] Quoted uncertainties are upper limits.

[‡] From (d,2nγ) at 125°. ΔIγ assigned (evaluators) as 5% for Iγ>15, 15% for Iγ=5-15, and 30% for Iγ<5, based on a general statement (1972Fu09) that ΔIγ=5% to 30% depending on Iγ. 1972Fu09 also give Iγ(p,nγ)/Iγ(d,2nγ) ratios for most transitions.

[#] From α(K)exp, normalized to α(K)(297.9, E3). Transitions with A_2≈+0.2 are interpreted (1972Fu09) as ΔJ=2, E2 transitions, with small (<0.1) positive A_2 or negative A_2 as ΔJ=1, dipole transitions. ΔJ=0, dipole transitions have A_2≈+0.1.

[@] Assignment to ^{163}Ho is uncertain.

[&] 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.

[a] Multiply placed with intensity suitably divided.

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

[x] γ ray not placed in level scheme.

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Level Scheme

Intensities: Relative I_γ

@ Multiply placed: intensity suitably divided

Legend

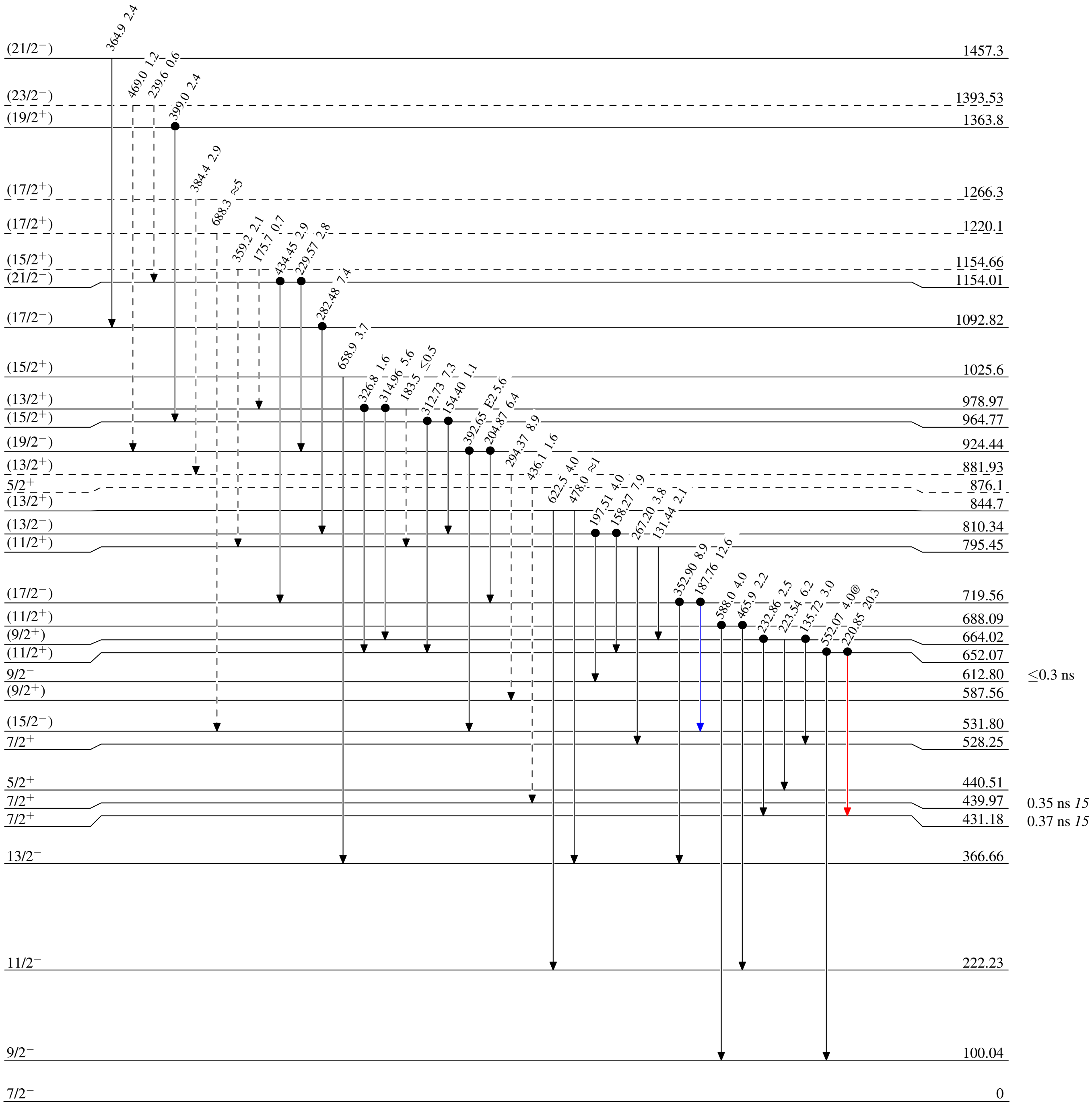
$I_\gamma < 2\% \times I_\gamma^{max}$

$I_\gamma < 10\% \times I_\gamma^{max}$

$I_\gamma > 10\% \times I_\gamma^{max}$

γ Decay (Uncertain)

Coincidence



$^{163}_{67}Ho_{96}$

^{163}Dy(d,2nγ),(p,nγ) 1972Fu09

Level Scheme (continued)

Intensities: Relative I_γ

@ Multiply placed: intensity suitably divided

Legend

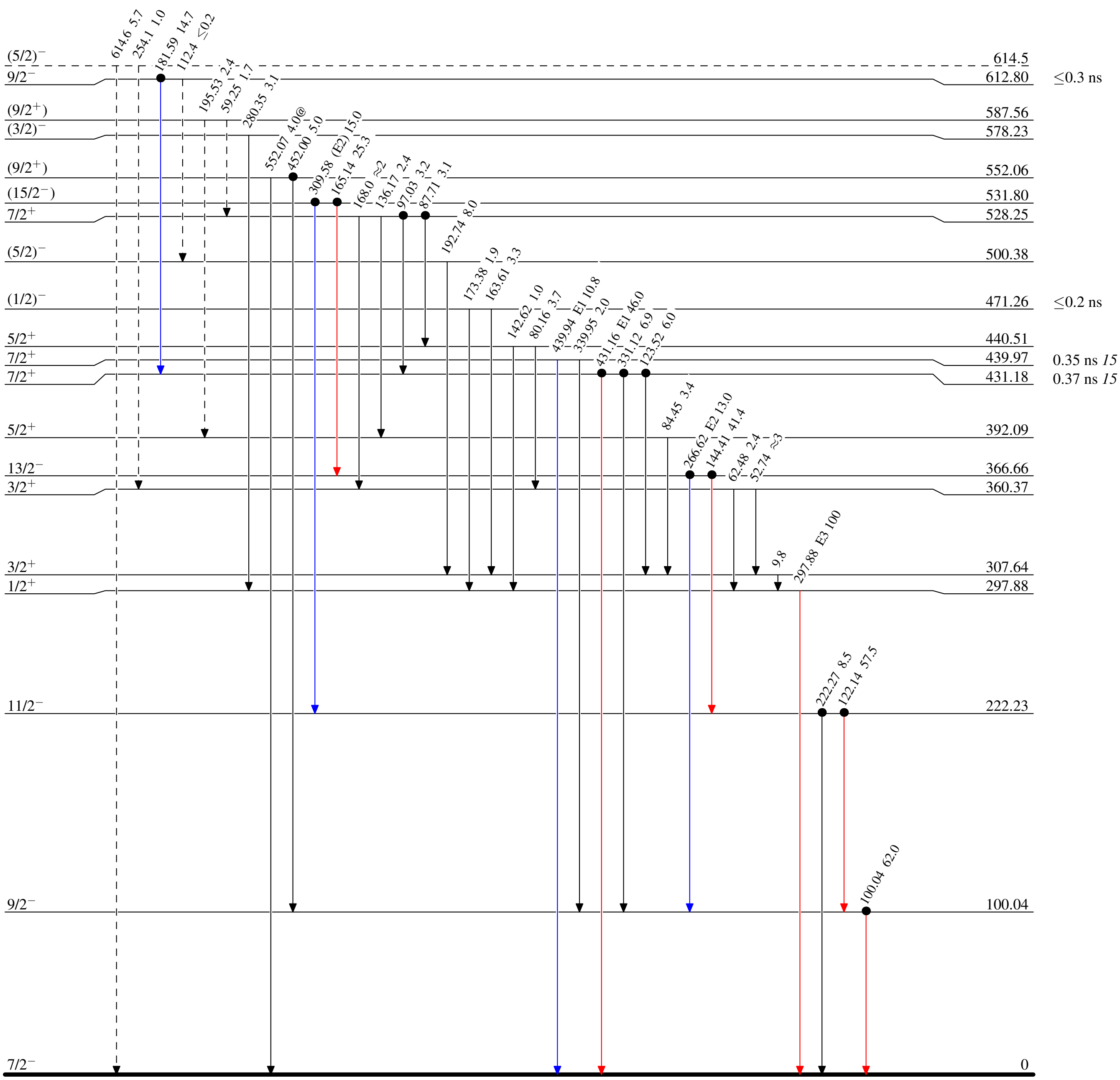
$I_\gamma < 2\% \times I_\gamma^{max}$

$I_\gamma < 10\% \times I_\gamma^{max}$

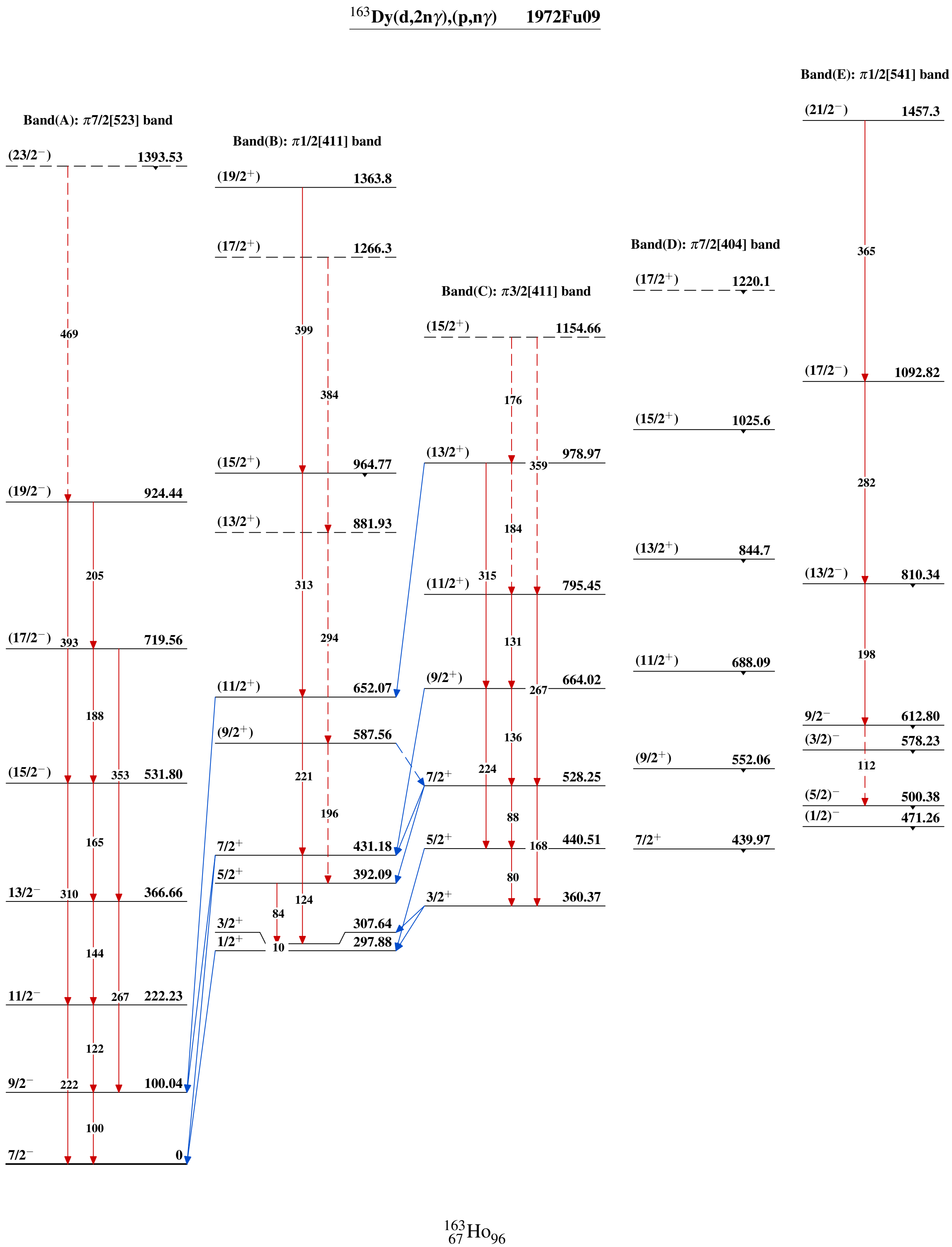
$I_\gamma > 10\% \times I_\gamma^{max}$

γ Decay (Uncertain)

Coincidence



$^{163}_{67}Ho_{96}$


^{163}Dy(d,2nγ),(p,nγ) 1972Fu09
Band(A): π7/2[523] band
Band(B): π1/2[411] band
Band(C): π3/2[411] band
Band(D): π7/2[404] band
Band(E): π1/2[541] band
(23/2−) 1393.53
(19/2−) 924.44
(17/2−) 719.56
(15/2−) 531.80
13/2− 366.66
11/2− 222.23
9/2− 100.04
7/2− 0
469
205
393
188
353
165
310
144
267
122
222
100
(19/2+) 1363.8
(17/2+) 1266.3
(15/2+) 964.77
(13/2+) 881.93
(11/2+) 652.07
(9/2+) 587.56
7/2+ 431.18
5/2+ 392.09
3/2+ 307.64
1/2+ 297.88
399
384
313
294
221
196
124
84
10
(15/2+) 1154.66
(13/2+) 978.97
(11/2+) 795.45
(9/2+) 664.02
7/2+ 528.25
5/2+ 440.51
3/2+ 360.37
176
359
184
315
131
267
136
224
88
168
80
(17/2+) 1220.1
(15/2+) 1025.6
(13/2+) 844.7
(11/2+) 688.09
(9/2+) 552.06
7/2+ 439.97
(21/2−) 1457.3
(17/2−) 1092.82
(13/2−) 810.34
9/2− 612.80
(3/2)− 578.23
(5/2)− 500.38
(1/2)− 471.26
365
282
198
112
$^{163}_{67}$Ho$_{96}$