

(HI,xn γ) 1983Ra19,2002Ap04

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 170, 1 (2020)	16-Aug-2020

1983Ra19: $^{141}\text{Pr}(^{16}\text{O},4n\gamma)$ with $E(^{16}\text{O})=80\text{-}100$ MeV and $^{122}\text{Sn}(^{35}\text{Cl},4n\gamma)$ with $E(^{35}\text{Cl})=145\text{-}165$ MeV. Measured $\gamma(\theta)$, excitation functions, $\gamma\gamma$, $T_{1/2}$, $\alpha_K(\text{exp})$.

2002Ap04: $^{120}\text{Sn}(^{37}\text{Cl},4n\gamma)$ with $E(^{37}\text{Cl})=177$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma(\theta)$ using EUROGAM II array with 30 Compton-suppressed HPGe detectors and 24 Clover detectors. Data from this paper originally compiled for the XUNDL database by B. Singh, McMaster University, October 2002.

 ^{153}Ho Levels

Some early papers reported half-lives observed for nonspecific levels; these include [1980Ja16](#) $T_{1/2}=56$ ns *10* followed by γ 's of 533, 557, and 576 keV and $T_{1/2}=245$ ns *20* followed by γ of 632 keV (this might be the isomer at 2772 keV); and [1980Bo07](#) reports half-lives for levels in ^{152}Ho or ^{153}Ho with $T_{1/2}=30$ ns *15* with excitation of 6.0 MeV *8* and $T \geq 400$ ns at 3.7 MeV *+2-5*.

E(level) ^{†‡}	J π #	$T_{1/2}$ [@]	Comments
0.0	(11/2 ⁻)		
576	(15/2 ⁻)		
727	(15/2 ⁻)		
1091	(15/2 ⁺)		
1207	(19/2 ⁻)		
1359	(19/2 ⁻)		
1646	(19/2 ⁺)		
1873	(23/2 ⁻)		
2002?			
2030	(23/2 ⁻)		
2125	(23/2 ⁻)		
2203	(23/2 ⁺)		
2297	(27/2 ⁻)		
2358	(25/2 ⁻)		
2736	(27/2 ⁺)		
2772 ^{&}	(31/2 ⁺)	229 ns <i>2</i>	Branching: $I(\gamma+\text{ce})(475)=1.5\%$.
3209	(33/2 ⁺)		
3687 ^{&}	(35/2 ⁺)		
4316 ^{&}	(39/2 ⁺)		
4679 ^{&}	(43/2 ⁺)	0.5 ps <i>2</i>	
5134 ^{&}	(45/2 ⁺)		
5771	(47/2 ⁻)		
5896 ^{&}	(49/2 ⁺)		
6076	(49/2 ⁻)		
6393	(51/2)		
6518	(53/2 ⁻)		
6937 ^{&}	(53/2 ⁺)		
7127	(55/2)		E(level): Given in 1983Ra19 as 7309.
7403	(57/2 ⁺)		
7598	(61/2 ⁺)	2.95 ns <i>15</i>	
7933	(63/2 ⁺)		
8934	(65/2 ⁻)		
9074	(67/2 ⁻)	0.3 ns <i>1</i>	
9871	(67/2 ⁻)		
10200?	(69/2)		

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(HI,xn γ) 1983Ra19,2002Ap04 (continued) ^{153}Ho Levels (continued)

E(level) ^{†‡}	J π [#]	Comments
10260	(69/2 ⁻)	
10603	(71/2 ⁻)	
10912	(71/2)	E(level): Given in 1983Ra19 as 10903.
11304	(73/2)	
11680	(75/2)	
12121	(77/2)	
12477	(81/2)	
x ^a	53/2 ⁻	E(level): From strong feeding of level at 5896 keV and weak population of level at 6937, X is ≥ 7 MeV.
806.2+x ^a 13	57/2 ⁻	
1669.1+x ^a 15	61/2 ⁻	
2616.9+x ^a 20	65/2 ⁻	
3631.5+x ^a 21	69/2 ⁻	
4714.1+x ^a 21	73/2 ⁻	
5864.3+x ^a 22	77/2 ⁻	
7083.0+x ^a 22	81/2 ⁻	
8370.4+x ^a 23	85/2 ⁻	
9713.3+x ^a 24	89/2 ⁻	

[†] As suggested in 2002Ap04, the order of the 762 and 1043 γ 's given in 1983Ra19 has been reversed. (These papers have two authors in common.) This moves 49/2⁺ level at 6176 keV down to 5896 keV, 6573 to 6393, and 7307 to 7127 on the assumption that these levels follow the 49/2⁺ level.

[‡] Band A has been assigned by the evaluator and is based on the 31/2⁺ isomer at 2772 keV and band B by 2002Ap04.

[#] Deduced by the authors of 1983Ra19 from measured $\gamma\gamma$ coincidence data and expected configurations and from 2002Ap04 coincidences with lower transitions.

[@] The values for levels above 3000 keV are stated (1983Ra19) as from "D. C. Radford et al., to be published." These values are given by authors with both uncertainties and \approx signs. Quadrupole transitions are E2. These T_{1/2} values were not retrieved by evaluator in regular literature as of February 2018.

[&] Band(A): Band based on 31/2⁺ isomer at 2772 keV.

^a Band(B): π 1/2[541] band, $\alpha=+1/2$. (triaxial).

 $\gamma(^{153}\text{Ho})$

E γ	E _i (level)	J π _i	E _f	J π _f	Mult. [†]	α [@]	Comments
36	2772	(31/2 ⁺)	2736	(27/2 ⁺)	E2	238.4	$\alpha(L)= 180.8; \alpha(M)= 43.3$
61	2358	(25/2 ⁻)	2297	(27/2 ⁻)	M1(+E2)		
140	9074	(67/2 ⁻)	8934	(65/2 ⁻)	(M1) [‡]	1.023	
150	727	(15/2 ⁻)	576	(15/2 ⁻)	(M1) [‡]	0.842	
152	1359	(19/2 ⁻)	1207	(19/2 ⁻)	(M1,E2) [‡]		
173	2203	(23/2 ⁺)	2030	(23/2 ⁻)	E1+M2		
195	7598	(61/2 ⁺)	7403	(57/2 ⁺)	E2	0.268	
233	2358	(25/2 ⁻)	2125	(23/2 ⁻)	M1	0.2482	
252	2125	(23/2 ⁻)	1873	(23/2 ⁻)	M1	0.2003	
287	1646	(19/2 ⁺)	1359	(19/2 ⁻)	E1	0.01998	
305	6076	(49/2 ⁻)	5771	(47/2 ⁻)	M1	0.1198	
330	2203	(23/2 ⁺)	1873	(23/2 ⁻)			
335	7933	(63/2 ⁺)	7598	(61/2 ⁺)	(M1) [‡]	0.0934	
343	10603	(71/2 ⁻)	10260	(69/2 ⁻)			
356	2358	(25/2 ⁻)	2002?				

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(HI,xn γ) 1983Ra19,2002Ap04 (continued) $\gamma(^{153}\text{Ho})$ (continued)

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	$a^@$	Comments
356		12477	(81/2)	12121	(77/2)			
363		4679	(43/2 ⁺)	4316	(39/2 ⁺)	E2	0.0382	
364		1091	(15/2 ⁺)	727	(15/2 ⁻)	E1 [#]	0.01113	
376		11680	(75/2)	11304	(73/2)			
378		2736	(27/2 ⁺)	2358	(25/2 ⁻)	E1	0.01017	
389		10260	(69/2 ⁻)	9871	(67/2 ⁻)			
392		11304	(73/2)	10912	(71/2)			
424		2297	(27/2 ⁻)	1873	(23/2 ⁻)			
437		3209	(33/2 ⁺)	2772	(31/2 ⁺)	M1	0.0465	
439		1646	(19/2 ⁺)	1207	(19/2 ⁻)	E1	0.00719	
439		2736	(27/2 ⁺)	2297	(27/2 ⁻)	E1 [#]	0.00719	
441		12121	(77/2)	11680	(75/2)			
442		6518	(53/2 ⁻)	6076	(49/2 ⁻)			
455		5134	(45/2 ⁺)	4679	(43/2 ⁺)	M1	0.0419	
466		7403	(57/2 ⁺)	6937	(53/2 ⁺)	E2	0.01911	
475		2772	(31/2 ⁺)	2297	(27/2 ⁻)	M2	0.1211	
476		3687	(35/2 ⁺)	3209	(33/2 ⁺)	(M1) [‡]	0.0373	
485		2358	(25/2 ⁻)	1873	(23/2 ⁻)	(M1) [‡]	0.0355	
497		6393	(51/2)	5896	(49/2 ⁺)			
515		1091	(15/2 ⁺)	576	(15/2 ⁻)	E1 [#]	0.00506	
533		2736	(27/2 ⁺)	2203	(23/2 ⁺)	E2	0.01356	
555		1646	(19/2 ⁺)	1091	(15/2 ⁺)	E2	0.01224	
557		2203	(23/2 ⁺)	1646	(19/2 ⁺)	E2	0.01213	
576		576	(15/2 ⁻)	0.0	(11/2 ⁻)	E2	0.01116	
631		1207	(19/2 ⁻)	576	(15/2 ⁻)	E2	0.00895	
631		4316	(39/2 ⁺)	3687	(35/2 ⁺)	E2	0.00895	
633		1359	(19/2 ⁻)	727	(15/2 ⁻)			
637		5771	(47/2 ⁻)	5134	(45/2 ⁺)	E1+M2		
652		10912	(71/2)	10260	(69/2 ⁻)			
666		1873	(23/2 ⁻)	1207	(19/2 ⁻)	E2	0.00787	
671		2030	(23/2 ⁻)	1359	(19/2 ⁻)			
701		11304	(73/2)	10603	(71/2 ⁻)			
711		10912	(71/2)	10200?	(69/2)			
727		727	(15/2 ⁻)	0.0	(11/2 ⁻)	E2	0.00643	
732		10603	(71/2 ⁻)	9871	(67/2 ⁻)			
734		7127	(55/2)	6393	(51/2)			
762		5896	(49/2 ⁺)	5134	(45/2 ⁺)	E2		
783		1359	(19/2 ⁻)	576	(15/2 ⁻)	E2	0.00545	
795		2002?		1207	(19/2 ⁻)			
796		9871	(67/2 ⁻)	9074	(67/2 ⁻)			
806.2 13	32 1	806.2+x	57/2 ⁻	x	53/2 ⁻			
822		2030	(23/2 ⁻)	1207	(19/2 ⁻)			
862.9 6	62 2	1669.1+x	61/2 ⁻	806.2+x	57/2 ⁻	E2		Ratio(asymmetry)=0.85 4.
913		3687	(35/2 ⁺)	2772	(31/2 ⁺)	E2	0.00390	
918		2125	(23/2 ⁻)	1207	(19/2 ⁻)	E2	0.00385	
947.8 13	91 3	2616.9+x	65/2 ⁻	1669.1+x	61/2 ⁻	E2		Ratio(asymmetry)=0.94 4.
1001		8934	(65/2 ⁻)	7933	(63/2 ⁺)	E1+M2		
1014.6 6	90 3	3631.5+x	69/2 ⁻	2616.9+x	65/2 ⁻	E2		Ratio(asymmetry)=0.88 3.
1042		6937	(53/2 ⁺)	5896	(49/2 ⁺)	E2		
1082.6 5	88 2	4714.1+x	73/2 ⁻	3631.5+x	69/2 ⁻	E2		Ratio(asymmetry)=1.25 25.
1126		10200?	(69/2)	9074	(67/2 ⁻)			
1150.2 5	70 2	5864.3+x	77/2 ⁻	4714.1+x	73/2 ⁻	E2		Ratio(asymmetry)=0.97 3.
1185		10260	(69/2 ⁻)	9074	(67/2 ⁻)			
1218.7 5	100 2	7083.0+x	81/2 ⁻	5864.3+x	77/2 ⁻	E2		Ratio(asymmetry)=0.73 3.
1287.4 5	67 2	8370.4+x	85/2 ⁻	7083.0+x	81/2 ⁻	E2		Ratio(asymmetry)=0.97 4.

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(HI,xn γ) 1983Ra19,2002Ap04 (continued) $\gamma(^{153}\text{Ho})$ (continued)

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	α [@]	Comments
1326		10260	(69/2 ⁻)	8934	(65/2 ⁻)			
1342.9	7	9713.3+x	89/2 ⁻	8370.4+x	85/2 ⁻	E2		Ratio(asymmetry)=1.21 5.
1476		9074	(67/2 ⁻)	7598	(61/2 ⁺)	E3	0.00292	
1528		10603	(71/2 ⁻)	9074	(67/2 ⁻)	E2	0.00117	$\alpha(\text{K})=0.00117$

[†] From $\alpha_{\text{K}}(\text{exp})$ values, see fig. 2 of 1983Ra19 (values not available), except the assignments for 36 and 61 γ 's are from α deduced from I_γ and intensity balance in delayed spectrum. For the γ 's associated with the levels of the B band, the assignments are from the asymmetry ratios of 2002Ap04 given with the assumption that all Q transitions are stretched E2's.

[‡] E3 is not ruled out.

$\Delta J=0$ transition (1983Ra19).

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

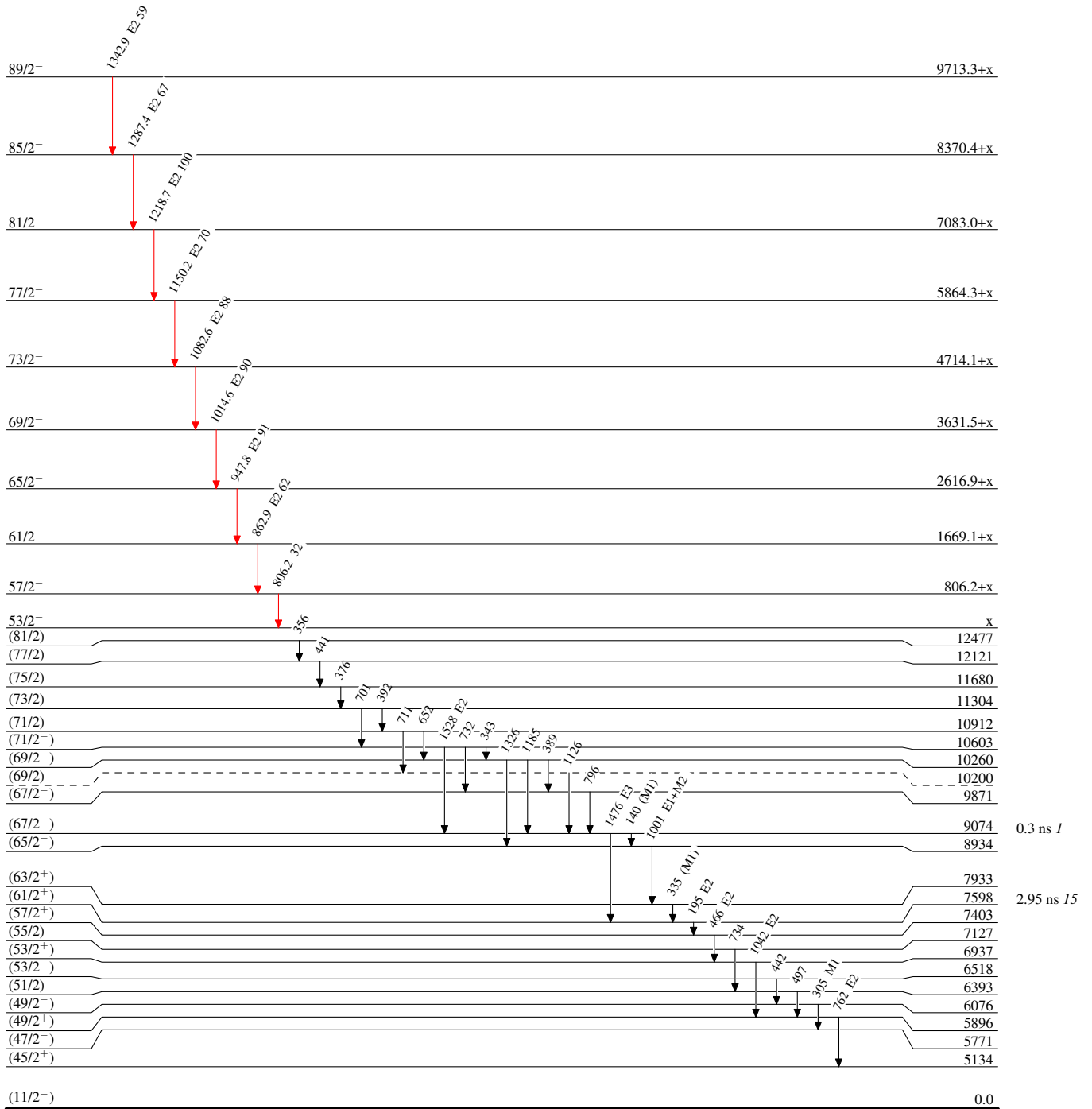
(HI,xn γ) 1983Ra19,2002Ap04

Level Scheme

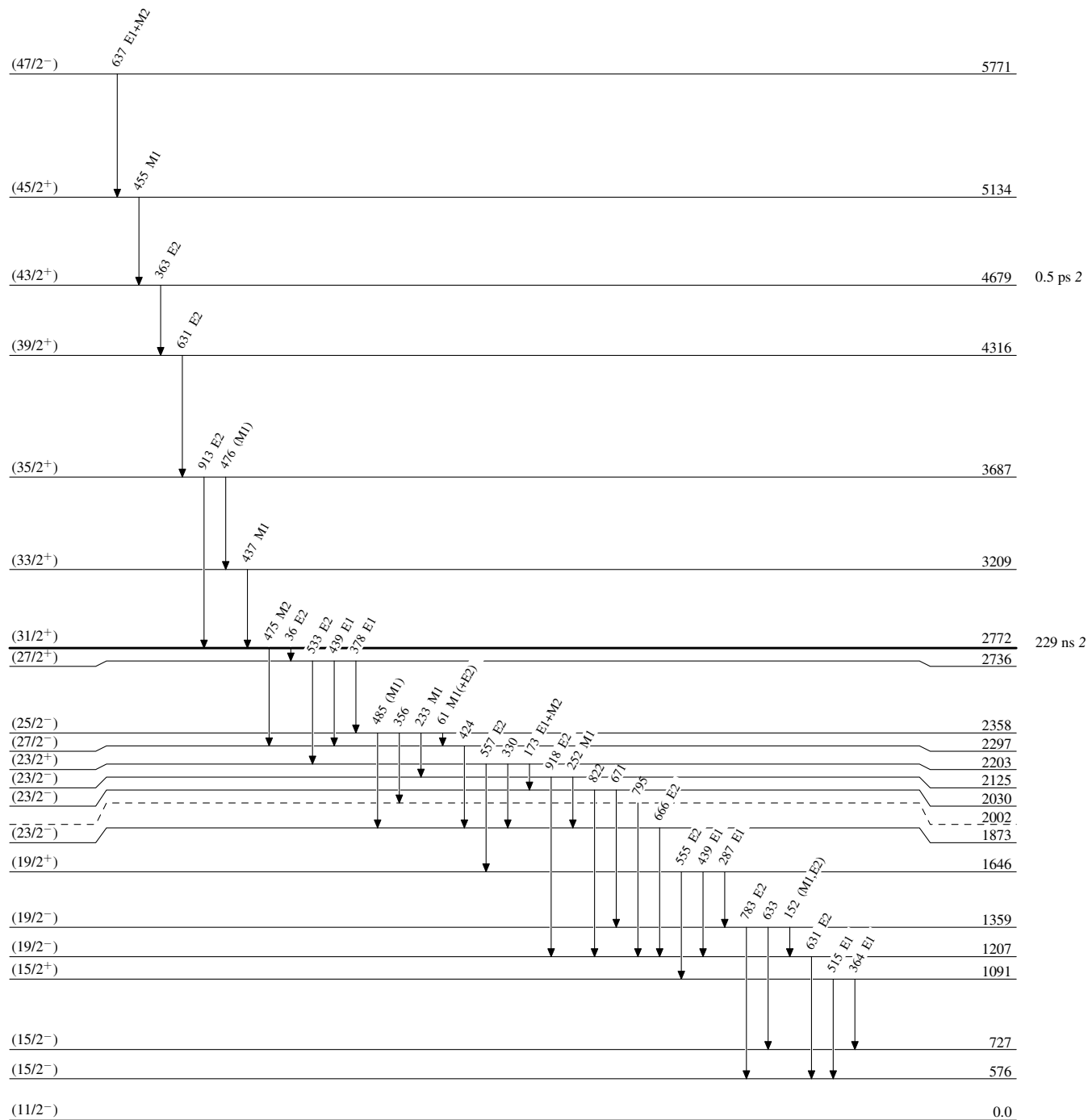
Intensities: Relative I_γ

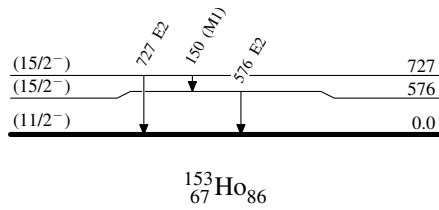
Legend

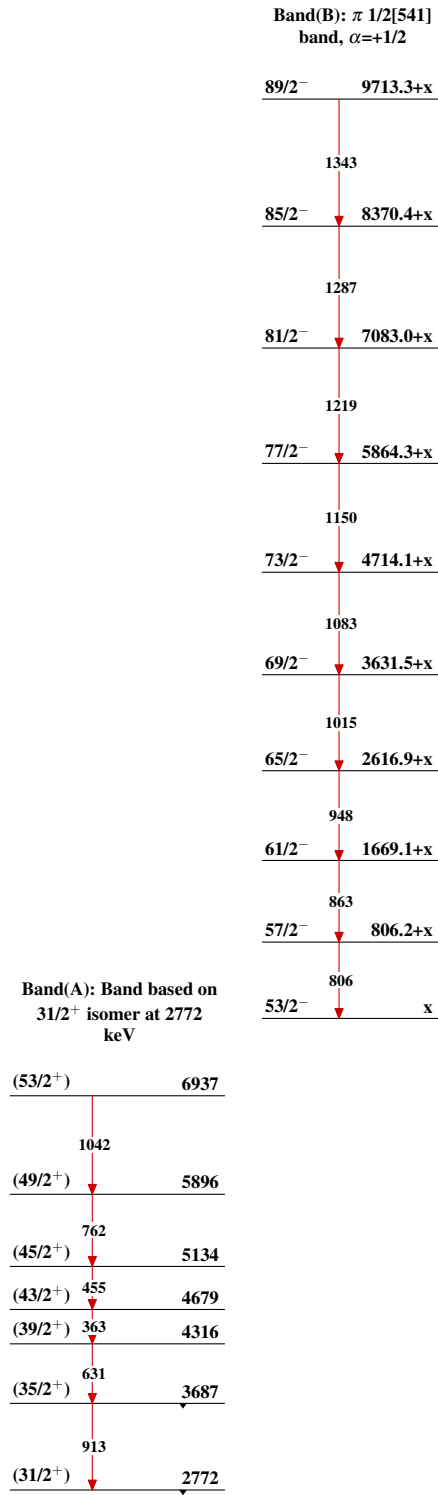
- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$



$^{153}_{67}\text{Ho}_{86}$

(HI,xn γ) 1983Ra19,2002Ap04**Level Scheme (continued)**Intensities: Relative I_γ  $^{153}_{67}\text{Ho}_{86}$

(HI,xn γ) 1983Ra19,2002Ap04**Level Scheme (continued)**Intensities: Relative I_γ 

(HI,xn γ) 1983Ra19,2002Ap04 $^{153}_{67}\text{Ho}_{86}$