(HI,xnγ) 1990Bu07,1982Do11,1981We07

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, Jun Chen and Ameenah R. Farhan	NDS 194,3 (2024)	8-Jan-2024

Includes ^{48}Ti(^{32}S,n3pγ), ^{65}Cu(^{14}N,p2nγ), ^{66}Zn(^{12}C,pnγ), ^{74}Se(α,pnγ), and ^{75}As(α,3nγ) reactions.

Extensive high-spin data are presented in two other datasets: ^{63}Cu(^{16}O,n2pγ),(^{19}F,αpnγ) from 1997Wi01 and 1990Wi02; and ^{55}Mn(^{30}Si,2αnγ) from 1997Pa35; the latter is the most detailed study carried out using large detector array GASP at Legnaro.

1990Bu07: ^{48}Ti(^{32}S,n3pγ),E=106 MeV. Measured Eγ, Iγ, γγ-coin, lifetimes by DSAM and some γγ(θ)(DCO) data. The γ-ray energies and intensities are given for levels above 1 MeV.

1986KuZW, 1983GuZV: ^{65}Cu(^{14}N,p2nγ),E=46 MeV; measured lifetimes by RDDS and DSA methods.

1982Do11: ^{74}Se(α,pnγ),E=27 MeV, ^{76}Se(p,nγ),E=6.7 MeV, ^{76}Se(d,2nγ),E=13.5 MeV, ^{76}Se(^{3}He,p2nγ),E=32 MeV. Report γ, γγ-coin, $T_{1/2}$, γ(θ) and γ(lin pol) measurements but results of these measurements such as γ-ray intensities are not available. A detailed level scheme based on γγ-coin data is given.

1982AnZZ: ^{63}Cu(^{16}O,n2pγ); measured half-life of an isomer above 584 level. Details of methodology are given in 1982An09.

1981We07: ^{66}Zn(^{12}C,pnγ),E=38.0 MeV. γ, γγ-coin, γ(θ) and G(lin pol) data.

1977Be18 (also 1979Kr04): ^{75}As(α,3nγ),E=30-55 MeV. Measured γ, γγ-coin, γ(θ). A total of eight γ rays reported placed amongst five excited states. 1979Kr04 identify the 4^+ isomer at 102.7 keV. All the five levels proposed in 1977Be18 need to be adjusted upward in energy by 102.7 keV.

Others:

1993Mo14: using ^{40}Ca target and ^{36}Ar beam, levels in ^{73}Kr were studied in this work. The following γ rays with Eγ(Iγ) assigned to ^{73}Kr, most likely, belong to ^{76}Br: 93.0 (3.1), 111.8 (16.1), 142.2 (20.4), 238.0 (9.7), 254.0 (15.0), 331.4 (6.4), 431.9 (<2). Impurities in the target or beam may have contributed to these lines in the ^{73}Kr spectrum. There is a general agreement of the generic relationship of these transitions as suggested by 1993Mo14 and 1981We07, except for the branching ratio disagreement (Iγ(112γ)/Iγ(254γ)=5.9 (1981We07), 1.1 (1993Mo14)) from 357 level.

^{76}Br Levels

The level scheme given here is mainly based on the one given by 1997Pa35 (date from this work are given separately in ^{55}Mn(^{30}Si,2αnγ) dataset) which is a much larger extension of earlier ones in 1977Be18, 1981We07, 1982Do11, 1990Wi02 and 1997Wi01. 1990Bu07 presented data for mainly the positive parity band. Some differences exist between 1990Bu07 and 1997Pa35 in the assignment of even-spin positive-parity band members above 10^+.

E(level)[†]	J^π[‡]	$T_{1/2}$[#]	Comments
0.0[b]	1^-		
45.5[b] *4*	$(2)^-$		
102.6[&] *4*	$(4)^+$	1.31 s *2*	%IT>99.4 $T_{1/2}$: from Adopted Levels.
212.2[b] *4*	(3^-)	111 ps *28*	$T_{1/2}$: RDDS for 212γ (1986KuZW).
244.8[a] *5*	$(5)^+$	76 ps *14*	$T_{1/2}$: RDDS for 142.2γ (1986KuZW).
301.7[c] *5*	(4^-)	0.52 ns *7*	$T_{1/2}$: RDDS for 199γ (1986KuZW). Other: 0.5 ns *2* (1982Do11).
356.9[&] *5*	$(6)^+$	118 ps *21*	$T_{1/2}$: RDDS for 112γ (1986KuZW).
363.2[b] *5*	$(4)^-$	59 ps *10*	$T_{1/2}$: RDDS for 318γ (1986KuZW).
425.8 *7*		45 ps *17*	Level and $T_{1/2}$ (from RDDS for 124γ) from 1986KuZW.
467.3[d] *5*	(5^-)	242 ps *35*	$T_{1/2}$: RDDS for 222γ (1986KuZW).
583.6[b] *5*	(5^-)		
583.6+x?		0.8 ns *2*	E(level): level at 585.6+x suggested by 1982AnZZ. $T_{1/2}$: from centroid shift method (1982AnZZ).
594.8[a] *5*	$(7)^+$	21 ps *4*	$T_{1/2}$: RDDS for 238γ (1986KuZW).
687.7[c] *5*	(6^-)	73 ps *24*	$T_{1/2}$: RDDS for 386γ (1986KuZW).
688.3[&] *5*	$(8)^+$	69 ps *21*	$T_{1/2}$: RDDS for 331γ (1986KuZW).
761.2?[@] *5*			

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(HI,xnγ) 1990Bu07,1982Do11,1981We07 (continued)

^{76}Br Levels (continued)

E(level)[†]	Jπ[‡]	$T_{1/2}$[#]	Comments
882.6 *7*		2.4 ps *4*	Level and $T_{1/2}$ (from RDDS for 519γ) from 1986KuZW.
988.3 *11*		17 ps *6*	$T_{1/2}$: RDDS for 521γ (1986KuZW).
1025.9[d] *6*	(7^-)	7.6 ps *2*	$T_{1/2}$: RDDS for 338γ (1986KuZW).
1120.5[a] *5*	$(9)^+$	0.59 ps *6*	$T_{1/2}$: DSA for 432γ (1990Bu07). Other: 0.83 ps *14* (RDDS,1986KuZW).
1338.5[c] *6*	(8^-)	5.5 ps *14*	$T_{1/2}$: from 1983GuZV.
1511.5[&] *5*	$(10)^+$	0.49 ps *6*	$T_{1/2}$: DSA for 823γ (1990Bu07). Other: 0.90 ps *14* (RDDS,1986KuZW).
1610.6?[@] *7*			
1825.9[d] *8*	(9^-)	0.76 ps *21*	$T_{1/2}$: from 1983GuZV.
1993.4[a] *6*	$(11)^+$	0.21 ps *4*	$T_{1/2}$: DSA for 873γ (1990Bu07). Other: 1.1 ps *2* (1983GuZV).
2080.1?[@] *6*			
2197.8?[@] *8*			
2217.9[c] *8*	(10^-)	0.69 ps *21*	$T_{1/2}$: from 1983GuZV.
2577.5? *12*			This level is assigned 12^+ by 1990Bu07 but a 1067.2γ is placed from a 3286 level in 1997Wi01 and 1997Pa35.
2625.5[&] *12*	(12^+)		The 12^+ level is suggested at 2578 by 1990Bu07 on the basis of 1066γ in coin with 823γ. But 1066γ is not confirmed in later studies of 1997Pa35 and 1997Wi01.
3107.4[a] *8*	(13^+)	0.20 ps *2*	$T_{1/2}$: DSA for 1114γ (1990Bu07).
3118.4?[@] *12*			
3835.5? *23*			Level from 1990Bu07 assigned as 14^+ band member but 1258γ is from 4365 level in 1997Pa35.
3999[&] *4*	(14^+)		The 14^+ band member is suggested at 3836 by 1990Bu07 on the basis of a 1258γ in coin with other γ rays in the band, but 1258γ is placed from a 4365 level in 1997Pa35.
4433.4[a] *22*	(15^+)	0.11 ps *3*	$T_{1/2}$: DSA for 1326γ (1990Bu07).
5549[&] *6*	(16^+)		
5929[a] *4*	(17^+)	0.055 ps *28*	$T_{1/2}$: DSA for 1496γ (1990Bu07).
7303?[&] *7*	(18^+)		Jπ: from band assignment.
7584[a] *6*	(19^+)	<0.06 ps	$T_{1/2}$: DSA for 1655γ (1990Bu07).
9414?[a] *8*	(21^+)		

[†] From a least-squares fit to Eγ data, assuming 0.5 keV uncertainty when Eγ is listed to nearest tenth of a keV, 1 keV or larger otherwise.

[‡] From Adopted Levels.

[#] From Recoil-distance Doppler shift (RDDS) and DSA methods (1986KuZW,1983GuZV,1990Bu12), unless otherwise stated.

[@] Level from 1981We07 only. The level is treated as uncertain by evaluators since it is not confirmed in later more detailed studies by 1997Pa35 and 1997Wi01. The deexciting γ shown by 1981We07 is either not seen or assigned to another level in later studies. For this reason this level is not included in Adopted Levels, Gammas dataset.

[&] Band(A): $K^\pi=(4)^+$ band, even spin. Ordering of the 1753γ-1654γ-1550γ-1374γ-1115γ-823γ-331γ-254γ cascade is from 1997Pa35. 1997Wi01 (also 1990Wi02) had a similar cascade, except that 1654γ was not reported by them. The assignment (from 20^+ to 4^+) by 1990Bu07 is defined by a somewhat different cascade: 1753γ-1550γ-1374γ-1258γ-1066γ-823γ-331γ-254γ.

[a] Band(B): $K^\pi=(4)^+$ band, odd spin.

[b] Band(C): $K^\pi=1^-$ band.

[c] Band(D): $K^\pi=(4)^-$ band,α=0.

[d] Band(E): $K^\pi=(4)^-$ band,α=1.

(HI,xnγ) 1990Bu07,1982Do11,1981We07 (continued)

γ(^{76}Br)

γ-ray intensities in ^{48}Ti(^{32}S,n3pγ),E=106 MeV (1990Bu07)

Eγ	Iγ	Eγ	Iγ
391.3	35 *3*	1258	18 *3*
432.3	118 *12*	1326	27 *4*
482	68 *7*	1374	21 *3*
526.0	13 *1*	1496	22 *3*
823.4	132 *13*	1550	12 *3*
873	32 *3*	1655	13 *3*
1066	28 *4*	1753	
1114	100 *10*	1830	8 *3*

γ-ray intensities in ^{75}As(α,3nγ),E=45 MeV (1977Be18)

Eγ	Iγ	Eγ	Iγ
93.1	40 *4*	254.0	15 *2*
111.9	120 *12*	331.1	50 *5*
141.8	185 *19*	349.7	12 *1*
237.9	90 *9*	431.4	80 *8*

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.	α[&]	Comments
45.5[@]		45.5	$(2)^-$	0.0	1^-			
57.11[#] *2*		102.6	$(4)^+$	45.5	$(2)^-$			
72.9[†] *2*	2.7[†] *4*	761.2?		688.3	$(8)^+$			
89.6[@]		301.7	(4^-)	212.2	(3^-)			
93.4[†] *2*	26[†] *2*	688.3	$(8)^+$	594.8	$(7)^+$	M1(+E2)	0.22 *9*	α(K)=0.19 *7*; α(L)=0.024 *11*; α(M)=0.0038 *17* α(N)=0.00034 *14* A_2=−0.23 *4*; A_4=−0.09 *4* (1981We07) A_2=−0.500 *8*; A_4=−0.03 *10* (1977Be18) α value for M1.
104.3[@]		687.7	(6^-)	583.6	(5^-)			
112.0[†] *2*	79[†] *4*	356.9	$(6)^+$	244.8	$(5)^+$	M1+E2	0.12 *4*	α(K)=0.11 *4*; α(L)=0.013 *5*; α(M)=0.0021 *8* α(N)=0.00019 *7* A_2=−0.33 *4*; A_4=−0.04 *4*; pol=+0.51 *18* (1981We07) A_2=−0.38 *3*; A_4=−0.06 *8* (1977Be18) Mult.: from γ(θ,pol). Deduced δ=−0.3 to −2.4 (1981We07).
124.1		425.8		301.7	(4^-)			
142.2[†] *2*	100[†] *5*	244.8	$(5)^+$	102.6	$(4)^+$	M1+E2	0.060 *16*	α(K)=0.053 *14*; α(L)=0.0061 *19*; α(M)=0.0010 *3* α(N)=8.8×10^{-5} *25* A_2=−0.39 *3*; A_4=−0.02 *3*; pol=+0.28 *14* (1981We07) A_2=−0.48 *3*; A_4=0.00 *8* (1977Be18) Mult.: from γ(θ,pol). Deduced δ=−0.2 to −1.8 (1981We07).
151.0[@]		363.2	$(4)^-$	212.2	(3^-)			
165.6[@]		467.3	(5^-)	301.7	(4^-)			
166.8[@]		212.2	(3^-)	45.5	$(2)^-$			

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(HI,xnγ) 1990Bu07,1982Do11,1981We07 (continued)

γ(^{76}Br) (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	α[&]	Comments
199.2[@]		301.7	(4$^-$)	102.6	(4)$^+$				
212.2[@]		212.2	(3$^-$)	0.0	1$^-$				
220.4[a@]		583.6	(5$^-$)	363.2	(4)$^-$				
220.4[a@]		687.7	(6$^-$)	467.3	(5$^-$)				
222.5[@]		467.3	(5$^-$)	244.8	(5)$^+$				
237.9[†] *2*	36[†] *2*	594.8	(7)$^+$	356.9	(6)$^+$	M1+E2	−0.20 *4*	0.0137 *21*	α(K)=0.0121 *18*; α(L)=0.00133 *22*; α(M)=0.00021 *4* α(N)=2.0×10^{-5} *3* A_2=−0.40 *3*; A_4=−0.03 *3*; pol=−0.12 *3* (1981We07) A_2=−0.49 *6*; A_4=+0.04 *1* (1977Be18) Mult.,δ: from γ(θ,pol) (1981We07).
253.9[†] *5*	13.4[†] *7*	356.9	(6)$^+$	102.6	(4)$^+$	E2		0.0286 *5*	α(K)=0.0252 *4*; α(L)=0.00292 *5*; α(M)=0.000462 *8* α(N)=4.15×10^{-5} *7* A_2=+0.17 *6*; A_4=−0.06 *6*; pol=+0.14 *6* (1981We07) A_2=+0.41 *9*; A_4=−0.25 *10* (1977Be18)
312.6[@]		1338.5	(8$^-$)	1025.9	(7$^-$)				
317.8[@]		363.2	(4)$^-$	45.5	(2)$^-$				
331[@]		687.7	(6$^-$)	356.9	(6)$^+$				
331.3[†] *2*	25[†] *2*	688.3	(8)$^+$	356.9	(6)$^+$	E2		0.01131	α(K)=0.00999 *15*; α(L)=0.001124 *16*; α(M)=0.000178 *3* α(N)=1.618×10^{-5} *23* A_2=+0.33 *3*; A_4=−0.05 *3*; pol=+0.43 *6* (1981We07) A_2=+0.33 *8*; A_4=−0.21 *10* (1977Be18)
337.7[@]		1025.9	(7$^-$)	688.3	(8)$^+$				
350.1[†] *2*	4[†] *1*	594.8	(7)$^+$	244.8	(5)$^+$				A_2=−0.20 *15*; A_4=+0.02 *15*; pol=−0.08 *15* (1981We07) γ(θ) data disagree with ΔJ=2, Q transition from DCO in 1997Pa35.
364.6[@]		467.3	(5$^-$)	102.6	(4)$^+$				
371.5[@]		583.6	(5$^-$)	212.2	(3$^-$)				
386.1[@]		687.7	(6$^-$)	301.7	(4$^-$)				
390.9[†] *3*	2.5[†] *2*	1511.5	(10)$^+$	1120.5	(9)$^+$	M1+E2		0.0037 *3*	α(K)=0.00328 *23*; α(L)=0.00035 *3*; α(M)=5.6×10^{-5} *5* α(N)=5.2×10^{-6} *4* A_2=−0.56 *4*; A_4=−0.02 *4* (1981We07) Mult.: from γ(θ,pol). Deduced δ=−0.16 to −1.3 (1981We07).
432.0[†] *2*	14[†] *1*	1120.5	(9)$^+$	688.3	(8)$^+$	M1+E2	−0.29 *9*	0.00288 *17*	α(K)=0.00256 *15*; α(L)=0.000273 *17*; α(M)=4.3×10^{-5} *3* α(N)=4.05×10^{-6} *25* A_2=−0.42 *4*; A_4=−0.09 *4*; pol=−0.06 *5* (1981We07)

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(HI,xnγ) 1990Bu07,1982Do11,1981We07 (continued)

γ(^{76}Br) (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Comments
						A_2=−0.65 *13*; A_4=+0.06 *7* (1977Be18) Mult.,δ: from γ(θ,pol) (1981We07).
442.5[@]		687.7	(6$^-$)	244.8	(5)$^+$	
482.1[†] *5*	4.8[†] *4*	1993.4	(11)$^+$	1511.5	(10)$^+$	
519.4		882.6		363.2	(4)$^-$	E_γ: from 1986KuZW.
520.9		988.3		467.3	(5$^-$)	E_γ: from 1986KuZW.
526.0 *2*	1.3 *2*	1120.5	(9)$^+$	594.8	(7)$^+$	A_2=−0.35 *20*; A_4=+0.16 *20* (1981We07) Eγ from 1990Bu07, Iγ from 1981We07. γ(θ) data disagree with that expected for ΔJ=2 (from ΔJ^π).
558[@]		1025.9	(7$^-$)	467.3	(5$^-$)	
650.3[@]		1338.5	(8$^-$)	688.3	(8)$^+$	
800.0[@]		1825.9	(9$^-$)	1025.9	(7$^-$)	This γ is placed from 1488 to 688 level by 1981We07, but from 1825 level in 1997Pa35.
823.4 *5*	9.5 *20*	1511.5	(10)$^+$	688.3	(8)$^+$	Eγ from 1990Bu07; Iγ from 1981We07.
872.8[†] *3*	0.6[†] *2*	1993.4	(11)$^+$	1120.5	(9)$^+$	A_2=+0.19 *25*; A_4=+0.09 *25* (1981We07) Iγ(873γ)/Iγ(482γ)=0.47 *6* (1990Bu07), 0.12 *4* (1981We07).
879.4[@]		2217.9	(10$^-$)	1338.5	(8$^-$)	
922.3[†] *5*	3.6[†] *4*	1610.6?		688.3	(8)$^+$	
959.6[†] *3*	0.9[†] *3*	2080.1?		1120.5	(9)$^+$	
1066[‡] *1*		2577.5?		1511.5	(10)$^+$	E_γ: this γ is reassigned by 1997Wi01 and 1997Pa35 from a 3286 level. Instead a 497.8γ deexcites a 2579 level in 1997Pa35.
1077.3[†] *6*	0.9[†] *3*	2197.8?		1120.5	(9)$^+$	
1114[@]		2625.5	(12$^+$)	1511.5	(10)$^+$	
1114.0[†] *6*	1.2[†] *3*	3107.4	(13$^+$)	1993.4	(11)$^+$	
1125 *1*		3118.4?		1993.4	(11)$^+$	E_γ: from 1981We07.
1258[‡] *2*		3835.5?		2577.5?		
1326[‡] *2*		4433.4	(15$^+$)	3107.4	(13$^+$)	
1374[‡] *3*		3999	(14$^+$)	2625.5	(12$^+$)	
1496[‡] *3*		5929	(17$^+$)	4433.4	(15$^+$)	
1550[‡] *4*		5549	(16$^+$)	3999	(14$^+$)	
1655[‡] *4*		7584	(19$^+$)	5929	(17$^+$)	
1753[‡b]		7303?	(18$^+$)	5549	(16$^+$)	
1830[‡b] *5*		9414?	(21$^+$)	7584	(19$^+$)	

† From 1981We07.
‡ From 1990Bu07.
# From ^{76}Br IT decay.
@ From 1982Do11.
& 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.
b Placement of transition in the level scheme is uncertain.

(HI,xnγ) 1990Bu07,1982Do11,1981We07

Level Scheme

Intensities: Relative I_γ

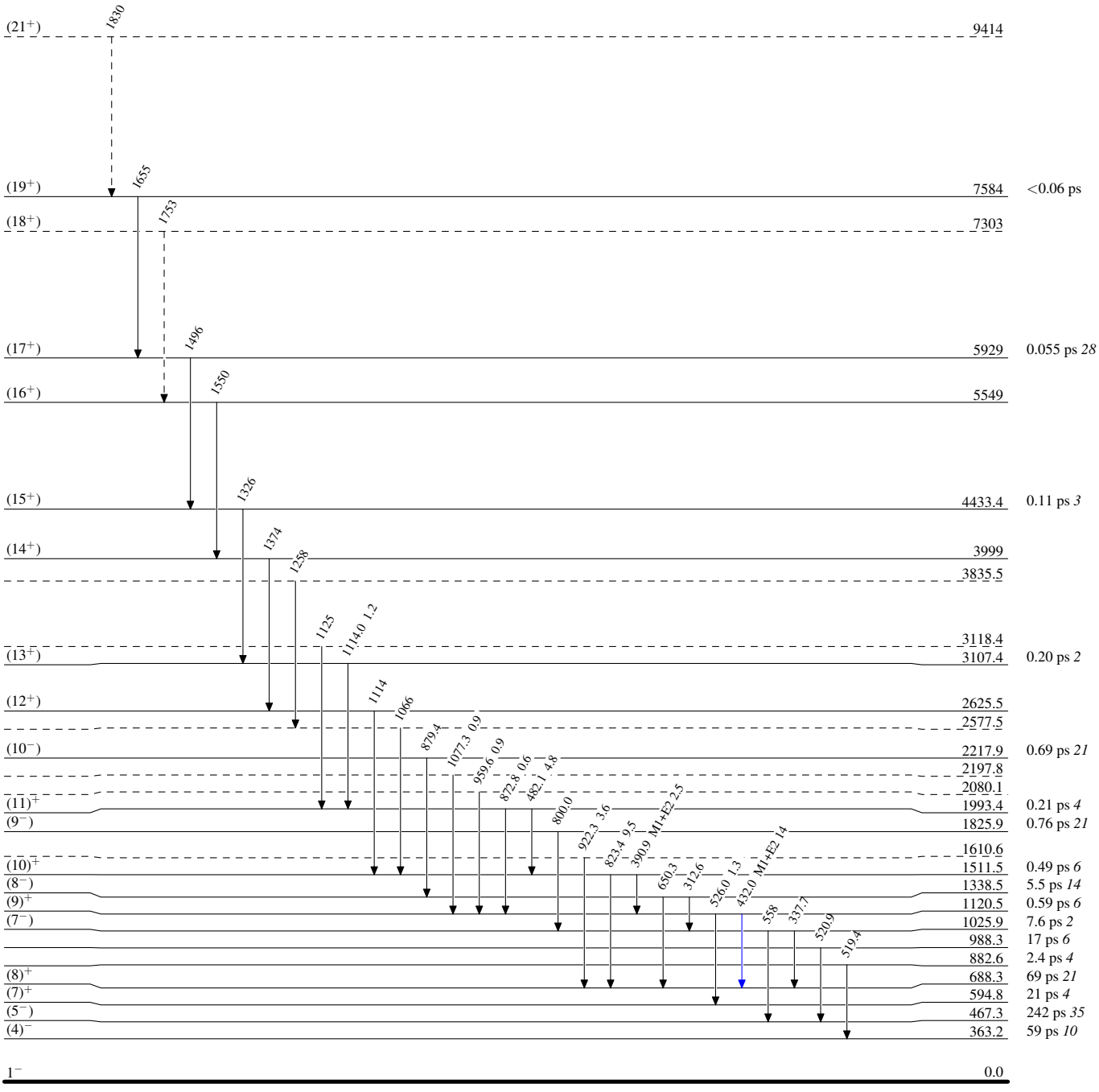
Legend

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

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

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

γ Decay (Uncertain)

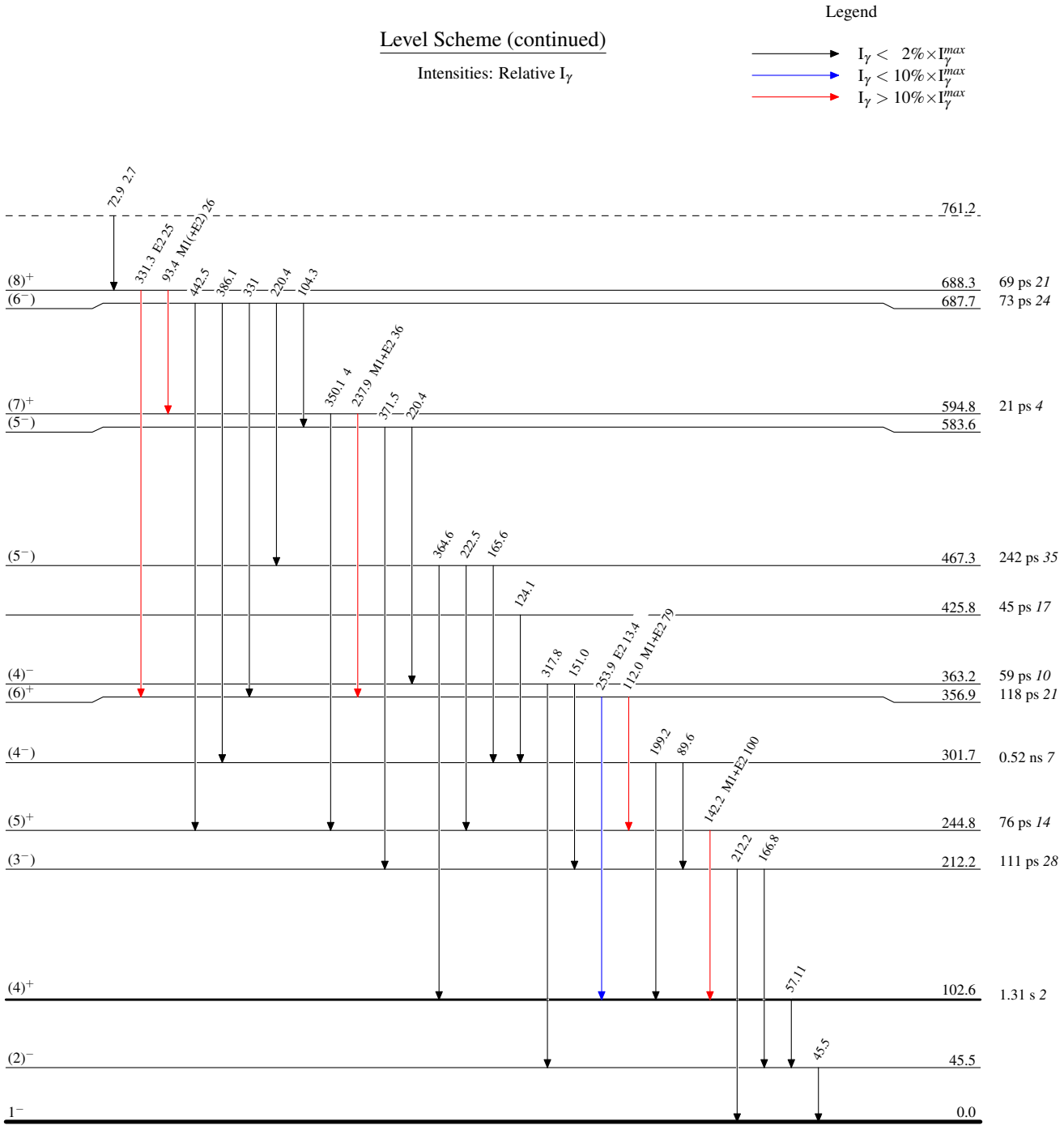


$^{76}_{35}Br_{41}$

(HI,xnγ) 1990Bu07,1982Do11,1981We07

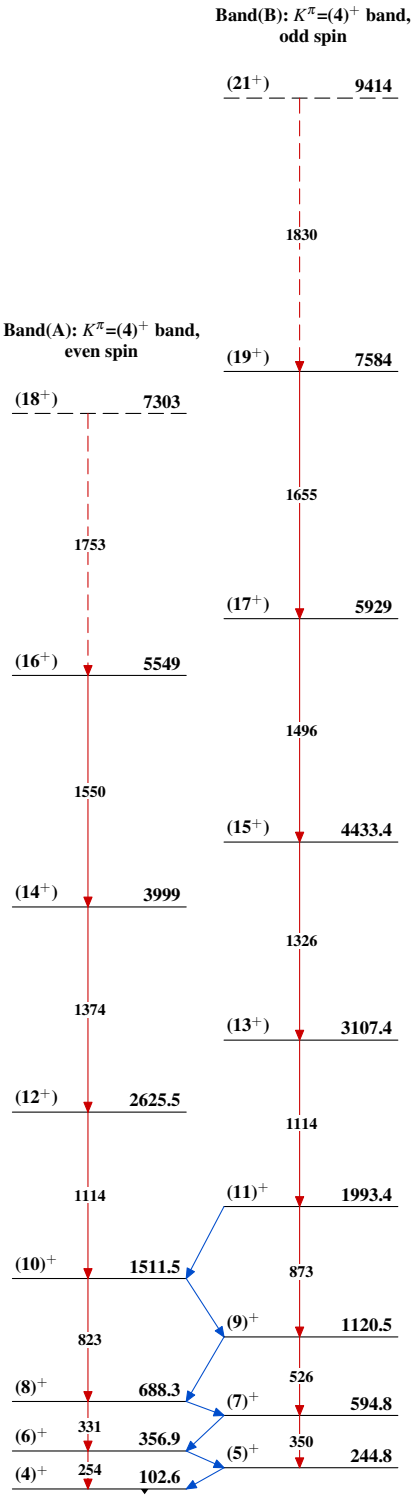
Level Scheme (continued)

Intensities: Relative I_γ



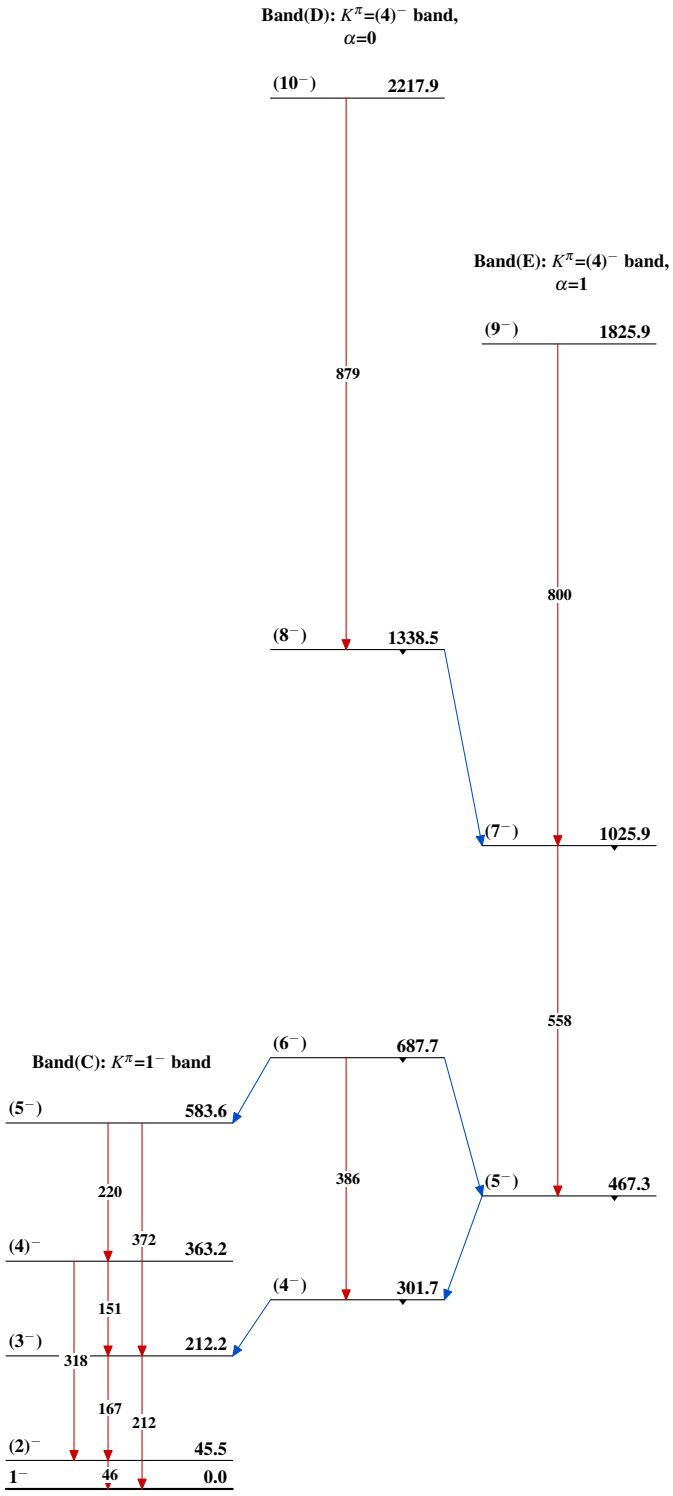
$^{76}_{35}Br_{41}$

(HI,xnγ) 1990Bu07,1982Do11,1981We07



$^{76}_{35}Br_{41}$

(HI,xnγ) 1990Bu07,1982Do11,1981We07 (continued)



$^{76}_{35}Br_{41}$