(HI,xnγ) 2001Id01,2004To07,1976Na15

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 140 1, (2017)	30-Sep-2015

Includes reactions ^{28}Si(^{24}Mg,3$\alpha\gamma$); ^{28}Si(^{20}Ne,2$\alpha\gamma$); ^{28}Si(^{14}N,pnγ); ^{27}Al(^{19}F,α2nγ); ^{27}Al(^{16}O,p2nγ); ^{27}Al(^{14}N,nγ); ^{24}Mg(^{24}Mg,2$\alpha\gamma$); ^{24}Mg(^{19}F,p2nγ); ^{36}Ar(^{16}O,^{12}Cγ).

2001Id01: ^{28}Si(^{20}Ne,2$\alpha\gamma$) E=84 MeV ^{20}Ne beam was produced from the Argonne ATLAS accelerator. Target was a 0.45 mg/cm^2 ^{28}Si evaporated onto a 1.0 mg/cm^2 Ta foil. Charged particles were detected with the MICROBALL 4π array of 95 CsI(Tl) scintillation counters and γ rays were detected with the GAMMASPHERE array of 101 Compton-suppressed Ge detectors. Measured Eγ, $\gamma\gamma$, $\gamma\alpha$ coin, $\gamma(\theta)$, Doppler-shift attenuation. Deduced levels, J, π, lifetimes, quadrupole moment, deformation parameter.

2004To07: ^{28}Si(^{24}Mg,3$\alpha\gamma$): E=139 MeV ^{24}Mg beam was produced at INFN. Charged particles were detected with the silicon telescope array ISIS and γ rays were detected with the GASP array. Measured Eγ, Iγ, $\gamma\gamma$, $\gamma\gamma(\theta)$(DCO).Deduced levels, J, π, negative parity bands . Comparisons with shell-model calculations.

1976Na15: ^{28}Si(^{14}N,pnγ) E=36 MeV. Measured γ, $\gamma\gamma$, nγ coin, $\gamma\gamma(\theta)$, lifetimes by DSA and recoil-distance methods.

1975Si12: ^{28}Si(^{14}N,pnγ) E=34 MeV. Measured $\gamma(\theta)$, $\gamma\gamma(\theta)$.

2003Ch22: ^{24}Mg(^{24}Mg,2$\alpha\gamma$) E=92 MeV. Measured Eγ, Iγ, $\gamma\gamma$, lifetimes using Doppler-shift attenuation analyses; deduced transition quadrupole moments for SD band.

Others:

1976Po03: ^{27}Al(^{19}F,α2nγ) E=40 MeV. Measured $\gamma\gamma$, lifetimes by recoil-distance method.

1974Wa07: ^{24}Mg(^{19}F,p2nγ) E=20-45 MeV; ^{27}Al(^{16}O,p2nγ) E=20-45 MeV; ^{27}Al(^{14}N,nγ) E=20-45 MeV. Measured γ.

1973Te04: ^{36}Ar(^{16}O,^{12}Cγ) E=58 MeV. Measured (^{12}C)γ coin. Three levels reported: g.s., 3904, 5278. 1973Te04 report data mostly from (p,p$'\gamma$) and (^{3}He,dγ).

Additional information 1.

^{40}Ca Levels

E(level)[†]	J$^\pi$[‡]	T$_{1/2}$	Comments
0	0$^+$		
3351.2[@] *11*	0$^+$		
3736.3 *3*	3$^-$		
3904.3[@] *3*	2$^+$		
4491.1 *4*	5$^-$	0.38 ns *8*	T$_{1/2}$: from recoil-distance method (1976Po03).
5211.4[c] *11*	0$^+$		
5248.3 *6*	2$^+$		
5278.6[@] *4*	4$^+$		
5613.0 *7*	4$^-$		
5629.9[c] *8*	2$^+$		
6029.2[a] *9*	3$^+$		
6508.3 *12*	4$^+$		
6543.3[c] *7*	4$^+$		
6931.2[@] *7*	6$^+$	0.34 ps *+9−17*	T$_{1/2}$: from DSA (1976Na15).
7398.2[a] *8*	(5$^+$)		E(level),J$^\pi$: 2004To07 propose this level as the 5$^-$ member of negative-parity band, based on systematics. These authors do not find any feeding transition to this level.
7676.3 *8*	(6$^+$)		
7974.8[c] *8*	(6$^+$)		
8100.1[&] *7*	8$^+$	12.5 ps *17*	T$_{1/2}$: recoil-distance method (1976Na15).
8700.7[#] *9*	(6$^-$)		
8935.6[a] *9*	(7$^+$)		
9033.4[#b] *11*	(7$^-$)		
9304.9[@] *8*	(8$^+$)		
9854.4[c] *8*	(8$^+$)		

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(HI,xnγ) 2001Id01,2004To07,1976Na15 (continued)

^{40}Ca Levels (continued)

E(level)[†]	Jπ[‡]	Comments
10473.8[#] *13*	(8⁻)	
10895.4[#b] *15*	(9⁻)	
11002.7[&] *9*	(10⁺)	
11685.7[@] *9*	(10⁺)	
11708.5[a] *12*	(9⁺)	
12336.3[c] *10*	(10⁺)	
12591.7 *10*	(10⁺)	
12923.5[#b] *18*	(11⁻)	
13114.8[&] *10*	(12⁺)	
13195.5[#] *18*	(10⁻)	
13535.3[a] *13*	(11⁺)	
14231.8[@] *11*	(12⁺)	
15152.1[&] *13*	(13⁺)	Jπ: 14⁺ in figure 5 of 2004To07.
15269.4[c] *14*	(12⁺)	
15306.6[#b] *21*	(13⁻)	
15747.9 *14*	(12⁺)	
16528.9[@] *12*	(14⁺)	
16579.4[a] *17*	(13⁺)	
17698.0 *15*	(14⁺)	
18054.0 *15*	(14⁺)	
18215?[#b]	(15⁻)	
18499.6[c] *18*	(14⁺)	
18723.6[c] *18*	(14⁺)	
19195.3[&] *16*	(15⁺)	
20579.2[@] *16*	(16⁺)	
22062.7[c] *20*	(16⁺)	

[†] From least-squares fit to γ-ray energies, assuming 1 keV uncertainty when not stated.

[‡] As proposed by 2001Id01, 2003Ch22 and 2004To07. For low-spin levels (J<6), assignments are from Adopted Levels; higher spins are from deduced multipolarities based on angular correlation data and band assignments, the parentheses are added by the evaluator.

[#] From 2004To07.

[@] Band(A): 4p-4h, 0⁺ band. Q(intrinsic)=0.74 *14* from lifetime data corresponding to $\beta_2 \approx 0.27$.

[&] Band(B): Yrast band.

[a] Band(C): 3⁺ band.

[b] Band(D): $K^\pi=0^-$ band (2004To07). 2004To07 propose this band as a partner of 4p-4h band based on 3353,0⁺ state; the 1⁻, 3⁻ and 5⁻ members of this band are proposed at 5902, 1⁻; 6280, 3⁻ or 6580, 3⁻; and 7399, (5⁻), respectively. The 5902, 6280 and 6580 levels are seen in other reaction.

[c] Band(E): SD band (2001Id01,2003Ch22). Q(transition)=1.30 *15* for one value assumed over the whole band. For separated fits for high-spin and low-spin states, Q(transition)=1.81 *+46−33* and Q(transition)=1.18 *+14*, respectively (2003Ch22). Corresponding β_2=0.59 *+13−9* for high-spin and 0.40 *4* for low-spin states. Q(transition)=1.80 *+39−29* from lifetime data (2001Id01), corresponding to β_2=0.59 *+11−7*. Configuration=8p−8h defined by $\pi 3^4 \nu 3^4$, where superscripts are the number of protons and neutrons occupying the N=3 ($f_{7/2}$) intruder orbital.

(HI,xnγ) 2001Id01,2004To07,1976Na15 (continued)

γ(^{40}Ca)

E_γ [†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	Comments
553	3904.3	2^+	3351.2	0^+		
754.8[#] *2*	4491.1	5^-	3736.3	3^-	E2	A_2=+0.217 *5*, A_4=−0.106 *6*, affected by contamination (1975Si12). DCO=1.29 *15* (1975Si12), 1.0 *2* (2004To07).
781	6029.2	3^+	5248.3	2^+		
787[a]	5278.6	4^+	4491.1	5^-		
914	6543.3	4^+	5629.9	2^+		
1122[@]	5613.0	4^-	4491.1	5^-		E_γ: also seen in 2004To07.
1168.8 *3*	8100.1	8^+	6931.2	6^+	E2	E_γ: weighted average of 1168.7 *3* (1975Si12) and 1168.9 *4* (1976Na15). A_2=+0.29 *7*, A_4=−0.01 *8* (1975Si12); A_2=+0.39 *7* (A_4=−0.075 assumed) (1976Na15). DCO=0.84 *27*, 1.4 *4* (1975Si12); 0.95 *14*, 1.09 *14*, 1.07 *18* (1976Na15).
1260	6508.3	4^+	5248.3	2^+		
1295	6543.3	4^+	5248.3	2^+	(Q)	
1343	5248.3	2^+	3904.3	2^+		
1369	7398.2	(5^+)	6029.2	3^+	(Q)	
1374.30 *20*	5278.6	4^+	3904.3	2^+	Q	E_γ: weighted average of 1374.3 *3* (1975Si12) and 1374.30 *20* (1976Na15). A_2=+0.41 *5* (A_4=−0.075 assumed) (1976Na15). DCO=1.00 *16* (1976Na15).
1429	13114.8	(12^+)	11685.7	(10^+)	(Q)	
1432	7974.8	(6^+)	6543.3	4^+	(Q)	
1538	8935.6	(7^+)	7398.2	(5^+)	(Q)	
1617	15152.1	(13^+)	13535.3	(11^+)	(Q)	
1629	9304.9	(8^+)	7676.3	(6^+)	(Q)	Additional information 7.
1651.9 *7*	6931.2	6^+	5278.6	4^+	E2	E_γ: weighted average of 1651.0 *5* (1975Si12) and 1652.4 *4* (1976Na15). Additional information 5. A_2=+0.27 *7* (A_4=−0.075 assumed) (1976Na15). DCO=0.82 *24* (1975Si12), 1.17 *20*, 1.58 *25* (1976Na15).
1698	11002.7	(10^+)	9304.9	(8^+)	(Q)	
1773[&]	10473.8	(8^-)	8700.7	(6^-)		
1827	13535.3	(11^+)	11708.5	(9^+)	(Q)	
1862[&]	10895.4	(9^-)	9033.4	(7^-)	(Q)	DCO=1.2 *4* (2004To07).
1877[@]	5613.0	4^-	3736.3	3^-		
1880	9854.4	(8^+)	7974.8	(6^+)	(Q)	
2004	8935.6	(7^+)	6931.2	6^+	(D)	
2028[&]	12923.5	(11^-)	10895.4	(9^-)		DCO=0.4 *3* (2004To07).
2037	15152.1	(13^+)	13114.8	(12^+)	(D)	
2112	13114.8	(12^+)	11002.7	(10^+)	(Q)	
2120	7398.2	(5^+)	5278.6	4^+	(D)	
2178	9854.4	(8^+)	7676.3	(6^+)	(Q)	Additional information 9.
2297	16528.9	(14^+)	14231.8	(12^+)	(Q)	
2300[&]	13195.5	(10^-)	10895.4	(9^-)		
2374	9304.9	(8^+)	6931.2	6^+	(Q)	Additional information 8.
2381	11685.7	(10^+)	9304.9	(8^+)	(Q)	
2383[&]	15306.6	(13^-)	12923.5	(11^-)		DCO=1.2 *6* (2004To07).
2398	7676.3	(6^+)	5278.6	4^+	(Q)	
2482	12336.3	(10^+)	9854.4	(8^+)	(Q)	Additional information 11.
2546	14231.8	(12^+)	11685.7	(10^+)	(Q)	Additional information 13.
2639	6543.3	4^+	3904.3	2^+	(Q)	Additional information 4.
2696	7974.8	(6^+)	5278.6	4^+	(Q)	Additional information 6.

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(HI,xnγ) 2001Id01,2004To07,1976Na15 (continued)

γ(^{40}Ca) (continued)

E_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	Comments
2773	11708.5	(9^+)	8935.6	(7^+)	(Q)	
2902	11002.7	(10^+)	8100.1	8^+	(Q)	
2909[&][a]	18215?	(15^-)	15306.6	(13^-)		
2923	9854.4	(8^+)	6931.2	6^+	(Q)	Additional information 10.
2933	15269.4	(12^+)	12336.3	(10^+)	(Q)	Additional information 14.
3031	12336.3	(10^+)	9304.9	(8^+)	(Q)	Additional information 12.
3044	16579.4	(13^+)	13535.3	(11^+)	(Q)	
3088[&]	8700.7	(6^-)	5613.0	4^-		
3156	15747.9	(12^+)	12591.7	(10^+)	(Q)	
3229	14231.8	(12^+)	11002.7	(10^+)	(Q)	
3230	18499.6	(14^+)	15269.4	(12^+)	(Q)	
3287	12591.7	(10^+)	9304.9	(8^+)	(Q)	
3414	16528.9	(14^+)	13114.8	(12^+)	(Q)	
3454	18723.6	(14^+)	15269.4	(12^+)	(Q)	Additional information 15.
3466	17698.0	(14^+)	14231.8	(12^+)	(Q)	
3563	22062.7	(16^+)	18499.6	(14^+)	(Q)	
3585	11685.7	(10^+)	8100.1	8^+	(Q)	
3736.1[#] *3*	3736.3	3^-	0	0^+	E3	A_2=+0.34 *2*; A_4=+0.005 *18* (1975Si12) Mult.: from Adopted Gammas. DCO=1.5 *5* (2004To07).
3822	18054.0	(14^+)	14231.8	(12^+)	(Q)	
3903.9 *3*	3904.3	2^+	0	0^+	Q	A_2=+0.15 *4*; A_4=−0.10 *5* (1975Si12) E_γ: weighted average of 3904.0 *3* (1975Si12) and 3903.7 *4* (1976Na15). Additional information 2. A_2=+0.41 *7* (A_4=−0.075 assumed) (1976Na15).
4043	19195.3	(15^+)	15152.1	(13^+)	(Q)	
4050	20579.2	(16^+)	16528.9	(14^+)	(Q)	Additional information 16.
4209[&]	8700.7	(6^-)	4491.1	5^-		
4491	12591.7	(10^+)	8100.1	8^+	(Q)	
4542[&]	9033.4	(7^-)	4491.1	5^-		
5249	5248.3	2^+	0	0^+		
5630	5629.9	2^+	0	0^+		Additional information 3.

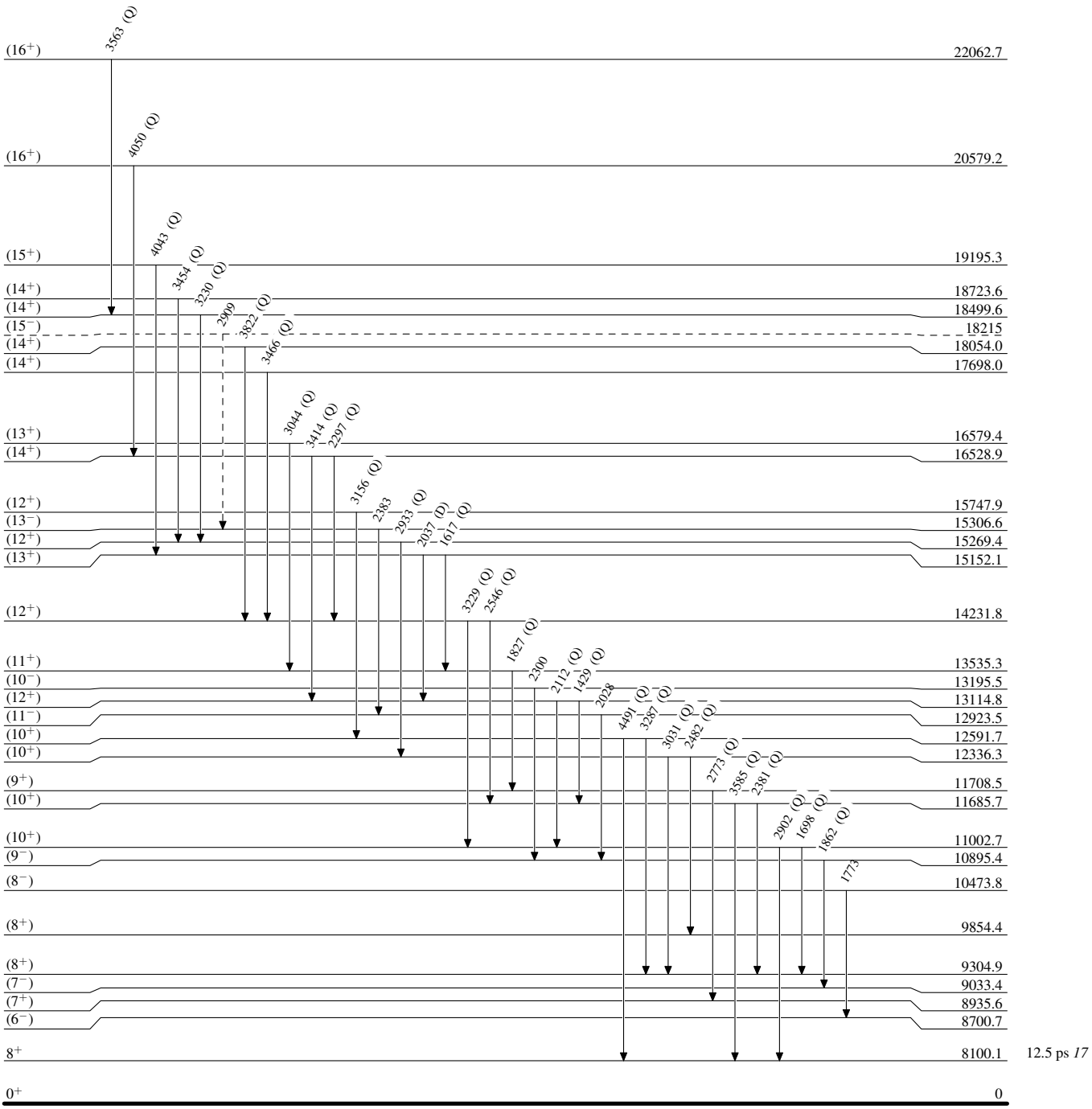
[†] From 2001Id01, unless otherwise stated.
[‡] Deduced based on measured γ(θ) and γγ(DCO) as well as RUL of measured half-lives. The authors 2001Id01 state that γ(θ) data are consistent with stretched quadrupole transitions (assumed as ΔJ=2, E2) for most γ rays, except for 2004, 2037 and 2120 which are assigned as ΔJ=1, dipole. Results of γ(θ) measurements are not quoted in 2001Id01.
[#] From 1974Wa07.
[@] From 1976Na15.
[&] From 2004To07.
[a] Placement of transition in the level scheme is uncertain.

Legend

(HI,xnγ) 2001Id01,2004To07,1976Na15

Level Scheme

γ Decay (Uncertain)



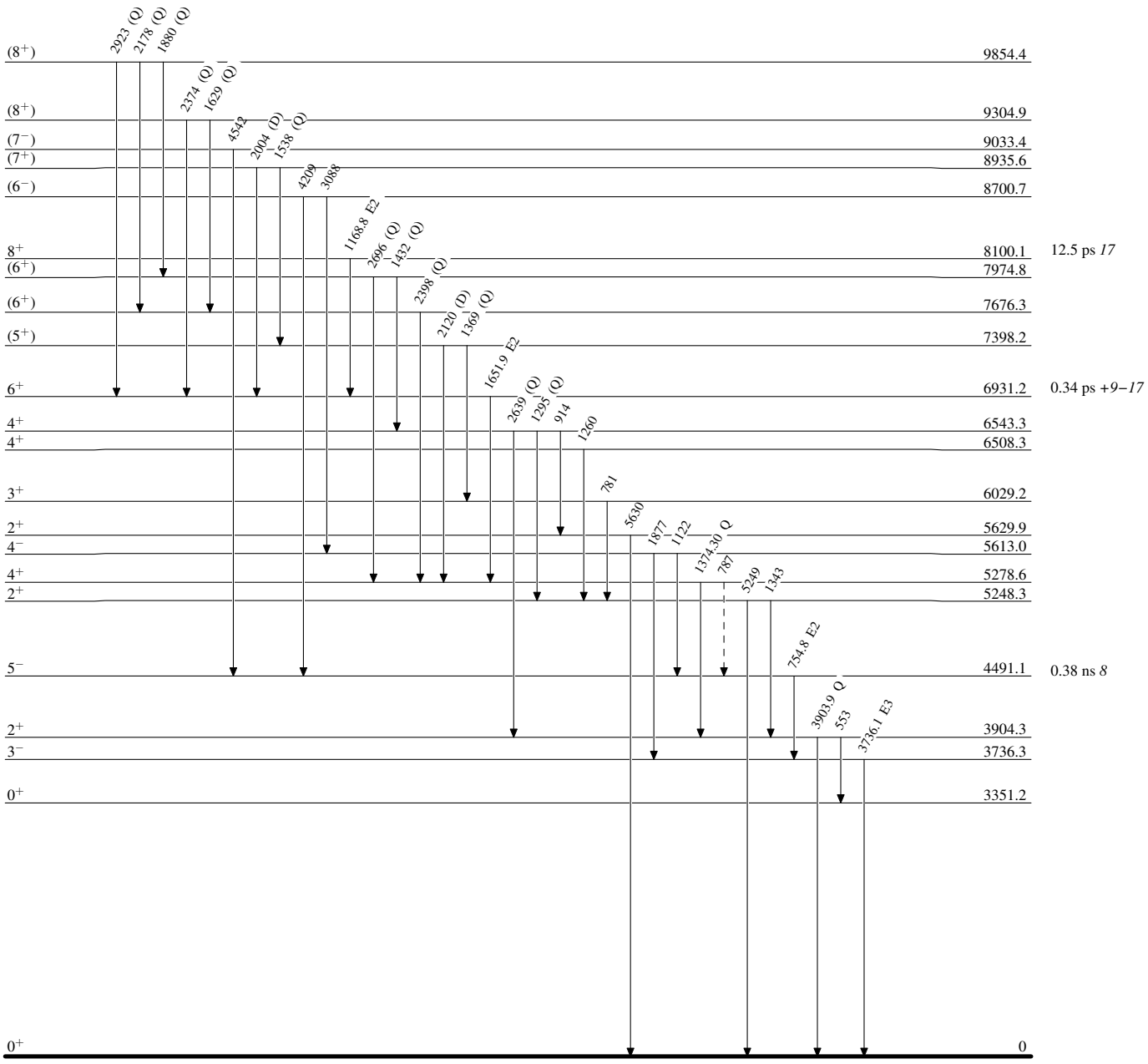
$^{40}_{20}Ca_{20}$

(HI,xnγ) 2001Id01,2004To07,1976Na15

Legend

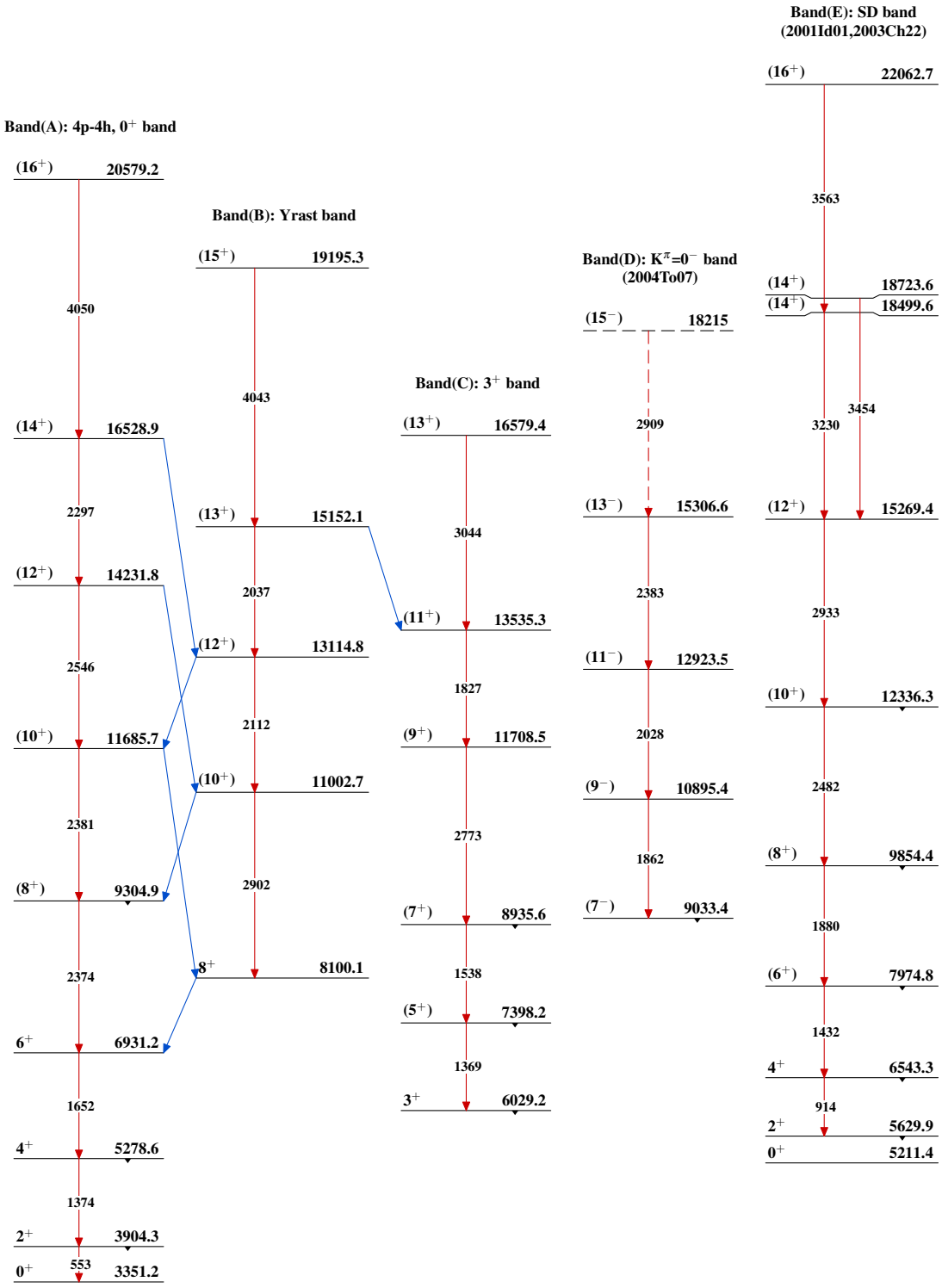
Level Scheme (continued)

γ Decay (Uncertain)



$^{40}_{20}Ca_{20}$

(HI,xnγ) 2001Id01,2004To07,1976Na15



$^{40}_{20}Ca_{20}$