^{72}Ge(^{35}Cl,αp2nγ) 2001Zh26,2001ZhZR

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 172, 1 (2021)	31-Jan-2021

Includes ^{75}As(^{31}P,2p4nγ)^{100}Pd, where level lifetimes were measured for four levels in the band based on 9$^-$.

2001Zh26: E=135 MeV ^{35}Cl beam was produced from the ATLAS accelerator at ANL. Target was 1 mg/cm^2 ^{72}Ge evaporated on a 15 mg/cm^2 gold foil. γ rays were detected with the Gammasphere array consisting of 101 Compton-suppressed Ge. Measured Eγ, Iγ, $\gamma\gamma$-coin, $\gamma\gamma(\theta)$(DCO). Deduced evidence of anti-magnetic rotation. Deduced levels, J, π, band structure, γ-ray multipolarities. Comparisons with theoretical calculations.

Detailed data quoted here are from private communication (2001ZhZR) received by B. Singh on Oct 3, 2001 from the authors (S. Zhu and U. Garg) of 2001Zh26.

2020Si20: ^{75}As(^{31}P,2p4nγ),E(^{31}P)=125 MeV. Measured level lifetimes of four levels in the band based on 9$^-$ using DSAM method. Measurements were made using the INGA array of 21 Compton-suppressed clover Ge detectors at the Pelletron-LINAC facility of TIFR-Mimbai.

^{100}Pd Levels

E(level)[†]	J$^\pi$[@]
0.0[e]	0$^+$
665.0[e] 5	2$^+$
1414.9[e] 7	4$^+$
2054.3[g] 8	(4$^-$)
2187.8[e] 8	6$^+$
2467.8 8	(6$^+$)
2503.8[h] 8	5$^-$
2985.8[e] 9	8$^+$
3020.2[g] 9	(6$^-$)
3175.8 8	8$^+$[&]
3229.6[h] 8	7$^-$
3437.8 9	(8$^+$)
3866.8[e] 9	10$^+$
3877.2[g] 9	(8$^-$)
4051.7[f] 9	9$^-$
4090.9[h] 9	9$^-$
4142.7[j] 9	(10$^+$)
4630.9[g] 10	(10$^-$)
4758.4[e] 9	12$^+$
4776.1[j] 9	(11$^+$)
4860.8[f] 9	11$^-$
4923.2 9	12$^{(+)}$
4943.9[h] 10	11$^-$
5074.6[j] 9	(12$^+$)
5449.0[j] 9	13$^{(+)}$
5569.9[g] 10	(12$^-$)
5665.8[f] 9	13$^-$
5702.7[e] 9	14$^+$
5915.2[j] 9	14$^{(+)}$
6065.9[h] 11	(13$^-$)
6131.0 10	14$^{(+)}$
6455.0[j] 10	15$^{(+)}$
6685.9[g] 12	(14$^-$)

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^{72}Ge(^{35}Cl,αp2nγ) 2001Zh26,2001ZhZR (continued)

^{100}Pd Levels (continued)

E(level)[†]	J$^{\pi}$[@]	T$_{1/2}$[d]	Comments
6700.9[f] *10*	15$^-$	0.90 ps *10*	T$_{1/2}$: DSAM for 1035γ (2020Si20).
6934.2[j] *10*	16$^{(+)}$		
7081.7[l] *10*	(15$^+$)[a]		
7271.1 *10*	(16$^+$)		
7338.2[l] *10*	(16$^+$)		
7640.6[#] *10*	17$^-$	0.55 ps *7*	T$_{1/2}$: DSAM for 940γ (2020Si20).
7830.9[l] *10*	(17$^+$)		
7965.2[j] *11*	(17$^+$)[b]		
8298.6[l] *10*	(18$^+$)		
8560.6 *11*	19$^{(-)}$		
8711.6[#] *11*	19$^-$	0.42 ps *5*	T$_{1/2}$: DSAM for 1071γ (2020Si20).
9384.2[j] *12*	(18$^+$)[c]		
9684.6[l] *11*	(19$^+$)[c]		
10099.6[#] *12*	21$^-$	<0.15 ps	T$_{1/2}$: effective half-life=0.15 ps from DSAM for 1388γ (2020Si20), assuming 100% side feeding.
10447.6[k] *11*	20$^{(+)}$		
10709.3?[‡][i] *13*	22$^{(-)}$		
11647.6[k] *12*	21$^{(+)}$		
11681.6[#] *13*	(23$^-$)		
11815.9[i] *13*	23$^{(-)}$		
13157.6?[‡][k] *13*	22$^{(+)}$		
13200.0[i] *14*	25$^{(-)}$		
13433.6[#] *14*	(25$^-$)		
14451.0?[‡] *14*			
15009.3[k] *14*			

[†] From least-squares fit to Eγ data, assigning ΔEγ=0.5 keV for each γ ray as suggested by 2001Zh26.
[‡] Level not supported in other reactions (2001Pe05 and/or 2000ApZY). The deexciting γ ray is placed differently in other reactions and in the Adopted Levels, Gammas.
[#] Antimagnetic-rotational structure suggested (2001Zh26).
[@] As proposed by 2001Zh26 based on $\gamma\gamma(\theta)$(DCO) data and band assignments. The assignments in the Adopted Levels are the same in most cases, except that many are placed in parentheses there, and in some cases the level energies differ due to reordering of the $\gamma\gamma$ cascades.
[&] From the Adopted Levels. 2001Zh26 propose 8$^-$.
[a] (16$^+$) in the Adopted Levels.
[b] (18$^+$) in the Adopted Levels.
[c] (20$^+$) in the Adopted Levels.
[d] From DSAM (2020Si20).
[e] Band(A): g.s. band.
[f] Band(B): Band based on 9$^-$. 2001Zh26 propose antimagnetic rotational structure for the band members above 17$^-$: 1071-1388-1582-1752 cascade. This assignment is based on their cranked shell-model calculations and spectroscopic properties.
[g] Band(C): Band based on (4$^-$).
[h] Band(c): Band based on 5$^-$.
[i] Seq.(D): γ cascade based on 22$^{(-)}$.
[j] Seq.(E): γ cascade based on (10$^+$).
[k] Seq.(F): γ cascade based on 20$^{(+)}$.
[l] Seq.(G): γ cascade based on (15$^+$).

^{72}Ge(^{35}Cl,αp2nγ) 2001Zh26,2001ZhZR (continued)

$\gamma(^{100}Pd)$

DCO values are for 32° (or 147°) and 37° (or 143°) with gates on ΔJ=2, quadrupole transitions. The values are from 2001ZhZR. Expected DCO≈1.0 for ΔJ=2, quadrupole transitions and ≈0.5 for ΔJ=1, dipole transitions with gate on quadrupole transitions.

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult. @	Comments
190.0 *5*	10.5 *5*	3175.8	8^+	2985.8	8^+		DCO=6.3 *11* Additional information 6.
209.0 *5*	0.8 *2*	3229.6	7^-	3020.2	(6^-)		
214.0 *5*	0.3 *1*	4090.9	9^-	3877.2	(8^-)		
254.0 *5*		5702.7	14^+	5449.0	$13^{(+)}$		
256.0‡ *5*	0.5 *2*	7338.2	(16^+)	7081.7	(15^+)		
262.0 *5*	1.8 *2*	3437.8	(8^+)	3175.8	8^+		Additional information 9.
276.0 *5*	2.8 *3*	4142.7	(10^+)	3866.8	10^+	D+Q&	DCO=2.8 *4* Additional information 15.
280.0 *5*	2.3 *2*	2467.8	(6^+)	2187.8	6^+	D+Q&	DCO=2.2 *3*
298.0 *5*	3.7 *4*	5074.6	(12^+)	4776.1	(11^+)		Additional information 20.
302.0‡ *5*		7640.6	17^-	7338.2	(16^+)		
312.0 *5*	0.3 *1*	4943.9	11^-	4630.9	(10^-)		
324.0 *5*		6455.0	$15^{(+)}$	6131.0	$14^{(+)}$		
370.0‡ *5*		7640.6	17^-	7271.1	(16^+)		
374.0 *5*	1.7 *2*	5449.0	$13^{(+)}$	5074.6	(12^+)		
449.0 *5*	1.1 *1*	2503.8	5^-	2054.3	(4^-)		
466.0 *5*	4.8 *5*	5915.2	$14^{(+)}$	5449.0	$13^{(+)}$	D	DCO=0.5 *1* Additional information 25.
468.0‡ *5*		8298.6	(18^+)	7830.9	(17^+)		
479.0 *5*	4.7 *5*	6934.2	$16^{(+)}$	6455.0	$15^{(+)}$	D	DCO=0.5 *1* Additional information 29.
492.0 *5*	0.5 *2*	7830.9	(17^+)	7338.2	(16^+)		
516.0 *5*	1.2 *1*	3020.2	(6^-)	2503.8	5^-		
526.0 *5*	0.5 *1*	5449.0	$13^{(+)}$	4923.2	$12^{(+)}$		
540.0 *5*	0.7 *1*	4630.9	(10^-)	4090.9	9^-		
540.0 *5*	1.4 *1*	6455.0	$15^{(+)}$	5915.2	$14^{(+)}$		DCO<0.5
558.0 *5*		15009.3		14451.0?			E_γ: placement from 13504, (24^+) level in the Adopted Levels, Gammas.
570.0‡ *5*	0.1 *1*	6700.9	15^-	6131.0	$14^{(+)}$		
591.0 *5*	0.8 *2*	5665.8	13^-	5074.6	(12^+)		
609.0# *5*	1.0 *1*	10709.3?	$22^{(-)}$	10099.6	21^-	D	DCO=0.5 *1* E_γ: placement from 11821, (23^-) level in the Adopted Levels, Gammas.
614.0 *5*	1.1 *1*	4051.7	9^-	3437.8	(8^+)		
616.0 *5*	0.6 *1*	4758.4	12^+	4142.7	(10^+)		
626.0 *5*	0.6 *1*	5569.9	(12^-)	4943.9	11^-		
633.0 *5*	0.6 *1*	4776.1	(11^+)	4142.7	(10^+)	D	DCO<0.5
639.0 *5*	1.2 *1*	2054.3	(4^-)	1414.9	4^+		DCO>10.
648.0 *5*	0.3 *1*	3877.2	(8^-)	3229.6	7^-		
665.0 *5*	100 *5*	665.0	2^+	0.0	0^+	Q	DCO=1.1 *2* Additional information 1.
682.0 *5*	1.7 *2*	6131.0	$14^{(+)}$	5449.0	$13^{(+)}$	D	DCO=0.5 *1* Additional information 27.
691.0 *5*	6.6 *7*	5449.0	$13^{(+)}$	4758.4	12^+	D	DCO=0.5 *1* Additional information 21.
706.0 *5*	1.9 *2*	7640.6	17^-	6934.2	$16^{(+)}$		Additional information 30.
708.0 *5*	0.6 *1*	3175.8	8^+	2467.8	(6^+)		

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^{72}Ge(^{35}Cl,αp2nγ) 2001Zh26,2001ZhZR (continued)

$\gamma(^{100}Pd)$ (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult. @	Comments
718.0 *5*	0.7 *1*	4860.8	11^-	4142.7	(10^+)		
726.0 *5*	8.4 *8*	3229.6	7^-	2503.8	5^-	Q	DCO=1.0 *3* Additional information 8.
742.0‡ *5*	0.4 *2*	5665.8	13^-	4923.2	$12^{(+)}$		
750.0 *5*	88 *4*	1414.9	4^+	665.0	2^+	Q	DCO=1.0 *2* Additional information 2.
753.0 *5*	6.2 *9*	6455.0	$15^{(+)}$	5702.7	14^+		
770.0 *5*	1.0 *1*	4860.8	11^-	4090.9	9^-		
773.0 *5*	68 *3*	2187.8	6^+	1414.9	4^+	Q	DCO=1.1 *2* Additional information 3.
786.0 *5*	1.0 *1*	6700.9	15^-	5915.2	$14^{(+)}$		
798.0 *5*	51.6 *25*	2985.8	8^+	2187.8	6^+	Q	DCO=1.1 *2* Additional information 5.
805.0 *5*	27.4 *14*	5665.8	13^-	4860.8	11^-	Q	DCO=1.1 *2* Additional information 23.
809.0 *5*	23.2 *12*	4860.8	11^-	4051.7	9^-	Q	DCO=1.1 *2* Additional information 17.
816.0‡ *5*	0.7 *3*	7271.1	(16^+)	6455.0	$15^{(+)}$		
822.0 *5*	5.0 *5*	4051.7	9^-	3229.6	7^-	Q	DCO=1.0 *3* Additional information 12.
853.0 *5*	1.9 *2*	4943.9	11^-	4090.9	9^-	Q	DCO=1.0 *4* Additional information 19.
861.0 *5*	5.3 *5*	4090.9	9^-	3229.6	7^-	Q	DCO=0.9 *3* Additional information 14.
876.0 *5*	18.2 *9*	4051.7	9^-	3175.8	8^+	D	DCO=0.5 *1* Additional information 13.
881.0 *5*	37.7 *19*	3866.8	10^+	2985.8	8^+	Q	DCO=1.1 *2* Additional information 11.
892.0 *5*	26.7 *13*	4758.4	12^+	3866.8	10^+	Q	DCO=1.0 *2* Additional information 16.
908.0 *5*	1.5 *3*	5665.8	13^-	4758.4	12^+		
909.0 *5*	0.5 *1*	4776.1	(11^+)	3866.8	10^+		
920.0‡ *5*	0.4 *1*	8560.6	$19^{(-)}$	7640.6	17^-	Q	DCO=0.9 *3*
932.0 *5*	0.7 *2*	5074.6	(12^+)	4142.7	(10^+)		
939.0‡ *5*	24.8 *13*	5569.9	(12^-)	4630.9	(10^-)	Q	DCO=1.0 *3* Additional information 22.
940.0 *5*	24.8 *12*	7640.6	17^-	6700.9	15^-	E2	DCO=1.0 *3* Additional information 31.
944.0 *5*	14.0 *7*	5702.7	14^+	4758.4	12^+	Q	DCO=0.9 *3* Additional information 24.
967.0 *5*	1.3 *1*	4142.7	(10^+)	3175.8	8^+		
970.0 *5*	3.4 *3*	3437.8	(8^+)	2467.8	(6^+)	Q	DCO=0.9 *3* Additional information 10.
988.0 *5*	7.6 *8*	3175.8	8^+	2187.8	6^+	Q	DCO=1.0 *2* Additional information 7.
992.0 *5*	2.1 *2*	5915.2	$14^{(+)}$	4923.2	$12^{(+)}$		Additional information 26.
994.0 *5*	1.2 *1*	4860.8	11^-	3866.8	10^+		
998.0 *5*	0.4 *1*	6700.9	15^-	5702.7	14^+		
1006.0 *5*		6455.0	$15^{(+)}$	5449.0	$13^{(+)}$		
1019.0 *5*	0.5 *1*	6934.2	$16^{(+)}$	5915.2	$14^{(+)}$		
1031.0 *5*	1.2 *2*	7965.2	(17^+)	6934.2	$16^{(+)}$		
1035.0 *5*	23.7 *12*	6700.9	15^-	5665.8	13^-	E2	DCO=0.9 *2* Additional information 28.
1042.0 *5*	1.5 *2*	3229.6	7^-	2187.8	6^+		
1053.0 *5*	3.2 *3*	2467.8	(6^+)	1414.9	4^+		

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^{72}Ge(^{35}Cl,αp2nγ) 2001Zh26,2001ZhZR (continued)

$\gamma(^{100}Pd)$ (continued)

E_γ[†]	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[@]	Comments
1056.0 *5*	4.1 *4*	4923.2	$12^{(+)}$	3866.8	10^+	Q	DCO=1.0 *2* Additional information 18.
1066.0 *5*	0.9 *1*	4051.7	9^-	2985.8	8^+		
1071.0 *5*	15.8 *8*	8711.6	19^-	7640.6	17^-	E2	DCO=0.9 *2* Additional information 32.
1089.0 *5*	9.6 *5*	2503.8	5^-	1414.9	4^+	D	DCO=0.5 *1* Additional information 4.
1106.0[#] *5*	0.9 *1*	11815.9	$23^{(-)}$	10709.3?	$22^{(-)}$	D	DCO=0.5 *1* E_γ: placement from 11211, (22^-) level in the Adopted Levels, Gammas.
1116.0 *5*	0.6 *1*	6685.9	(14^-)	5569.9	(12^-)		
1122.0 *5*	0.3 *1*	6065.9	(13^-)	4943.9	11^-		
1140.0[‡] *5*	0.4 *2*	7271.1	(16^+)	6131.0	$14^{(+)}$		
1157.0 *5*	0.7 *2*	5915.2	$14^{(+)}$	4758.4	12^+		
1166.0 *5*	0.8 *1*	7081.7	(15^+)	5915.2	$14^{(+)}$		
1200.0[#] *5*	0.7 *1*	11647.6	$21^{(+)}$	10447.6	$20^{(+)}$	D	DCO=0.6 *1*
1208.0[‡] *5*		6131.0	$14^{(+)}$	4923.2	$12^{(+)}$		
1209.0 *5*	2.4 *2*	5074.6	(12^+)	3866.8	10^+	Q	DCO=1.2 *2*
1231.0 *5*	2.7 *4*	6934.2	$16^{(+)}$	5702.7	14^+	Q	DCO=0.8 *1*
1250.0[‡] *5*	0.9 *1*	3437.8	(8^+)	2187.8	6^+		
1293.0 *5*		14451.0?		13157.6?	$22^{(+)}$		E_γ: placement from 12946, (23^+) level in the Adopted Levels, Gammas.
1364.0 *5*	1.7 *2*	8298.6	(18^+)	6934.2	$16^{(+)}$		
1377.0[‡] *5*	0.9 *3*	7830.9	(17^+)	6455.0	$15^{(+)}$		
1379.0 *5*	1.0 *4*	7081.7	(15^+)	5702.7	14^+		
1384.0 *5*	0.4 *1*	13200.0	$25^{(-)}$	11815.9	$23^{(-)}$	Q	DCO=0.8 *2*
1386.0 *5*		9684.6	(19^+)	8298.6	(18^+)		
1388.0 *5*	4.7 *4*	10099.6	21^-	8711.6	19^-	Q	DCO=0.8 *1*
1419.0[‡] *5*	0.5 *2*	9384.2	(18^+)	7965.2	(17^+)		E_γ: in ^{46}Ti(^{58}Ni,4pγ) (2000ApZY), a 1420.2γ is placed from 10139 to 8718 level.
1423.0 *5*	0.8 *1*	7338.2	(16^+)	5915.2	$14^{(+)}$		
1510.0[#] *5*	0.3 *1*	13157.6?	$22^{(+)}$	11647.6	$21^{(+)}$	D	DCO=0.4 *2* E_γ: placement from 15015, (25^+) level in the Adopted Levels, Gammas.
1569.0 *5*	0.4 *1*	7271.1	(16^+)	5702.7	14^+		
1582.0 *5*	0.4 *1*	11681.6	(23^-)	10099.6	21^-		DCO=0.7 *3*
1635.0[‡] *5*	0.4 *1*	7338.2	(16^+)	5702.7	14^+		
1717.0 *5*	0.4 *1*	11815.9	$23^{(-)}$	10099.6	21^-		
1736.0[#] *5*	1.2 *1*	10447.6	$20^{(+)}$	8711.6	19^-	D	DCO=0.4 *1*
1752.0 *5*	0.2 *1*	13433.6	(25^-)	11681.6	(23^-)	Q	DCO=1.0 *5*
1852.0[#] *5*	0.4 *1*	15009.3		13157.6?	$22^{(+)}$		E_γ: placement from 13504, (24^+) level in the Adopted Levels, Gammas.
1887.0[‡] *5*	0.4 *1*	10447.6	$20^{(+)}$	8560.6	$19^{(-)}$		

[†] From 2001ZhZR. The uncertainties in Iγ values quoted by 2001ZhZR are adjusted by the evaluators so that the minimum uncertainty is 5% for Iγ>10, 10% for Iγ<10, as suggested by 2001Zh26 in caption of their level scheme in Figure 2, since some of the uncertainties quoted by 2001ZhZR are much smaller implying that these are only the statistical uncertainties.

[‡] γ not reported in other high-spin studies (2000ApZY,2001Pe05).

[#] 1852-1510-1200-1736 cascade is reordered as 1510-1852-1200-1736 in 2001Pe05 and 1510-1200-1736-1852 in 2000ApZY. Based

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^{72}Ge(^{35}Cl,αp2nγ) 2001Zh26,2001ZhZR (continued)

$\gamma(^{100}Pd)$ (continued)

on transition intensities, ordering of 2001Pe05 is adopted by the evaluators in the Adopted Levels, Gammas. Also 1106-609 cascade from 11816 level in 2001Zh26 is reordered in 2001Pe05 and 2000ApZY as 609-1106, which is also given in the Adopted Levels, Gammas.

@ From $\gamma\gamma$(DCO) in 2001ZhZR. Mult=Q indicates ΔJ=2, quadrupole (most likely E2); Mult=D indicates ΔJ=1, dipole (with possible quadrupole admixture); and Mult=D+Q indicates ΔJ=0, dipole+quadrupole (most likely M1+E2).

& DCO ratio >1 suggests ΔJ=0, dipole+quadrupole.

^{72}Ge(^{35}Cl,αp2nγ) 2001Zh26,2001ZhZR

Level Scheme

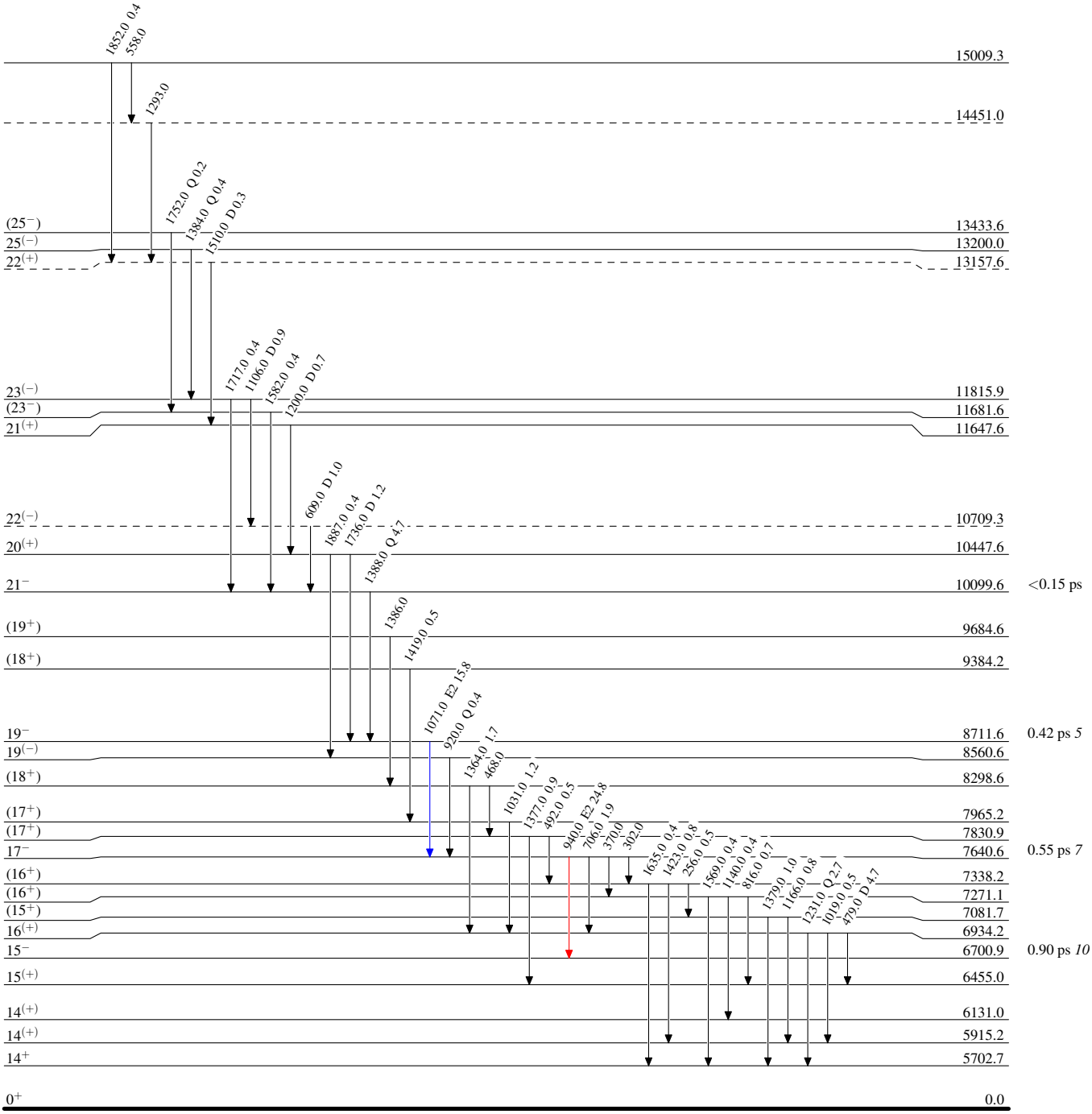
Intensities: Relative I_γ

Legend

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

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

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



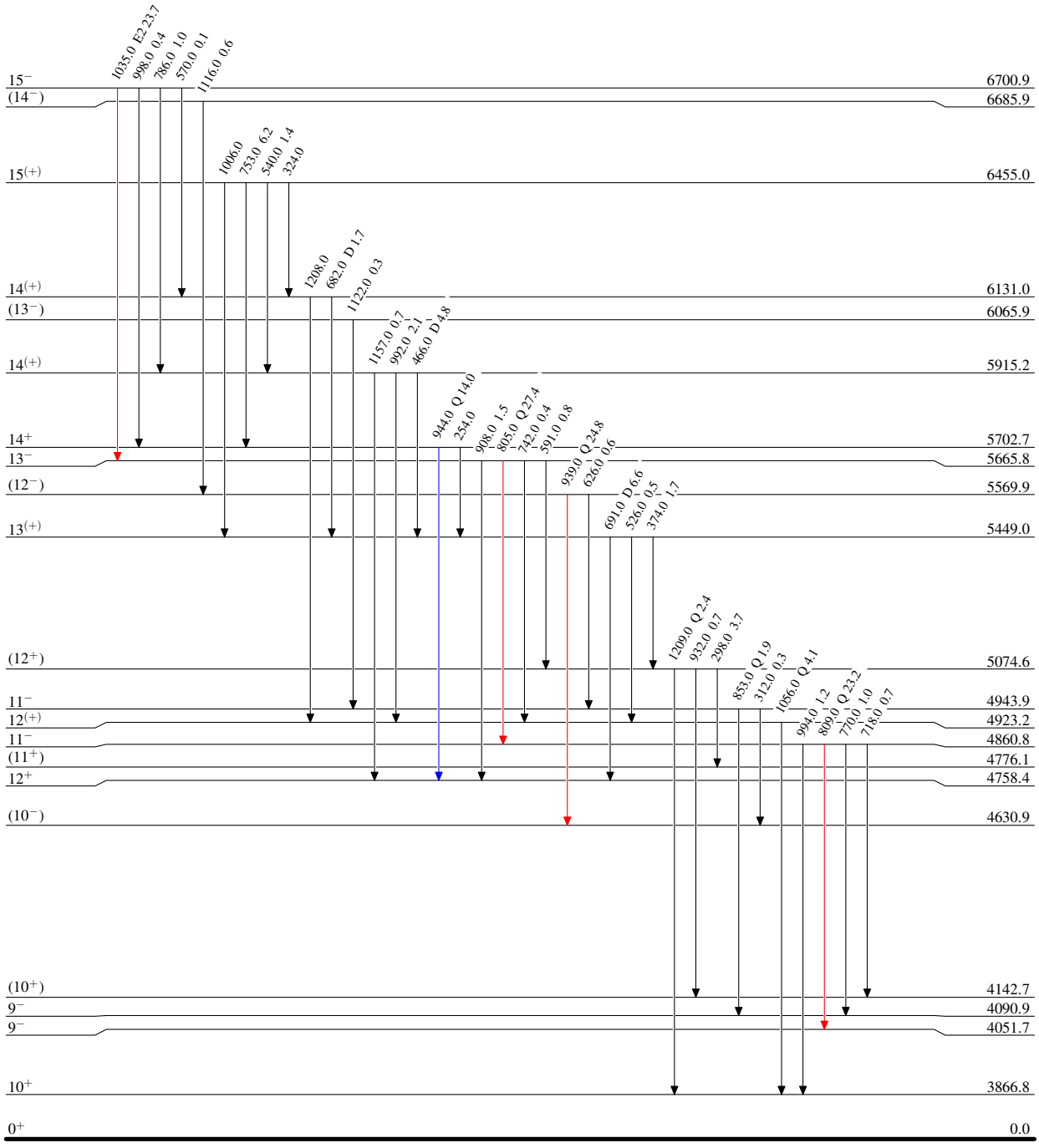
$^{100}_{46}Pd_{54}$

^{72}Ge(^{35}Cl,αp2nγ) 2001Zh26,2001ZhZR

Level Scheme (continued)

Intensities: Relative I_γ

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

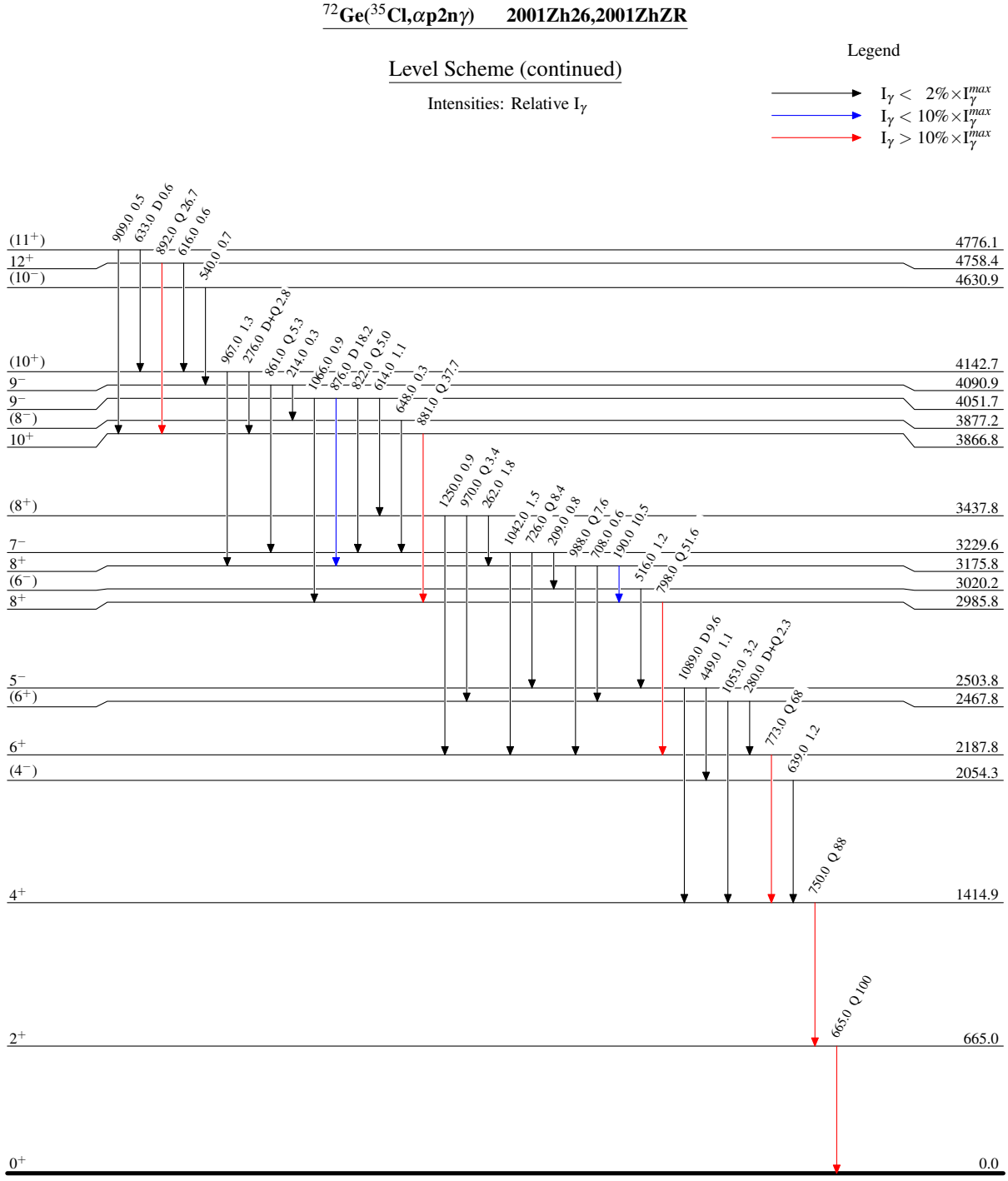


$^{100}_{46}Pd_{54}$

^{72}Ge(^{35}Cl,αp2nγ) 2001Zh26,2001ZhZR

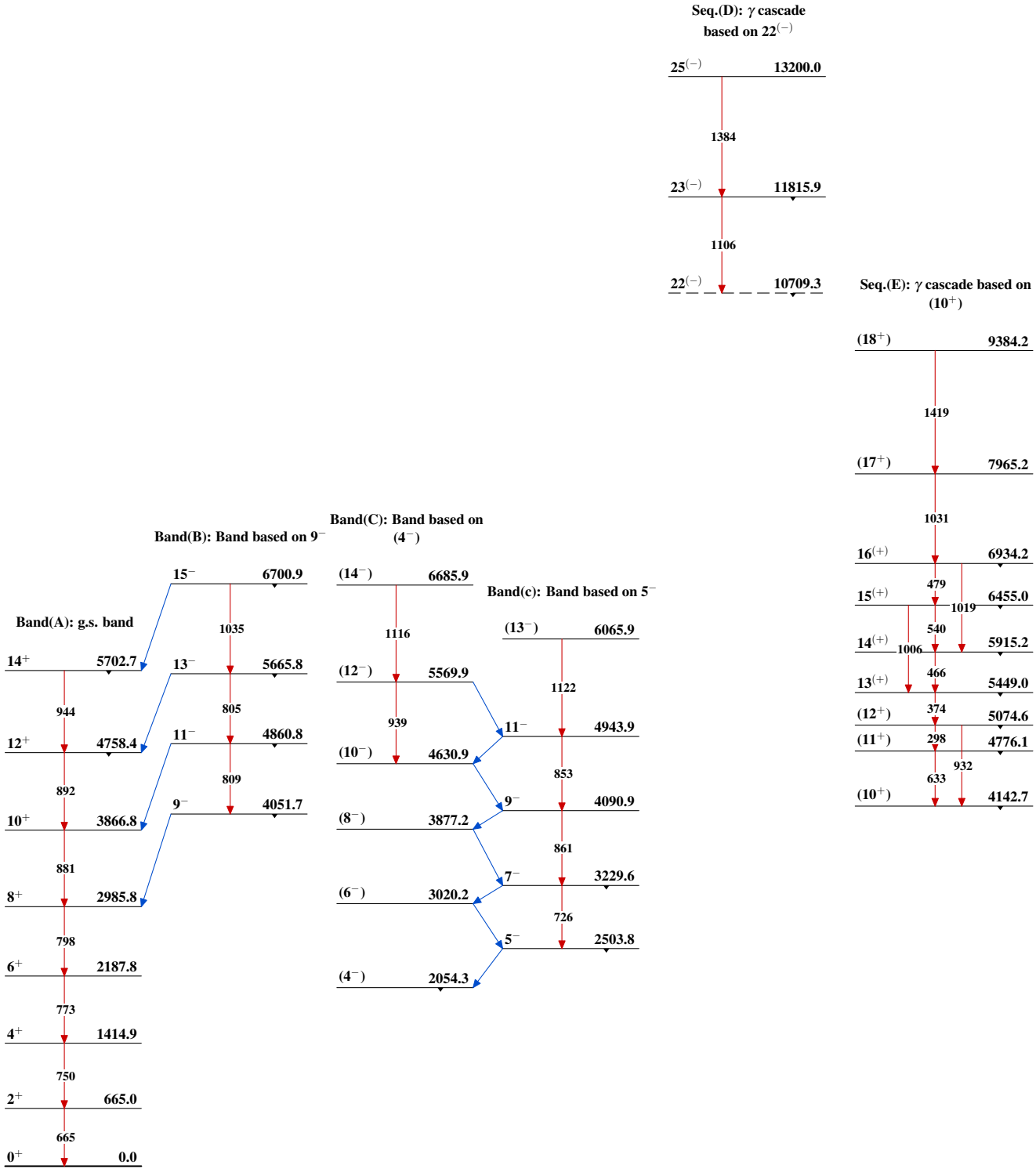
Level Scheme (continued)

Intensities: Relative I_γ



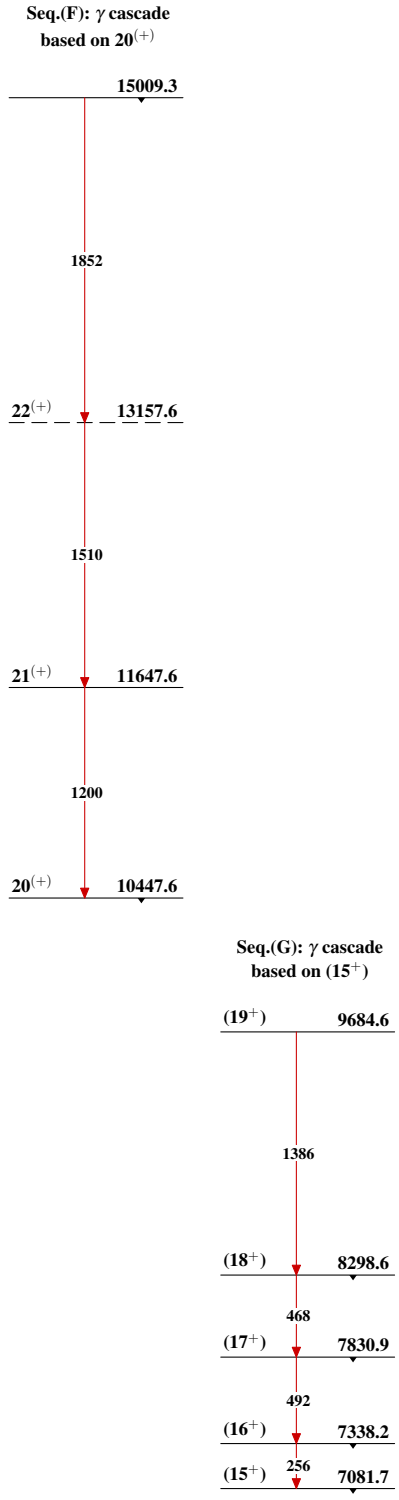
$^{100}_{46}Pd_{54}$

^{72}Ge(^{35}Cl,αp2nγ) 2001Zh26,2001ZhZR



$^{100}_{46}Pd_{54}$

^{72}Ge(^{35}Cl,αp2nγ) 2001Zh26,2001ZhZR (continued)



$^{100}_{46}Pd_{54}$