$^{16}O(^{28}Si,\alpha 2p\gamma)$ 2002Ru01

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 152, 1 (2018)	30-Sep-2017

2002Ru01: E=125 MeV ^{28}Si beam was produced from the 88-Inch Cyclotron at LBNL. Target was ~0.5 mg/cm^2 thin enriched ^{40}Ca foil suffered from considerable oxidation. Charged-particles were detected with the 4π detector array MICROBALL, neutrons were detected with 15 liquid scintillator for proper channel selection, and γ rays were detected with the GAMMASPHERE Ge-detector array. Measured Eγ, Iγ, $\gamma\gamma$-coin, $\gamma\gamma$(DCO). Deduced levels, J, π, γ-ray multipolarities. Comparisons with shell-model calculations.

^{38}Ar Levels

E(level)†	Jπ‡	E(level)†	Jπ‡	E(level)†	Jπ‡	E(level)†	Jπ‡
0	0^+	7070.8 *7*	$6^{-\#}$	9537.8[a] *8*	8^+	13685.3[b] *9*	$12^{-\#}$
2167.6 *5*	2^+	7289.0[&] *7*	6^+	9934.9 *11*	9^+	14120.8 *19*	
3810.4[c] *6*	3^-	7491.9[a] *8*	6^+	10026.0[b] *8*	$8^{-\#}$	14392.2[a] *12*	12^+
3936.8[&] *7*	2^+	7508.8[c] *7*	7^-	10175.7[d] *7*	9^-	14878.4[&] *22*	(12^+)
4480.0 *7*	4^-	7859.0 *9*	6	10948.5[c] *10*	9^-	15395.8[d] *22*	13^-
4565.7[a] *10*	2^+	8078.0 *7*	7^+	11299.5 *10*	10^+	17003.3[a] *16*	(14^+)[@]
4585.9[c] *7*	5^-	8125.9[b] *8*	(6^-)	11550.4[b] *8*	$10^{-\#}$	17782.5[b] *22*	
5349.8[&] *7*	4^+	8491.9 *8*	(6^-)	11616.6[d] *8*	11^-	18071?[&] *4*	(14^+)
5659.0[d] *7*	5^-	8570.5 *7*	8^+	11651.3 *24*	(9^-)	21663?[&] *5*	(16^+)
6053.6[a] *7*	4^+	8973.8[d] *7*	7^-	11916.3[&] *10*	10^+		
6408.9 *7*	6^+	9340.2[&] *8*	8^+	11998.5[c] *14*			
6674.5 *8*	5^-	9350.2 *13*	7^-	12107.6[a] *22*	10^+		

† From least-squares fit to γ-ray energies.

‡ As proposed by 2002Ru01 based on earlier assignments for lower levels and $\gamma\gamma(\theta)$(DCO) measurements for higher levels. The assignments are mostly consistent with those in Adopted Levels, except that several are placed in parentheses due to lack of strong supporting arguments, unless otherwise noted.

All these assignments are based on J(13685)=12, which is made by 2002Ru01 from 2069γ ΔJ=1 to the 11615, $J^\pi=11^-$ level with ΔJ=1 given by DCO=0.30 *2*. But the resulting J(7070)=6, also favored by 437.8γ from the 7509, $J^\pi=7^-$ level, is inconsistent with $J^\pi=5^-$ in (α,pγ) which is strongly supported by RUL and $\gamma(\theta)$ of 2484γ giving ΔJ=0 or 2 to the 4586, $J^\pi=5^-$ level. Note that while J(7070)=6 gives ΔJ=1 for 2484γ, DCO=1.19 *9* for 2484γ in 2002Ru01 are marginally consistent with ΔJ=0 giving J(7070)=5 as in (α,pγ) and also with ΔJ=2 giving J(7070)=7. So the evaluator has adopted $J^\pi(7070)=(6)^-$ in Adopted Levels with 5^- not completely ruled out. In the opinion of the evaluator, the spin of this level needs reinvestigation.

@ From figure 1 of 2002Ru01.

& Band(A): 2^+ band 1.

a Band(B): 2^+ band 2.

b Band(C): Band based on (6^-).

c Seq.(D): γ sequence based on 3^-.

d Seq.(E): γ sequence based on 5^-.

$\gamma(^{38}Ar)$

Eγ	Iγ	Ei(level)	J_i^π	Ef	J_f^π	Mult.†	Comments
105.9 *1*	83 *8*	4585.9	5^-	4480.0	4^-	D+Q	
437.8 *2*	0.8 *1*	7508.8	7^-	7070.8	6^-	D+Q	DCO=0.82 *15*.
492.6 *2*	3.8 *2*	8570.5	8^+	8078.0	7^+	D+Q	DCO=0.61 *5*.
669.6 *2*	90 *3*	4480.0	4^-	3810.4	3^-	D+Q	DCO=0.63 *3*.

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$^{16}O(^{28}Si,\alpha 2p\gamma)$ 2002Ru01 (continued)

$\gamma(^{38}Ar)$ (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.[†]	Comments
703.9[‡] *3*	2.2 *2*	6053.6	4^+	5349.8	4^+		
749.9 *4*	0.3 *1*	6408.9	6^+	5659.0	5^-		
773[‡] *1*	0.8 *3*	10948.5	9^-	10175.7	9^-		
775.5 *3*	11 *1*	4585.9	5^-	3810.4	3^-		DCO=1.08 *7*.
784 *1*	0.2 *1*	5349.8	4^+	4565.7	2^+		
789.3 *6*	0.5 *1*	8078.0	7^+	7289.0	6^+		
835.3 *4*	0.7 *2*	10175.7	9^-	9340.2	8^+		
847.8 *4*	0.4 *1*	8973.8	7^-	8125.9	(6^-)		
879.9[‡] *3*	1.2 *1*	7289.0	6^+	6408.9	6^+		
967.4[‡] *3*	1.1 *1*	9537.8	8^+	8570.5	8^+	D	DCO=0.98 *10*.
1050 *1*	0.5 *1*	11998.5		10948.5	9^-		
1055 *1*	0.9 *2*	8125.9	(6^-)	7070.8	6^-	D	DCO=0.83 *31* for a doublet structure, possible ΔJ=0.
1058 *1*	1.8 *2*	6408.9	6^+	5349.8	4^+		
1061.4 *3*	7.3 *2*	8570.5	8^+	7508.8	7^-	D	DCO=0.66 *7* for a doublet structure.
1073.2[‡] *4*	7.2 *3*	5659.0	5^-	4585.9	5^-	D	DCO=1.08 *8*.
1100 *1*	0.2 *1*	7508.8	7^-	6408.9	6^+		
1178.6 *6*	0.7 *1*	5659.0	5^-	4480.0	4^-		
1184.5 *4*	1.1 *2*	7859.0	6	6674.5	5^-	D	DCO=0.59 *9*.
1201.8 *3*	14 *1*	10175.7	9^-	8973.8	7^-	Q	DCO=1.09 *6*.
1236 *1*	0.4 *1*	7289.0	6^+	6053.6	4^+		
1282 *1*	0.3 *1*	8570.5	8^+	7289.0	6^+		
1364 *1*	7 *1*	9934.9	9^+	8570.5	8^+	D+Q	DCO=0.46 *3* for a doublet structure.
1364 *1*	2 *1*	11299.5	10^+	9934.9	9^+	D+Q	DCO=0.46 *3* for a doublet structure.
1374.7 *4*	6.3 *2*	11550.4	10^-	10175.7	9^-	D+Q	DCO=1.29 *17*. δ: +0.5 to +2.2.
1413.1 *4*	3.8 *3*	5349.8	4^+	3936.8	2^+		
1421.0 *4*	3.3 *4*	8491.9	(6^-)	7070.8	6^-	D	DCO=0.51 *5*.
1438 *1*	2.4 *2*	7491.9	6^+	6053.6	4^+		
1440.9 *4*	21 *1*	11616.6	11^-	10175.7	9^-	Q	DCO=1.05 *5*.
1451 *1*	0.4 *1*	8125.9	(6^-)	6674.5	5^-		
1488 *1*	0.4 *1*	6053.6	4^+	4565.7	2^+		
1524.4 *4*	2.6 *2*	11550.4	10^-	10026.0	8^-	Q	DCO=0.91 *16*.
1539 *1*	0.9 *2*	5349.8	4^+	3810.4	3^-		
1598 *2*	0.3 *1*	10948.5	9^-	9350.2	7^-		
1605.4 *4*	19 *1*	10175.7	9^-	8570.5	8^+	D	DCO=0.58 *3*.
1642.7 *4*	100 *3*	3810.4	3^-	2167.6	2^+	D	DCO=0.64 *3*.
1669.4 *4*	6.7 *2*	8078.0	7^+	6408.9	6^+	D+Q	DCO=1.59 *12*.
1769[‡] *1*	0.2 *1*	3936.8	2^+	2167.6	2^+		
1823.3 *4*	55 *2*	6408.9	6^+	4585.9	5^-	D	DCO=0.56 *3*.
1833 *1*	0.8 *2*	7491.9	6^+	5659.0	5^-		
1848 *1*	1.3 *2*	9340.2	8^+	7491.9	6^+		
1850 *1*	0.7 *3*	7508.8	7^-	5659.0	5^-		
1900 *1*	2.4 *3*	10026.0	8^-	8125.9	(6^-)	Q	DCO=1.10 *34* for a doublet structure.
1903 *1*	0.4 *1*	8973.8	7^-	7070.8	6^-		
1939.4 *7*	7.8 *6*	7289.0	6^+	5349.8	4^+	Q	DCO=0.94 *8*.
1948 *1*	0.9 *2*	10026.0	8^-	8078.0	7^+		
1959.5 *7*	3.6 *2*	11299.5	10^+	9340.2	8^+	Q	DCO=1.17 *21*.
2046 *1*	0.8 *2*	9537.8	8^+	7491.9	6^+		
2051.3 *6*	7.9 *6*	9340.2	8^+	7289.0	6^+	Q	DCO=1.07 *11*.
2068.5 *7*	3.2 *2*	13685.3	12^-	11616.6	11^-	D+Q	DCO=0.30 *2*. δ: −2.7 *+6−8* or −0.30 *+8−11*.
2088.7[‡] *6*	5.7 *6*	6674.5	5^-	4585.9	5^-	D	DCO=1.16 *17*.
2116 *1*	0.6 *2*	6053.6	4^+	3936.8	2^+		
2134.9 *6*	3.1 *4*	13685.3	12^-	11550.4	10^-	Q	DCO=1.18 *17*.

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^{16}O(^{28}Si,α2pγ) 2002Ru01 (continued)

γ(^{38}Ar) (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.[†]	Comments
2142 *1*	1.1 *2*	7491.9	6^+	5349.8	4^+		
2162 *1*	30 *2*	8570.5	8^+	6408.9	6^+	Q	DCO=1.01 *5* for a doublet structure.
2167.5 *5*	110 *3*	2167.6	2^+	0	0^+	Q	DCO=1.01 *5* for a doublet structure.
2248 *1*	0.8 *3*	9537.8	8^+	7289.0	6^+		
2285[#] *1*	0.2 *1*	14392.2	12^+	12107.6	10^+		
2300 *1*	1.1 *2*	8973.8	7^-	6674.5	5^-	Q	DCO=1.14 *23* for a doublet structure.
2301 *2*	0.6 *2*	11651.3	(9^-)	9350.2	7^-	Q	DCO=1.14 *23* for a doublet structure.
2378 *1*	2.9 *2*	10948.5	9^-	8570.5	8^+	D	DCO=0.83 *9* for a doublet structure.
2378 *1*	0.7 *2*	11916.3	10^+	9537.8	8^+		
2398[‡] *2*	0.7 *2*	4565.7	2^+	2167.6	2^+		
2475.7 *8*	2.4 *2*	14392.2	12^+	11916.3	10^+	Q	DCO=1.02 *19*.
2483.9 *6*	10 *1*	7070.8	6^-	4585.9	5^-	D+Q	DCO=1.19 *9*. δ: +0.6 to +2.0 for J=6; ≈+0.5 for J=5.
2517 *1*	1.1 *2*	10026.0	8^-	7508.8	7^-		
2565 *1*	12 *1*	8973.8	7^-	6408.9	6^+	D	DCO=0.70 *5*.
2570[#] *2*	0.3 *1*	12107.6	10^+	9537.8	8^+		
2576.2 *8*	3.9 *2*	11916.3	10^+	9340.2	8^+	Q	DCO=0.95 *16*.
2590 *1*	1.1 *2*	7070.8	6^-	4480.0	4^-		
2611 *1*	0.9 *2*	17003.3	(14^+)	14392.2	12^+		DCO=1.1 *4*.
2704 *1*	2.6 *2*	7289.0	6^+	4585.9	5^-		
2821 *2*	0.7 *2*	14120.8		11299.5	10^+		
2923 *1*	9.1 *5*	7508.8	7^-	4585.9	5^-	Q	DCO=1.14 *9* for a doublet structure.
2931 *1*	1.9 *2*	9340.2	8^+	6408.9	6^+		
2941 *2*	0.4 *1*	9350.2	7^-	6408.9	6^+		
2956 *2*	1.3 *2*	10026.0	8^-	7070.8	6^-		
2962 *2*	0.6 *2*	14878.4	(12^+)	11916.3	10^+		
3093 *2*	0.7 *2*	14392.2	12^+	11299.5	10^+		
3128 *2*	1.4 *2*	9537.8	8^+	6408.9	6^+		
3183 *2*	8 *1*	5349.8	4^+	2167.6	2^+	Q	DCO=0.98 *8* for a doublet structure.
3192[#] *3*	0.4 *2*	18071?	(14^+)	14878.4	(12^+)		
3314 *1*	2.5 *1*	8973.8	7^-	5659.0	5^-	Q	DCO=1.15 *21*.
3439 *2*	0.3 *1*	10948.5	9^-	7508.8	7^-		
3537 *2*	1.2 *2*	12107.6	10^+	8570.5	8^+		
3538 *2*	1.4 *2*	8125.9	(6^-)	4585.9	5^-		
3592[#] *3*	0.2 *1*	21663?	(16^+)	18071?	(14^+)		
3691 *2*	0.3 *1*	9350.2	7^-	5659.0	5^-		
3779 *2*	1.6 *2*	15395.8	13^-	11616.6	11^-	Q	DCO=1.02 *19*.
3938 *2*	2.1 *3*	3936.8	2^+	0	0^+		
4097 *2*	0.5 *2*	17782.5		13685.3	12^-		
4185 *3*	0.4 *2*	14120.8		9934.9	9^+		
4388 *2*	4.1 *2*	8973.8	7^-	4585.9	5^-	Q	DCO=1.19 *14*.
4764 *3*	0.5 *1*	9350.2	7^-	4585.9	5^-		

[†] From $\gamma\gamma$(DCO) data in 2002Ru01. Typical values of DCO ratio are 1.0 for stretched quadrupole transitions and ~0.6 for stretched pure dipole transitions using known stretched E2 transitions for gating; non-stretched $\Delta J=0$ transitions have typical value of ~1.0. 2002Ru01 assign E2 to mult=Q and M1+E2 to mult=D+Q transitions.

[‡] $\Delta J=0$, dipole transition.

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

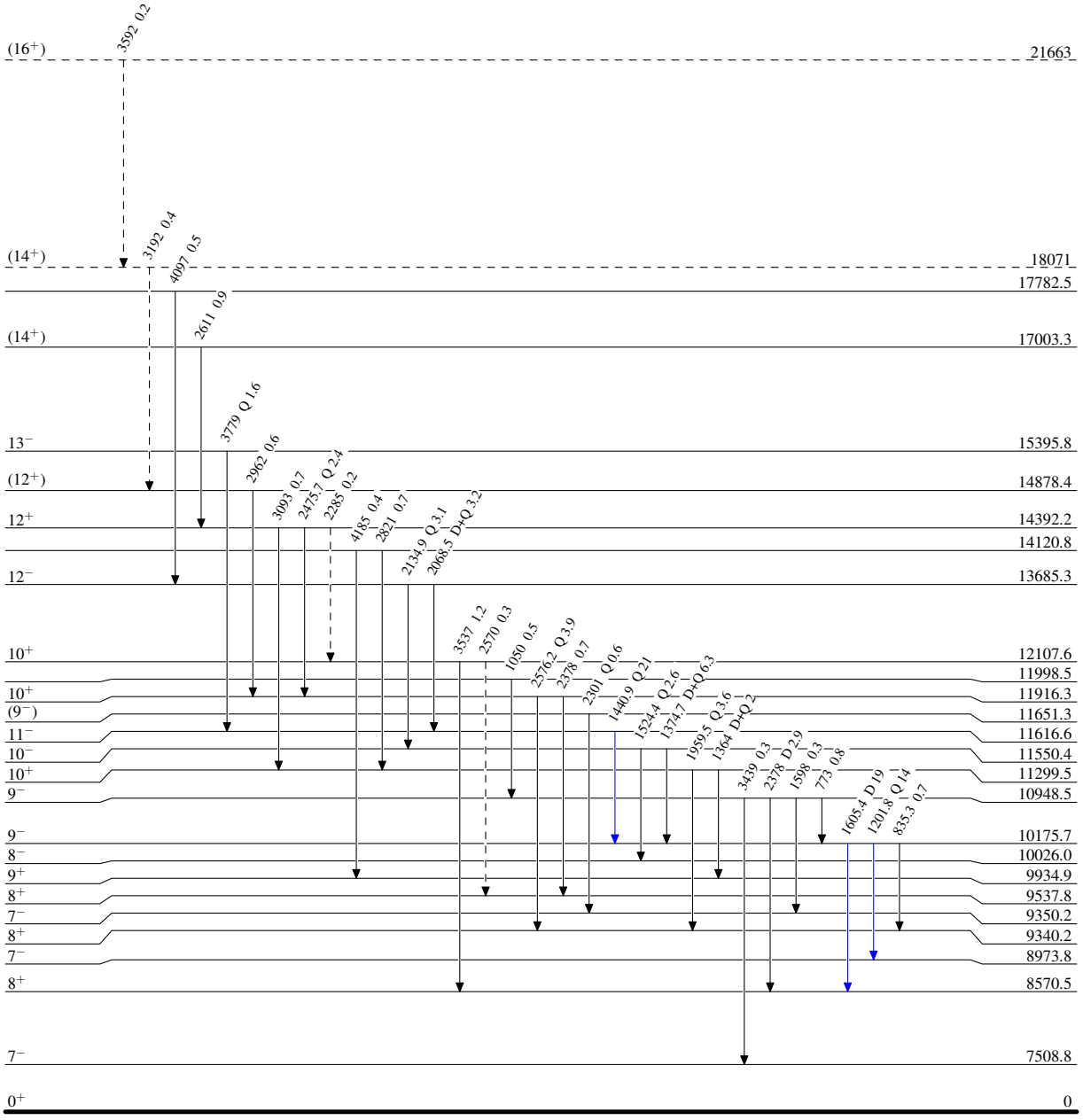
$^{16}O(^{28}Si,\alpha 2p\gamma)$ **2002Ru01**

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)

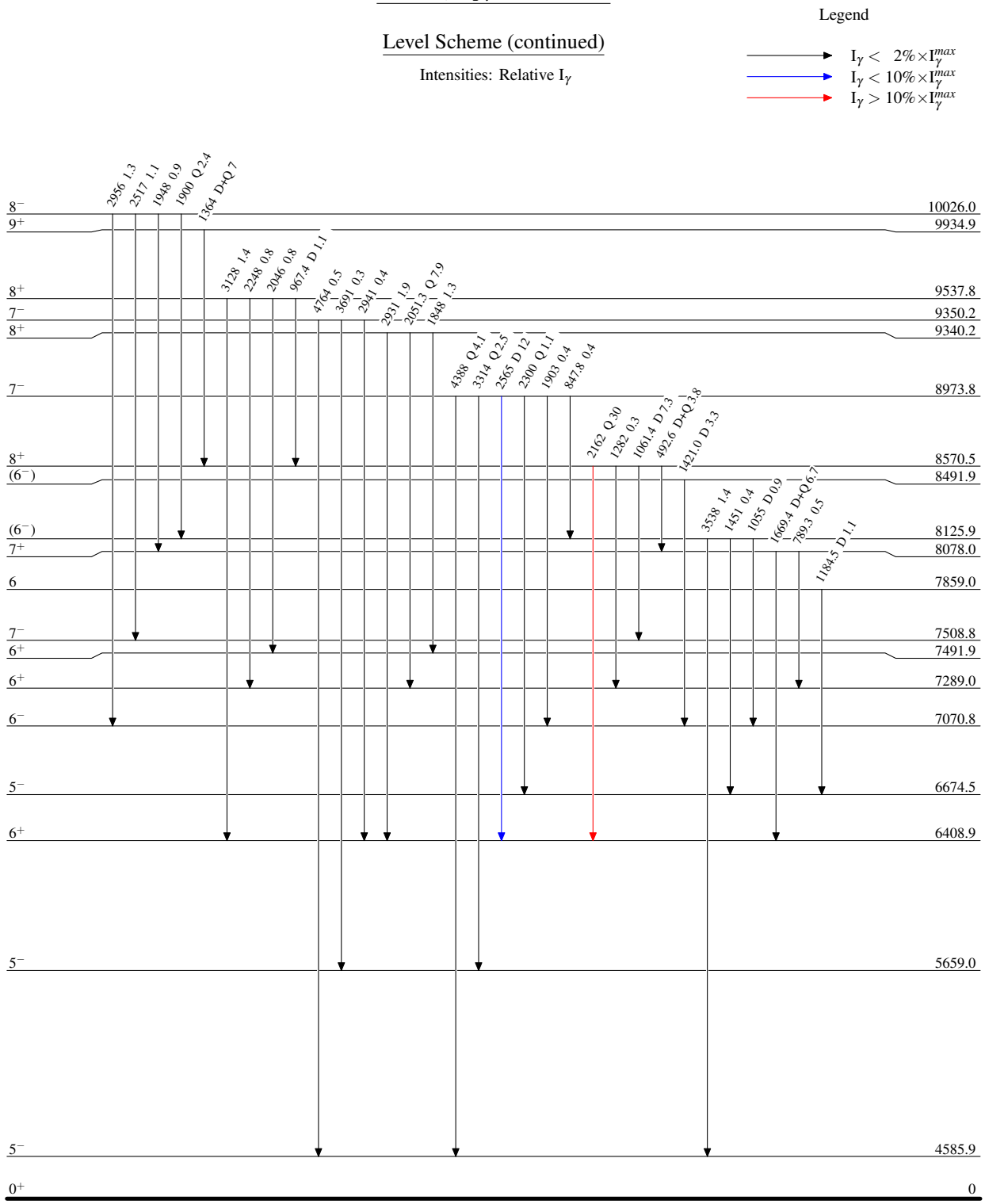


$^{38}_{18}Ar_{20}$

$^{16}O(^{28}Si,\alpha 2p\gamma)$ **2002Ru01**

Level Scheme (continued)

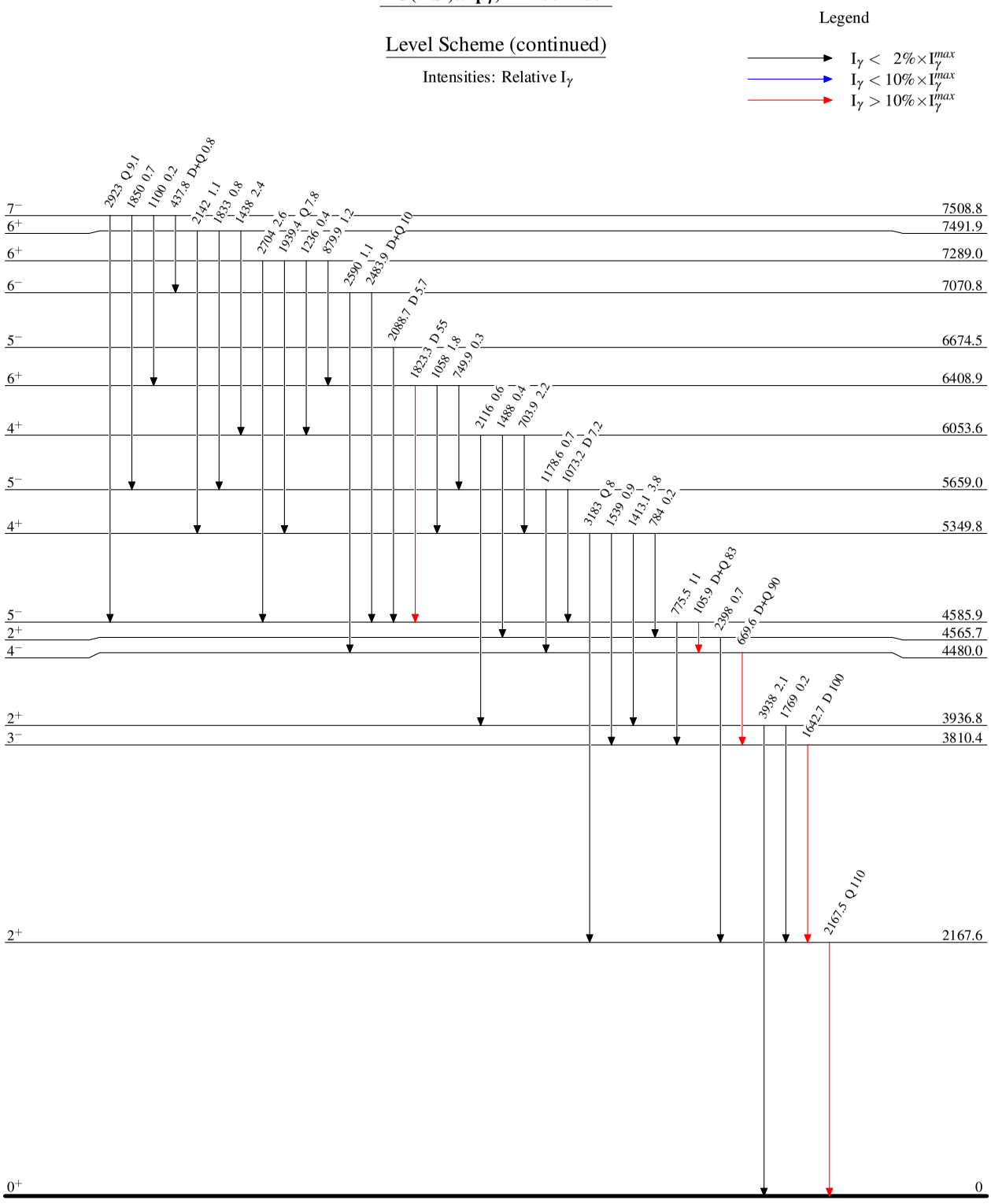
Intensities: Relative I_γ



$^{16}O(^{28}Si,\alpha 2p\gamma)$ **2002Ru01**

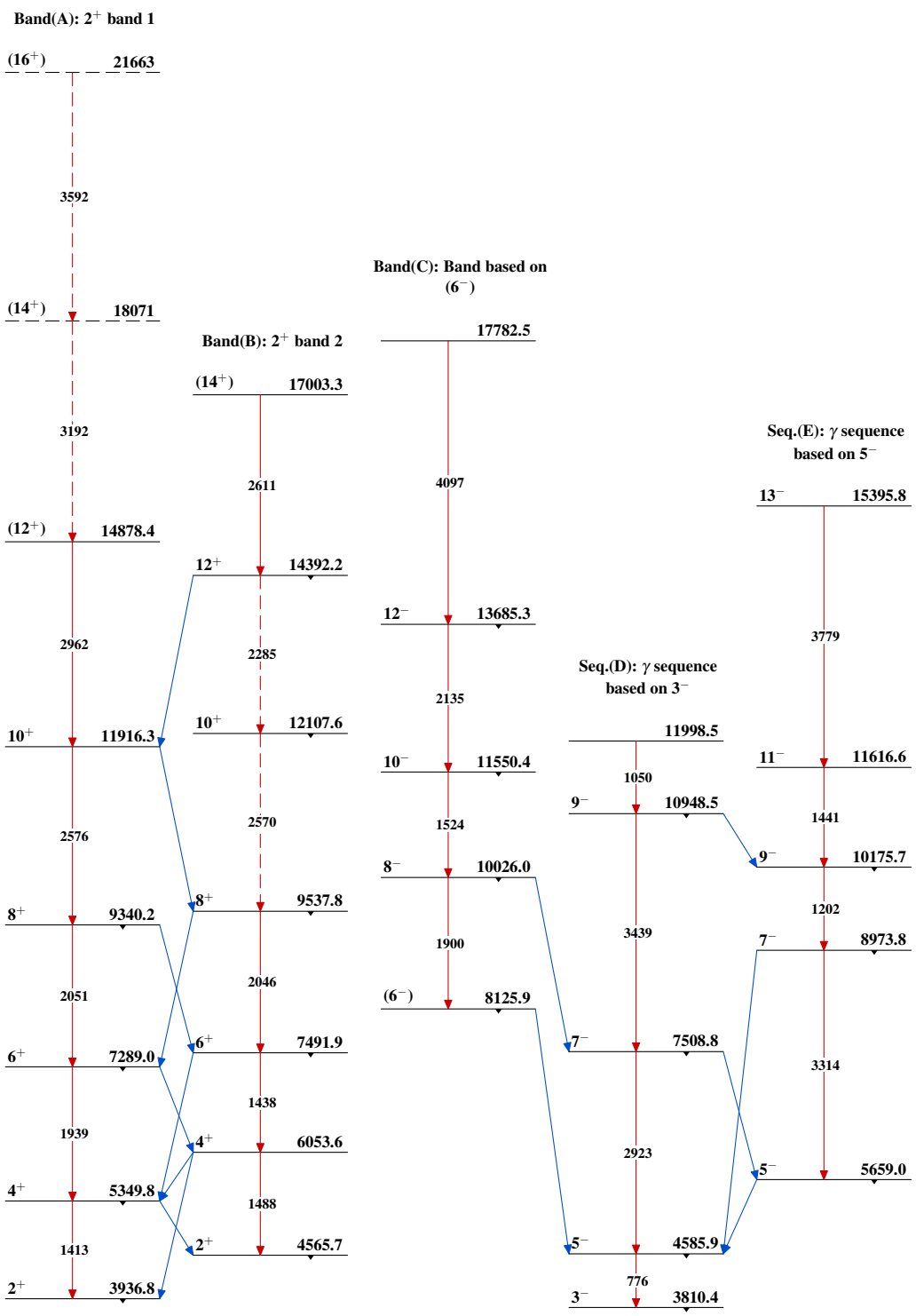
Level Scheme (continued)

Intensities: Relative I_γ



$^{38}_{18}Ar_{20}$

$^{16}O(^{28}Si,\alpha 2p\gamma)$ 2002Ru01



$^{38}_{18}Ar_{20}$