^{63}Cu(α,nγ), ^{64}Zn(α,npγ) 1978Mo21

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	E. Browne, J. K. Tuli	NDS 111, 1093 (2010)	3-Mar-2009

1978Mo21: ^{63}Cu(α,nγ): Eα=18.5 MeV; measured Eγ, Iγ, $\gamma(\theta)$, $T_{1/2}$ by delayed coincidences. ^{64}Zn(α,npγ): Eα=22-40 MeV, mainly 31 MeV; measured Eγ, Iγ, excitation functions, $\gamma(\theta)$, $\gamma\gamma$ coincidences, $T_{1/2}$ by delayed-γ coincidences with the beam burst.

1976Le03: ^{63}Cu(α,nγ): Eα=12.2 MeV; measured $T_{1/2}$ by pulsed-beam delayed-γ coincidences. ^{66}Zn(p,nγ): E(p)=6.6 MeV; measured $T_{1/2}$ by pulsed-beam delayed-γ coincidences.

Others: 1970HaZR, 1976PoZW.

The γ-decay scheme and other data are from 1978Mo21, except where noted otherwise. Coincidence data are taken from the prompt and delayed $\gamma\gamma$ spectra of 1978Mo21.

^{66}Ga Levels

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$[#]	Comments
0.0	0^+		
43.87 *18*	1^+	<25 ns	$T_{1/2}$: nearly identical decay curves for the 43.9γ and 22.4γ measured after the beam pulse indicate $T_{1/2}$(43.9 level)<$T_{1/2}$(66.3 level) (1976Le03).
66.17 *24*	$(2)^+$	23 ns *2*	$T_{1/2}$: from 1976Le03.
108.92 *18*	1^+		
162.5 *3*	$(3)^+$	13 ns *5*	J$^\pi$: 3 from $\gamma(\theta)$; π=(+) from (E2) to 1^+. $T_{1/2}$: from 1978Mo21.
234.15 *20*	2^+		J$^\pi$: 2 from $\gamma(\theta)$ and γ-decay modes.
415.4 *3*	$(4)^+$	<2 ns	J$^\pi$: 4 from $\gamma(\theta)$ and γ-decay systematics.
516.1 *4*	$(4)^+$	<2 ns	J$^\pi$: 4 from $\gamma(\theta)$ and γ-decay systematics.
553.05 *25*	$(3)^+$		J$^\pi$: 3 from $\gamma(\theta)$ and γ-decay modes.
721.8 *4*	$(3)^+$		J$^\pi$: 3 favored by 1978Mo21 from $\gamma(\theta)$ of 420γ from 1142 level and decay modes.
784.0 *3*	(3)		J$^\pi$: 3 from $\gamma(\theta)$ and γ-decay modes.
863.7 *3*	(5)	<2 ns	J$^\pi$: 5 from $\gamma(\theta)$ of 448γ and 701γ.
1142.1 *3*			J$^\pi$: 4 favored by 1978Mo21 from γ-decay mode systematics.
1350.7 *3*	(5)		J$^\pi$: 5 from $\gamma(\theta)$ of 935γ and excitation functions.
1464.4 *3*	(7)	58 ns *6*	J$^\pi$: 7 from $\gamma(\theta)$ of 601γ and excitation functions. $T_{1/2}$: weighted mean of 52 ns *8* (1978Mo21) and 63 ns *7* (attributed incorrectly in 1976Le03 to an isomeric state at E(level)=1442.).
1513.5 *3*	(6)		J$^\pi$: 6 from $\gamma(\theta)$ of 650γ.
1573.9? *4*	$1^{(+)}$		J$^\pi$: 5 favored by 1978Mo21.
1617.8 *4*	(6)		J$^\pi$: 6 from $\gamma(\theta)$ of 754γ.
1775.0 *4*	(7)		J$^\pi$: (7) from γ decay from $J^\pi=9^+$ at 3043, γ decay to J=6 at 1513 and observed weakness of population in the reactions ^{63}Cu(α,nγ) and ^{64}Zn(α,npγ).
2408.5 *4*	(8)		J$^\pi$: 8 from $\gamma(\theta)$.
2512.5 *4*	(8)	<2 ns	J$^\pi$: 8 from $\gamma(\theta)$ of 1048γ.
2653.1 *4*	(9^+)	<2 ns	J$^\pi$: 9 from $\gamma(\theta)$, excitation functions.
3043.5 *4*	(9^+)		J$^\pi$: 9 from $\gamma(\theta)$ and excitation functions.
3362.4 *4*			
3420.1 *4*	(10)		J$^\pi$: 10 from $\gamma(\theta)$.
4110.5 *4*	(10)		J$^\pi$: 10 favored from $\gamma(\theta)$.
4162.2 *4*	(11)	<2 ns	J$^\pi$: 11 from $\gamma(\theta)$ 1119γ, and 1119γ excitation function.
4192.8 *4*			J$^\pi$: (11) favored by 1978Mo21 from comparison of level populations ^{63}Cu(α,nγ) and ^{64}Zn(α,npγ).
4271.8 *5*	(12)		J$^\pi$: (12) from $\gamma(\theta)$.
4302.8 *4*			J$^\pi$: (10) favored by 1978Mo21 from comparison of level populations in ^{63}Cu(α,nγ) and ^{64}Zn(α,npγ).
5109.3 *5*	(13)		J$^\pi$: (13) from 947$\gamma(\theta)$, calculated from $\gamma(\theta)$ of the 944γ+947γ doublet in ^{64}Zn(α,npγ) and $\gamma(\theta)$ of 944γ in ^{63}Cu(α,nγ), excitation functions, and comparison of level populations in ^{63}Cu(α,nγ) and ^{64}Zn(α,npγ).

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^{63}Cu(α,nγ), ^{64}Zn(α,npγ) 1978Mo21 (continued)

^{66}Ga Levels (continued)

† From least-squares fit to Eγ data.
‡ From Adopted Levels. Supporting arguments from this data set are indicated.
# From delayed-γ coincidences with the beam burst in ^{64}Zn(α,npγ) at Eα=33 MeV (1978Mo21) or at Eα=12.2 MeV in ^{63}Cu(α,nγ) (1976Le03); measurements also made with ^{63}Cu(α,nγ) at Eα=18.5 MeV by 1978Mo21.

γ(^{66}Ga)

E_γ	I_γ‡	E_i(level)	J_i^π	E_f	J_f^π	Mult.#	δ#	Comments
22.4 *2*		66.17	$(2)^+$	43.87	1^+			I_γ: 80 *40* from ^{64}Zn(α,npγ) at Eα=31 MeV.
43.9 *2*	70 *20*	43.87	1^+	0.0	0^+	(M1)		
96.4 *2*	100	162.5	$(3)^+$	66.17	$(2)^+$	(M1+E2)		δ: −0.2 +*2*−*1* if J^π(162)=3^+ from γ(θ); −0.5≤δ(D+Q)≤ 0.0 if J^π(162)=2 from γ(θ) of the 96γ doublet in (p,nγ).
108.9 *2*	1.6	108.92	1^+	0.0	0^+	(M1)		
113.7 *2*	18.0	1464.4	(7)	1350.7	(5)	E2		Mult.: Q+O from γ(θ); E2+M3 from RUL. δ(M3/E2)=−0.09 *10*.
118.6 *2*	0.4	162.5	$(3)^+$	43.87	1^+	E2(+M3)		Mult.: Q+O from γ(θ); E2 from RUL. δ: −0.2 *2* if J^π(162)=3^+; δ(D+Q)=+0.9 *2* if J(162)=2 from γ(θ).
125.2 *2*	0.2	234.15	2^+	108.92	1^+	(D+Q)		δ: −4.0 *5* from γ(θ) for J=2 to 1 transition; −0.34 *10* for a J=1 to 1 transition.
162.6 *2*	3.0	1513.5	(6)	1350.7	(5)	(D)		δ(Q/D)=+0.0 *1*.
190.2 *2*	6.8	234.15	2^+	43.87	1^+			E_γ: contaminated γ line.
208.6 *2*	1.5	1350.7	(5)	1142.1				Mult.: D+Q; δ=+0.0 *1* for J=5 to J=4 transition.
252.8 *2*	67	415.4	$(4)^+$	162.5	$(3)^+$	(D)		δ(Q/D)=+0.03 *10*; +0.17 *10* from γ(θ) in ^{64}Zn(α,npγ) (1978Mo21).
261.4 *2*	4.6	1775.0	(7)	1513.5	(6)	(D+Q)	+0.28 *10*	
x303†								
318.8 *2*	1.8	553.05	$(3)^+$	234.15	2^+	(D(+Q))		δ: +0.0 *1* for J=3 to J=2 transition.
347†		415.4	$(4)^+$	66.17	$(2)^+$			E_γ: doublet.
347†@		863.7	(5)	516.1	$(4)^+$			E_γ: doublet.
353.6 *2*	21	516.1	$(4)^+$	162.5	$(3)^+$	(D)		δ(Q/D)=+0.0 *1*.
358.2 *2*	3.0	1142.1		784.0	(3)			E_γ: contaminated γ line. Mult.: D+Q; δ=+0.0 *1* for J=4 to J=3 transition.
371.5 *2*	4.0	1513.5	(6)	1142.1				Mult.: (Q+O) with δ=+0.0 *1* for a J=6 to J=4 transition.
376.6 *2*	2.0	3420.1	(10)	3043.5	(9^+)	(D)		δ(Q/D)=−0.02 *10*.
390.4 *2*	4.6	3043.5	(9^+)	2653.1	(9^+)	(D+Q)		δ: −0.1 *1* assuming J=9 for the 3043-keV level; +0.9 *1* assuming J^π=9^+ for the 3043-keV level.
420.2 *2*	2.5	1142.1		721.8	$(3)^+$			Mult.: D+Q; δ=+0.0 *1* for J=4 to J=3 transition.
431.8@ *2*	5.4	1573.9?	$1^{(+)}$	1142.1				Mult.: D+Q; δ=+0.05 *10* for J=5 to J=4 transition.
448.2 *2*	24.0	863.7	(5)	415.4	$(4)^+$	(D)		δ(Q/D)=−0.1 *1*.
450†		516.1	$(4)^+$	66.17	$(2)^+$			
487†@	<8.0	721.8	$(3)^+$	234.15	2^+			
487.2† *2*	<8.0	1350.7	(5)	863.7	(5)			E_γ: doublet. Mult.: D+Q; δ=−0.02 *10* for J=5 to J=5 transition.
531.2 *2*	1.4	3043.5	(9^+)	2512.5	(8)	(D)		δ(Q/D)=−0.02 *10*.
559†		721.8	$(3)^+$	162.5	$(3)^+$			
588.9 *2*	1.7	1142.1		553.05	$(3)^+$			Mult.: D+Q; δ=−0.05 *10* for J=4 to J=3 transition.

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^{63}Cu(α,nγ), ^{64}Zn(α,npγ) 1978Mo21 (continued)

$\gamma(^{66}Ga)$ (continued)

E_γ	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[#]	Comments
600.9 *2*	12.0	1464.4	(7)	863.7	(5)	(Q)		E_γ: contaminated γ line. δ(O/Q)=−0.03 *10*.
649.7 *2*	5.0	1513.5	(6)	863.7	(5)	(D)		δ(Q/D)=−0.02 *10*.
655[†]		721.8	$(3)^+$	66.17	$(2)^+$			
701.3 *2*	4.5	863.7	(5)	162.5	$(3)^+$	(Q)		δ(O/Q)=−0.1 *1*.
709.3 *2*	2.1	3362.4		2653.1	(9^+)			
718.0 *2*	3.0	784.0	(3)	66.17	$(2)^+$	(D)		δ(Q/D)=−0.02 *10*.
726.6 *2*	3.5	1142.1		415.4	$(4)^+$			Mult.: D+Q; δ=−0.07 *10* for J=4 to J=4 transition.
754.1 *2*	2.0	1617.8	(6)	863.7	(5)	(D+Q)	−0.34 *10*	
834[†@]		1350.7	(5)	516.1	$(4)^+$			
851.6 *2*	1.0	4271.8	(12)	3420.1	(10)	(Q)		δ(O/Q)=+0.05 *10*.
935.1 *2*	30.0	1350.7	(5)	415.4	$(4)^+$	(D)		δ(Q/D)=+0.0 *1*.
944.1 *2*	2.8	2408.5	(8)	1464.4	(7)	(D)		δ(Q/D)=−0.02 *10*.
947.1 *2*	0.4 *1*	5109.3	(13)	4162.2	(11)	(Q)		Mult.: from 947$\gamma(\theta)$, calculated from $\gamma(\theta)$ of the 944γ+947γ doublet in ^{64}Zn(α,npγ) and $\gamma(\theta)$ of 944γ in ^{63}Cu(α,nγ).
1048.3 *2*	8.0	2512.5	(8)	1464.4	(7)	(D+Q)	+0.72 *20*	
1066.9 *2*	2.2	4110.5	(10)	3043.5	(9^+)	(D)		δ(Q/D)=−0.02 *10*.
1118.6 *2*	1.8	4162.2	(11)	3043.5	(9^+)	(Q)		δ(O/Q)=+0.16 *20*.
1188.6 *2*	12.5	2653.1	(9^+)	1464.4	(7)	(Q)		δ(O/Q)=−0.09 *10*.
1268.4 *2*	5.0	3043.5	(9^+)	1775.0	(7)			E_γ: contaminated γ line.
1539.7 *2*	0.4	4192.8		2653.1	(9^+)			
1579.1 *2*	2.0	3043.5	(9^+)	1464.4	(7)	(Q)		δ(O/Q)=+0.03 *10*.
1649.7 *2*	2.0	4302.8		2653.1	(9^+)			E_γ: contaminated γ line.

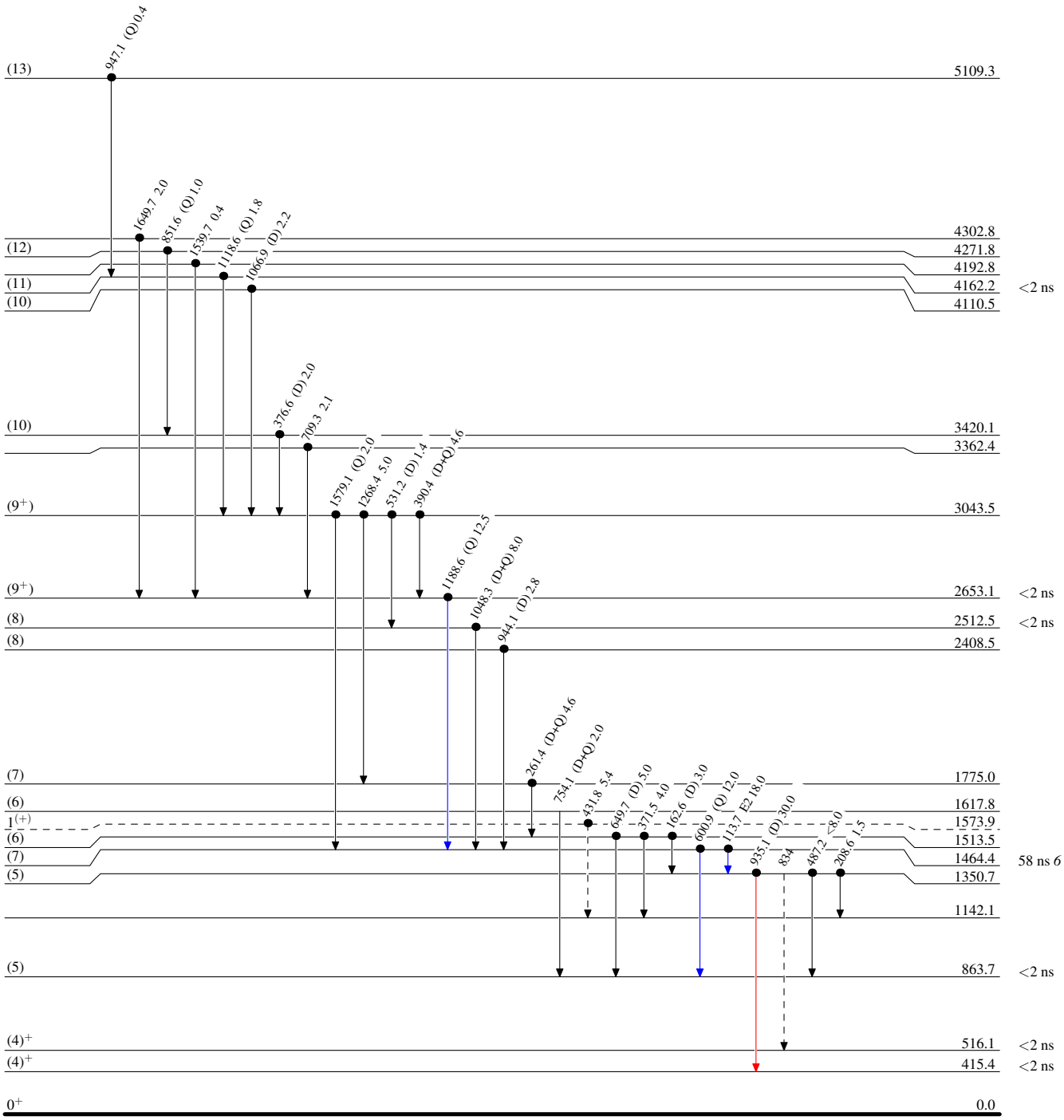
[†] Energy uncertainty and Iγ not available.
[‡] Relative photon intensity from ^{63}Cu(α,nγ) at Eα=18.5 MeV, except where noted otherwise; uncertainty not usually given (1978Mo21).
[#] From $\gamma(\theta)$ in ^{63}Cu(α,nγ) by 1978Mo21 and J^π of initial and final levels, except where noted otherwise.
[@] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

^{63}Cu(α,nγ), ^{64}Zn(α,npγ) 1978Mo21

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)
- Coincidence

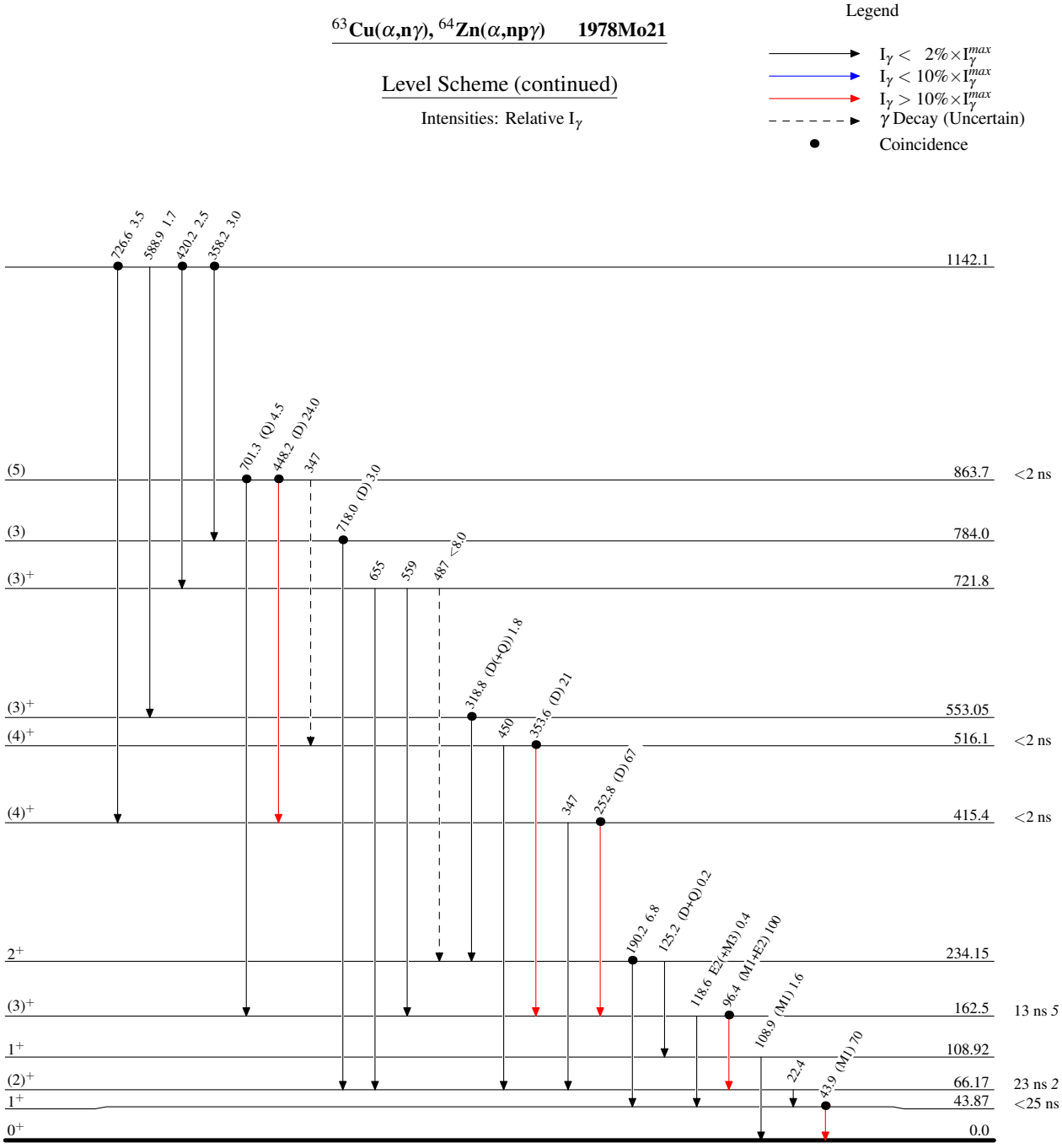


$^{66}_{31}Ga_{35}$

^{63}**Cu(α,nγ),** ^{64}**Zn(α,npγ)** **1978Mo21**

Level Scheme (continued)

Intensities: Relative I_γ



$^{66}_{31}Ga_{35}$