^{54}Cr(^{12}C,p3nγ) 2022Lu01

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, Huang Xiaolong, and Wang Xianghan	NDS 204,1 (2025)	30-Jun-2023

2022Lu01: E(^{54}Cr)=67 MeV beam from the Separated Sector Cyclotron of iThemba LABS. Measured Eγ, Iγ, $\gamma\gamma$-coin and $\gamma\gamma(\theta)$(ADO ratios) at 90° and 135°, $\gamma\gamma$(linear polarization) using AFRODITE array consisting of eleven Compton-suppressed clover detectors and three low-energy photon spectrometers (LEPS) for γ detection. Comparison with theoretical predictions from tilted axis cranking (TAC) covariant density functional theory (CDFT).

^{62}Cu Levels

E(level)[†]	J$^{\pi}$[‡]
0.0[#]	1$^+$
40.56[@] *17*	2$^+$
243.50[#] *10*	2$^+$
390.10[@] *16*	4$^+$
426.20[@] *18*	3$^+$
675.13[#] *16*	3$^+$
698.88 *22*	3$^+$
1249.49[#] *17*	4$^+$
1370.67[@] *19*	5$^+$
1485.53 *24*	4$^+$
1677.38[#] *17*	5$^+$
1917.42 *22*	5$^+$
1921.18 *20*	(5$^+$)
2147.75[@] *20*	6$^+$
2295.92[&] *19*	6$^-$
2518.8 *3*	6$^-$
2833.70[@] *20*	(7$^+$)
2893.16[a] *20*	7$^-$
3030.38[&] *23*	7$^-$
3190.92 *20*	6$^-$
3401.18[@] *22*	(8$^+$)
3435.11[a] *20*	8$^-$
3628.74[&] *20*	8$^-$
3678.17 *23*	8$^-$
3979.88[a] *22*	9$^-$
4105.37 *25*	9$^-$
4166.13[&] *21*	9$^-$
4448.09 *23*	9$^-$
4597.37 *24*	10$^-$
4628.96[b] *21*	(9$^-$)
4747.65[c] *23*	9$^+$
5001.22[&] *22*	10$^-$
5048.44[b] *22*	10$^-$
5108.8 *3*	(10$^-$)
5259.3 *3*	(10$^-$)
5619.14[b] *24*	11$^-$
5841.62[b] *23*	(12$^-$)
6009.48[c] *24*	11$^+$

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^{54}Cr(^{12}C,p3nγ) 2022Lu01 (continued)

^{62}Cu Levels (continued)

E(level)[†]	Jπ[‡]	Comments
6176.2[c] *3*	10^+	
6217.45 *24*	(11^-)	
6530.6 *3*	(13^-)	
7102.1 *3*	12^+	
7133.50[b] *24*	(13^-)	
7243.7 *5*	(14^-)	
7287.6[c] *3*	12^+	
7621.4 *3*	(12^+)	
8603.1 *9*	(13^+)	No γ rays from this level in 2022Lu01.
8961.3 *7*	(14^+)	

[†] From least-squares fit to Eγ data. The dataset is poorly fitted with reduced χ^2=9.1 as compared to critical χ^2=1.5, with 12 γ-ray energies with deviations of more than 3σ from the fitted values or level-energy differences, as indicated in comments.

[‡] As given in 2022Lu01, based on angular anisotropy (ADO ratios), and linear polarizations for selected transitions. Most assignments are the same as in earlier literature, except that some are given as firm values.

[#] Seq.(A): γ-cascade based on g.s. 1^+. Proposed configuration=$\pi(p_{3/2}f_{5/2})^1\otimes\nu(p_{3/2}f_{5/2})^5$ (2022Lu01).

[@] Seq.(B): γ-cascade based on 2^+. Proposed configuration=$\pi(p_{3/2}f_{5/2})^1\otimes\nu(p_{3/2}f_{5/2})^5$ (2022Lu01).

[&] Seq.(C): γ-cascade based on 6^-. Proposed configuration= $\pi(p_{3/2}f_{5/2})^1\otimes\nu g^1_{9/2}(p_{3/2}f_{5/2})^4$ (2022Lu01).

[a] Seq.(D): γ-cascade based on 7^-. Proposed configuration= $\pi f^{-1}_{7/2}(p_{3/2}f_{5/2})^2\otimes\nu g^1_{9/2}(p_{3/2}f_{5/2})^4$, with tentative magnetic rotational band (2022Lu01).

[b] Seq.(E): γ-cacade based on (9^-). Proposed configuration= $\pi f^{-1}_{7/2}(p_{3/2}f_{5/2})^2\otimes\nu g^1_{9/2}(p_{3/2}f_{5/2})^4$.

[c] Seq.(F): γ-cascade based on 9^+. Proposed configuration=$\pi g^1_{9/2}\otimes\nu g^1_{9/2}(p_{3/2}f_{5/2})^4$ (2022Lu01).

γ(^{62}Cu)

Typical ADO ratios: ≈1.2 for stretched quadrupole and ≈0.8 for ΔJ=1, pure dipole transitions.

Eγ	Iγ	Ei(level)	J^π_i	E_f	J^π_f	Mult.[‡]	Comments
40.4 *5*		40.56	2^+	0.0	1^+		
136.9 *2*	0.55 *9*	3030.38	7^-	2893.16	7^-	D	R(ADO)=1.30 *29*.
147.0 *3*	3.69 *45*	390.10	4^+	243.50	2^+	Q	R(ADO)=1.25 *4*.
191.8 *3*		1677.38	5^+	1485.53	4^+		
202.7 *2*	4.47 *54*	243.50	2^+	40.56	2^+		
222.9 *2*	0.74 *22*	2518.8	6^-	2295.92	6^-		
222.9 *1*	0.63 *16*	5841.62	(12^-)	5619.14	11^-	D	Eγ: poor fit. Level-energy difference=222.5. R(ADO)=0.81 *8*.
243.5 *1*	7.7 *18*	243.50	2^+	0.0	1^+		Iγ=7.69 *184* (2022Lu01).
243.7 *1*	4.40 *82*	3435.11	8^-	3190.92	6^-		Eγ: poor fit. Level-energy difference=244.2.
243.8 *1*		1921.18	(5^+)	1677.38	5^+		
253.5 *1*	0.72 *11*	5001.22	10^-	4747.65	9^+	D	R(ADO)=0.60 *6*.
272.9 *8*	0.18 *6*	698.88	3^+	426.20	3^+	D	R(ADO)=0.76 *5*.
285.0 *1*	0.50 *8*	675.13	3^+	390.10	4^+	D	R(ADO)=0.76 *8*.
335.6 *5*	0.42 *7*	7621.4	(12^+)	7287.6	12^+		Eγ: poor fit. Level-energy difference=333.8.
349.7 *2*	100.0	390.10	4^+	40.56	2^+	E2	R(ADO)=1.23 *9*, POL=+0.59 *8*.
358.2 *6*		8961.3	(14^+)	8603.1	(13^+)		
378.4 *2*	0.25 *4*	2295.92	6^-	1917.42	5^+	D	R(ADO)=0.46 *1*.
386.0 *5*	12.1 *15*	426.20	3^+	40.56	2^+	M1	Iγ=12.13 *147* (2022Lu01). R(ADO)=0.66 *2*. POL=−0.73 *9*.
403.9 *1*	1.51 *24*	5001.22	10^-	4597.37	10^-		
419.4 *2*	7.7 *12*	5048.44	10^-	4628.96	(9^-)	(D)	Iγ=7.69 *120* (2022Lu01). R(ADO)=0.92 *2*.

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^{54}Cr(^{12}C,p3nγ) 2022Lu01 (continued)

$\gamma(^{62}Cu)$ (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.‡	Comments
428.0 *2*	2.45 *38*	1677.38	5^+	1249.49	4^+	D	R(ADO)=0.72 *2*.
431.4 *2*	1.53 *24*	675.13	3^+	243.50	2^+	D	R(ADO)=0.72 *2*.
438.6 *1*	4.15 *65*	3628.74	8^-	3190.92	6^-		E_γ: poor fit. Level-energy difference=437.8.
467.6 *2*	2.52 *39*	4448.09	9^-	3979.88	9^-	D	R(ADO)=0.60 *2*.
476.7 *2*	3.32 *52*	4105.37	9^-	3628.74	8^-	D	R(ADO)=0.71 *2*.
487.8 *1*	0.81 *13*	4166.13	9^-	3678.17	8^-		
492.5 *3*	3.83 *60*	4597.37	10^-	4105.37	9^-	M1	R(ADO)=0.56 *2*. POL=−0.27 *15*.
519.3 *1*	1.79 *28*	7621.4	(12^+)	7102.1	12^+	(M1)	R(ADO)=0.52 *2*. POL=+0.37 *24*.
537.6 *1*	1.71 *32*	4166.13	9^-	3628.74	8^-		
537.8 *2*	4.9 *12*	2833.70	(7^+)	2295.92	6^-		Iγ=4.89 *119* (2022Lu01).
544.1 *2*	3.04 *74*	3435.11	8^-	2893.16	7^-		E_γ: poor fit. Level-energy difference=541.9.
544.5 *2*	19.9 *37*	3979.88	9^-	3435.11	8^-	D	Iγ=19.94 *374* (2022Lu01). R(ADO)=0.78 *1*.
567.8 *5*	0.73 *14*	3401.18	(8^+)	2833.70	(7^+)		
570.3 *2*	5.98 *94*	5619.14	11^-	5048.44	10^-	M1	R(ADO)=0.60 *2*. POL=−0.43 *21*.
574.6 *8*	2.12 *45*	1249.49	4^+	675.13	3^+		
596.9 *2*	56.7 *89*	2893.16	7^-	2295.92	6^-	(M1+E2)	Iγ=56.70 *887* (2022Lu01). R(ADO)=0.72 *3*. POL=+0.15 *4*.
599.1 *8*	1.23 *23*	3628.74	8^-	3030.38	7^-		
601.1 *8*		5048.44	10^-	4448.09	9^-		
x606.2†							
617.3 *3*	3.15 *49*	2295.92	6^-	1677.38	5^+	E1	E_γ: poor fit. Level-energy difference=618.5. R(ADO)=0.58 *2*. POL=+1.95 *32*.
660.7 *2*	5.35 *84*	5108.8	(10^-)	4448.09	9^-	D	R(ADO)=0.69 *9*.
675.4 *8*		675.13	3^+	0.0	1^+		
686.4 *2*	2.24 *42*	2833.70	(7^+)	2147.75	6^+		
689.0 *2*	4.12 *65*	6530.6	(13^-)	5841.62	(12^-)		
713.1 *3*	3.05 *48*	7243.7	(14^-)	6530.6	(13^-)		
730.2 *3*	2.50 *39*	4166.13	9^-	3435.11	8^-		
734.1 *5*	8.3 *17*	3030.38	7^-	2295.92	6^-		Iγ=8.26 *174* (2022Lu01).
735.1 *1*	4.84 *89*	3628.74	8^-	2893.16	7^-		E_γ: poor fit. Level-energy difference=735.6.
745.1 *2*	1.01 *16*	2893.16	7^-	2147.75	6^+		
777.3 *2*	6.6 *10*	2147.75	6^+	1370.67	5^+	M1+E2	Additional information 2. R(ADO)=0.77 *2*. POL=+0.38 *20*.
782.5 *4*	5.61 *88*	3678.17	8^-	2893.16	7^-	M1	R(ADO)=0.45 *2*. POL=−0.37 *32*. E_γ: poor fit. Level-energy difference=785.0.
789.2 *2*	1.65 *26*	3979.88	9^-	3190.92	6^-	[M3]	
793.3 *1*	1.79 *28*	5841.62	(12^-)	5048.44	10^-		POL=+0.33 *37*.
811.2 *2*	2.30 *36*	5259.3	(10^-)	4448.09	9^-	D	R(ADO)=0.56 *2*.
823.3 *1*	1.33 *21*	1249.49	4^+	426.20	3^+	M1	R(ADO)=0.73 *1*. POL=−0.39 *15*.
834.9 *2*	7.7 *12*	5001.22	10^-	4166.13	9^-	(D)	Iγ=7.73 *121* (2022Lu01). POL=+0.39 *13*.
x844.0†							
859.8 *3*	2.51 *39*	1249.49	4^+	390.10	4^+		
881.2 *3*	4.39 *69*	5048.44	10^-	4166.13	9^-		E_γ: poor fit. Level-energy difference=882.3.
895.5 *3*	3.28 *51*	5001.22	10^-	4105.37	9^-		
x903.5†							
925.1 *2*	91 *11*	2295.92	6^-	1370.67	5^+	E1	Additional information 3. R(ADO)=0.82 *2*. POL=+0.64 *8*.
944.5 *2*	1.87 *23*	1370.67	5^+	426.20	3^+	E2	R(ADO)=0.95 *1*. POL=+0.80 *18*.
980.6 *2*	99 *12*	1370.67	5^+	390.10	4^+	M1+E2	Additional information 1. R(ADO)=0.51 *1*. POL=+0.46 *6*.
990.1 *2*	4.02 *63*	5619.14	11^-	4628.96	(9^-)	(E2)	POL=+0.55 *28*.
1001.9 *2*	2.41 *45*	1677.38	5^+	675.13	3^+		
1005.8 *2*	0.21 *3*	1249.49	4^+	243.50	2^+	Q	R(ADO)=1.75 *6*.

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^{54}Cr(^{12}C,p3nγ) 2022Lu01 (continued)

γ(^{62}Cu) (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.‡	Comments
1008.1 *2*	2.43 *38*	6009.48	11^+	5001.22	10^-		
1014.2 *3*	4.11 *65*	4448.09	9^-	3435.11	8^-		E_γ: poor fit. Level-energy difference=1013.0.
x1040.4†							
1059.3 *2*	0.48 *8*	1485.53	4^+	426.20	3^+		
1068.7 *1*	1.85 *29*	5048.44	10^-	3979.88	9^-		
1092.5 *2*	3.26 *51*	7102.1	12^+	6009.48	11^+	(M1)	R(ADO)=0.30 *1*. POL=−0.33 *21*.
1111.7 *4*	2.36 *37*	7287.6	12^+	6176.2	10^+	Q	R(ADO)=1.28 *4*.
1118.8 *2*	17.7 *28*	4747.65	9^+	3628.74	8^-	E1	Iγ=17.67 *277* (2022Lu01). R(ADO)=0.54 *1*. POL=+0.23 *8*.
1135.2 *2*	3.96 *62*	4166.13	9^-	3030.38	7^-	Q	R(ADO)=1.46 *4*.
1139.2 *2*	20.0 *31*	3435.11	8^-	2295.92	6^-	Q	Iγ=20.04 *314* (2022Lu01). R(ADO)=1.07 *2*.
1147.8 *4*	4.23 *66*	2518.8	6^-	1370.67	5^+		
1169.0 *1*	3.43 *54*	6217.45	(11^-)	5048.44	10^-		
1193.9 *1*	3.82 *60*	4628.96	(9^-)	3435.11	8^-	D+Q	R(ADO)=1.59 *3*.
1222.3 *1*	0.17 *3*	1921.18	(5^+)	698.88	3^+	(Q)	R(ADO)=1.58 *8*.
1251.2 *2*	1.23 *19*	1677.38	5^+	426.20	3^+	(E2)	R(ADO)=1.56 *4*. POL=+0.44 *40*.
1253.4 *1*	1.14 *18*	3401.18	(8^+)	2147.75	6^+		
1261.9 *2*	7.7 *12*	6009.48	11^+	4747.65	9^+	(E2)	Additional information 5. R(ADO)=2.08 *2*. POL=+1.28 *22*.
1273.0 *2*	10.7 *17*	4166.13	9^-	2893.16	7^-	E2	Iγ=10.68 *167* (2022Lu01). R(ADO)=1.45 *1*. POL=+1.12 *22*.
1278.3 *2*	2.06 *32*	7287.6	12^+	6009.48	11^+	D	R(ADO)=0.61 *1*.
1287.3 *1*	2.10 *33*	1677.38	5^+	390.10	4^+		
1292.4 *1*	0.68 *11*	7133.50	(13^-)	5841.62	(12^-)		E_γ: poor fit. Level-energy difference=1291.9.
1332.6 *2*	25.7 *40*	3628.74	8^-	2295.92	6^-	E2	Iγ=25.69 *402* (2022Lu01). R(ADO)=1.22 *1*. POL=+1.05 *14*.
1372.7 *2*	3.29 *52*	5001.22	10^-	3628.74	8^-	E2	R(ADO)=1.24 *2*. POL=+1.38 *39*.
1417.8 *2*	1.06 *17*	4448.09	9^-	3030.38	7^-		
1428.6 *2*	2.81 *44*	6176.2	10^+	4747.65	9^+	(M1)	R(ADO)=0.96 *3*. POL=−0.97 *53*.
1437.6 *2*	3.12 *49*	4628.96	(9^-)	3190.92	6^-	[M3]	R(ADO)=1.90 *6*.
1462.9 *1*	3.52 *55*	2833.70	(7^+)	1370.67	5^+	Q	R(ADO)=1.44 *3*.
1491.1 *2*	1.00 *16*	1917.42	5^+	426.20	3^+	Q	R(ADO)=1.67 *3*.
1513.8 *1*	0.85 *25*	7133.50	(13^-)	5619.14	11^-		E_γ: poor fit. Level-energy difference=1514.3.
1514.0 *2*	0.71 *24*	3190.92	6^-	1677.38	5^+		
1554.9 *2*	2.99 *47*	4448.09	9^-	2893.16	7^-	Q	R(ADO)=1.15 *2*.
1611.4 *3*	5.08 *79*	7621.4	(12^+)	6009.48	11^+	(D)	R(ADO)=0.41 *1*.
1757.5 *2*	4.22 *26*	2147.75	6^+	390.10	4^+	E2	R(ADO)=1.30 *2*. POL=+1.21 *29*.
1820.7 *2*	6.6 *10*	3190.92	6^-	1370.67	5^+		Additional information 4.
1843.3 *2*	0.81 *13*	6009.48	11^+	4166.13	9^-		
1859.2 *6*		8961.3	(14^+)	7102.1	12^+		
1869.7 *5*	1.75 *28*	4166.13	9^-	2295.92	6^-	[M3]	
1906.0 *2*	0.79 *12*	2295.92	6^-	390.10	4^+		

† Probably belongs to ^{62}Cu, as observed in coincident spectrum with gate on 243.5γ+349.7γ+386.0γ, but not placed by 2022Lu01.
‡ Assigned by evaluators based on angular anisotropy (ADO ratios), and linear polarizations data in 2022Lu01.
x γ ray not placed in level scheme.

^{54}Cr(^{12}C,p3nγ) **2022Lu01**

Level Scheme

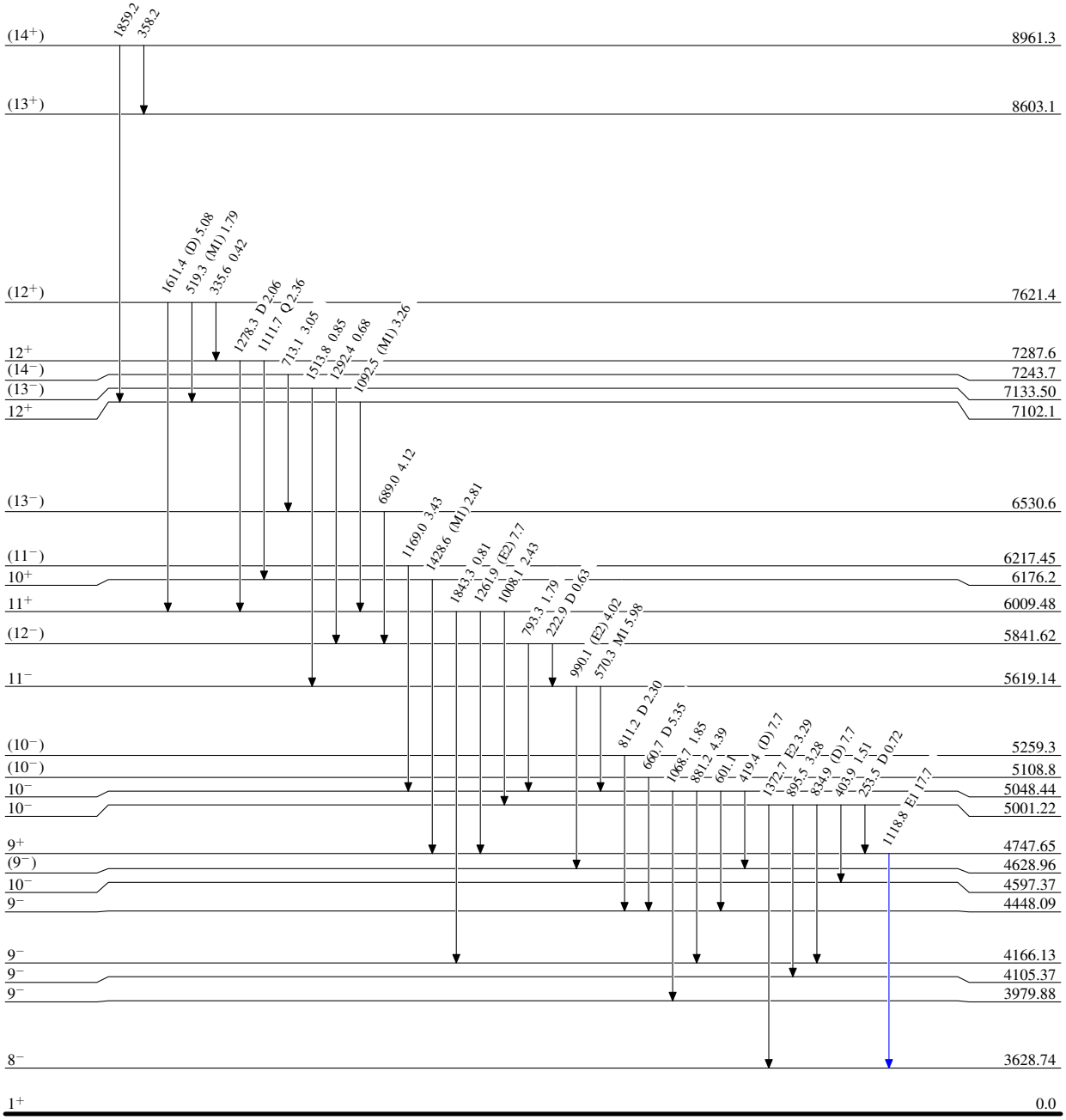
Intensities: Relative I_γ

Legend

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

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

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



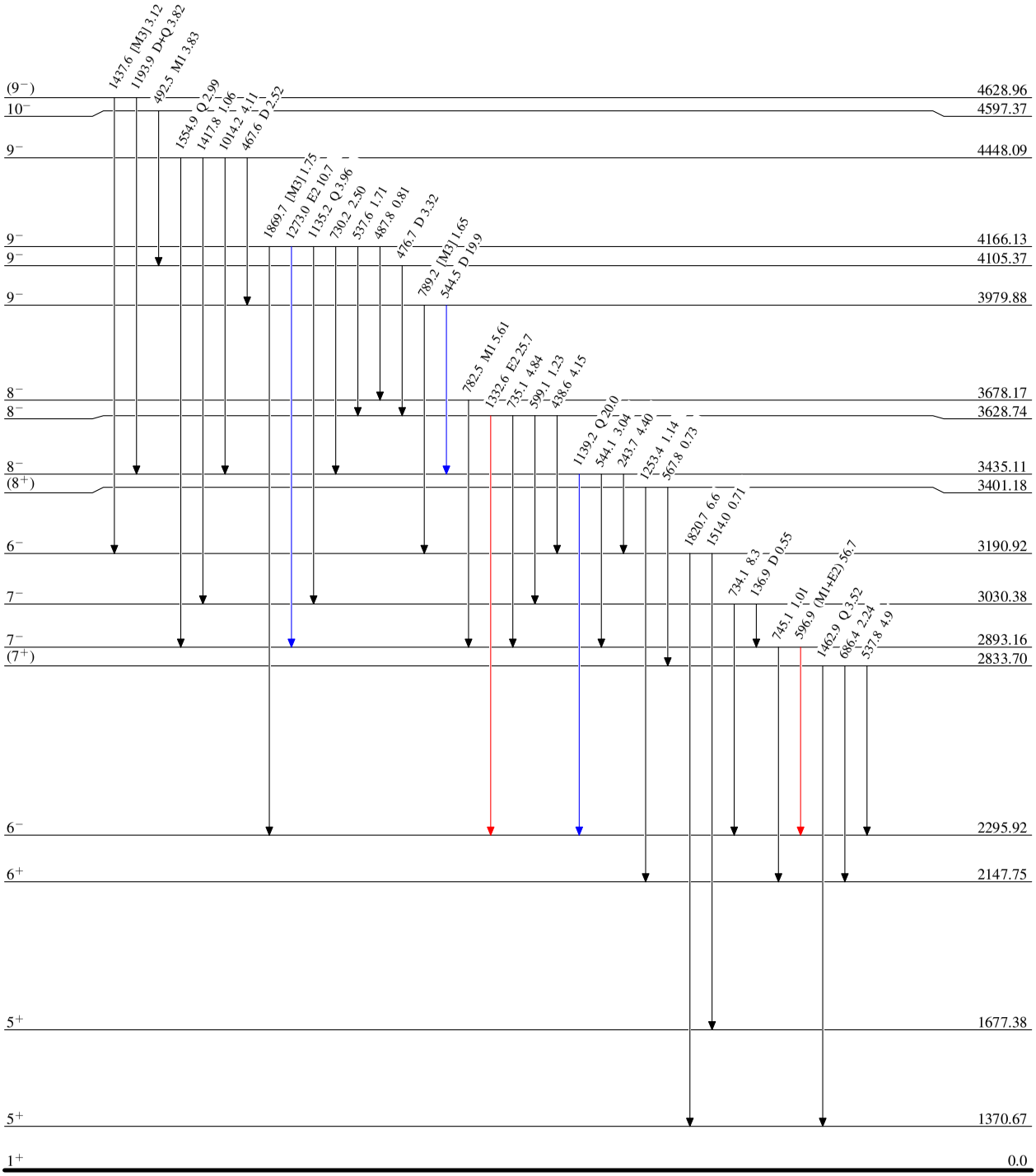
$^{62}_{29}Cu_{33}$

$^{54}Cr(^{12}C,p3n\gamma)$ **2022Lu01**

Level Scheme (continued)

Intensities: Relative I_γ

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

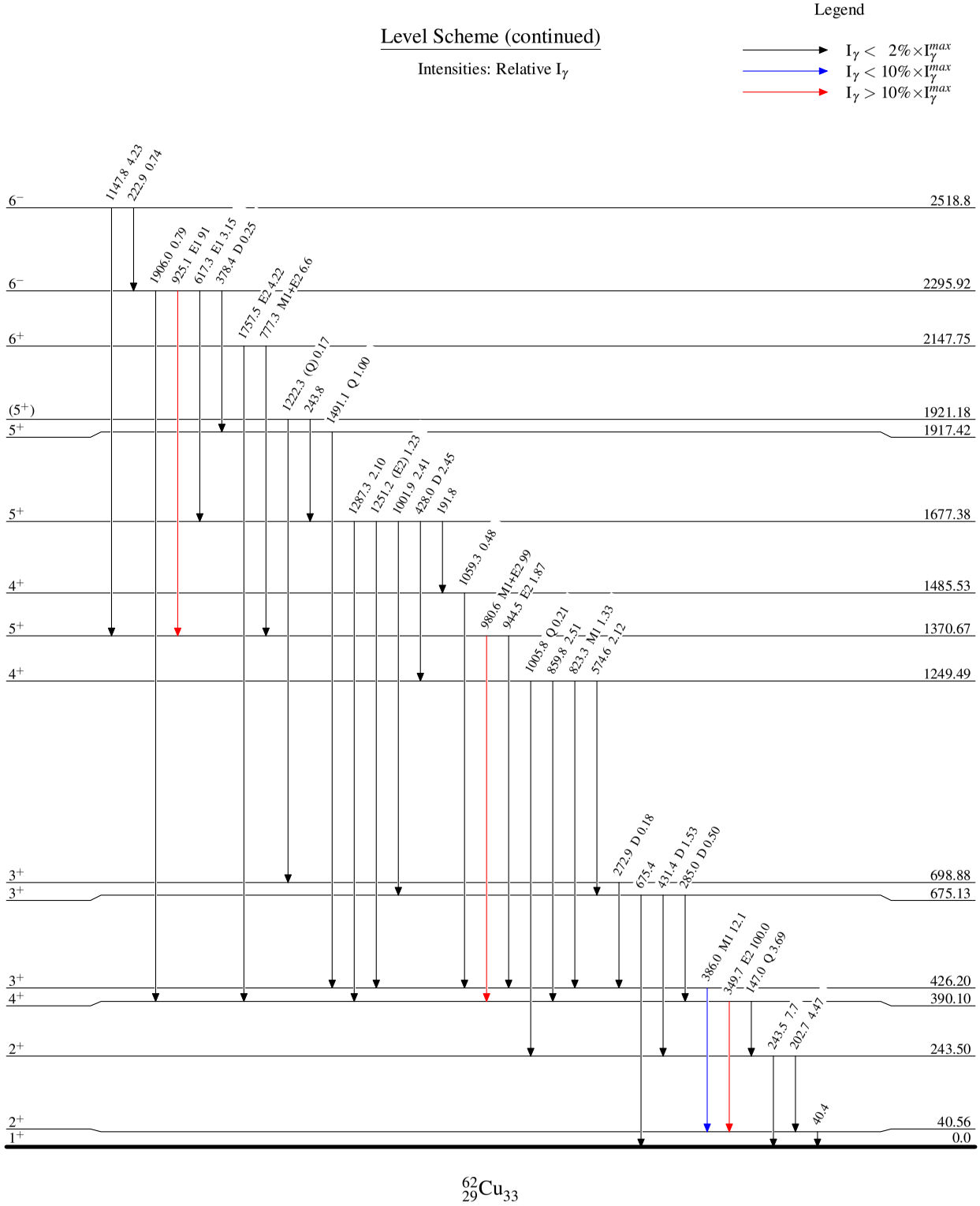


$^{62}_{29}Cu_{33}$

^{54}Cr(^{12}C,p3nγ) **2022Lu01**

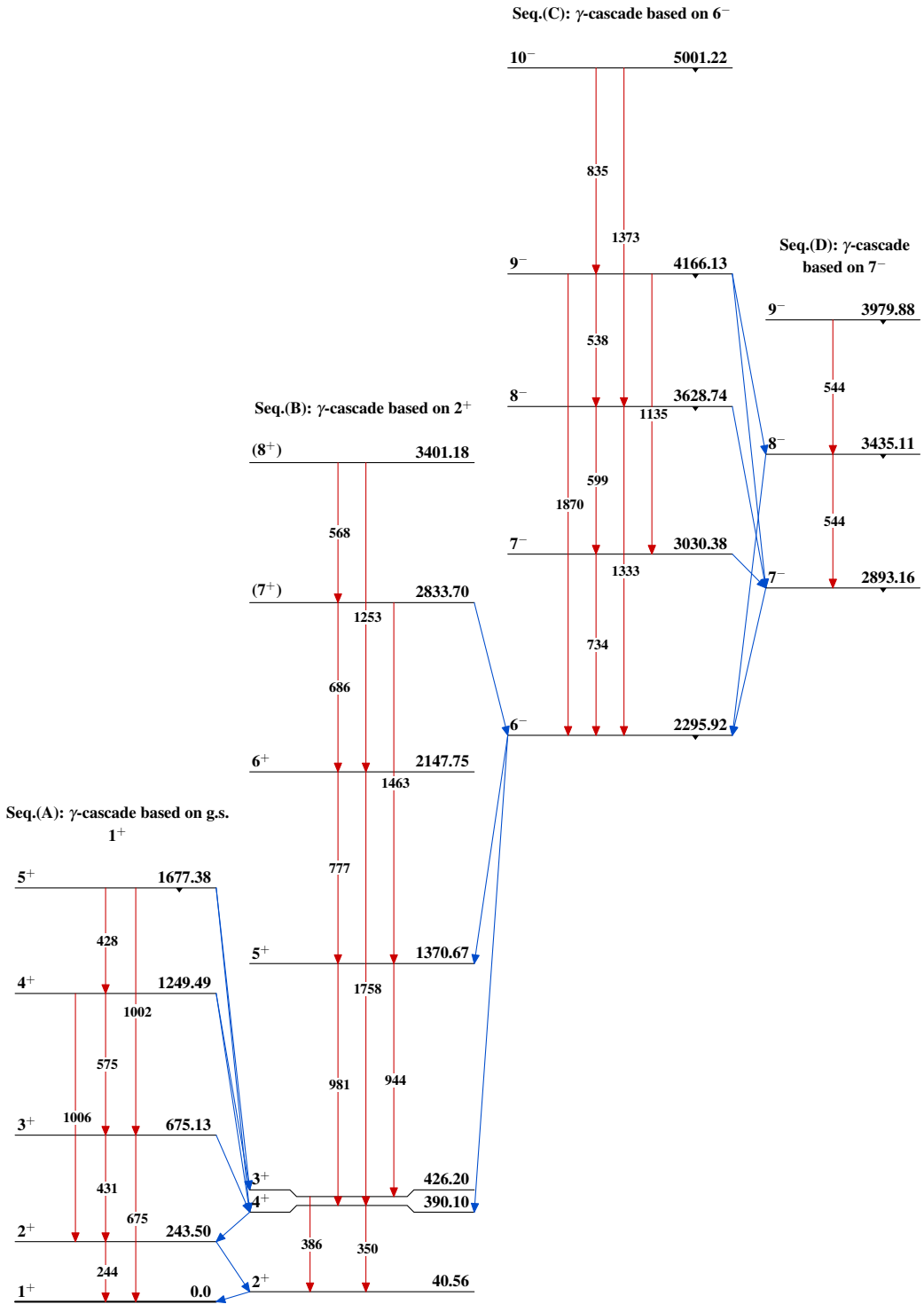
Level Scheme (continued)

Intensities: Relative I_γ



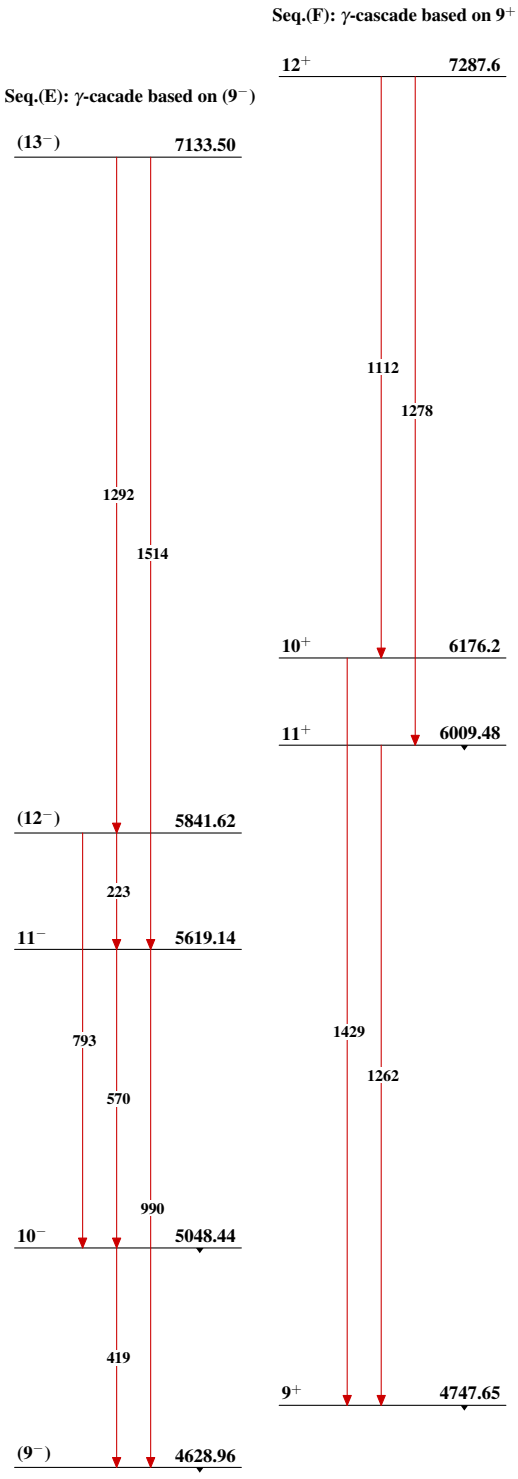
$^{62}_{29}Cu_{33}$

$^{54}Cr(^{12}C,p3n\gamma)$ 2022Lu01



$^{62}_{29}Cu_{33}$

$^{54}Cr(^{12}C,p3n\gamma)$ 2022Lu01 (continued)



$^{62}_{29}Cu_{33}$