^{65}Cu(^{36}S,3nγ) 1998Gh07

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen, Balraj Singh	NDS 164, 1 (2020)	15-Feb-2020

1998Gh07: E=142 MeV ^{36}S beam was produced from the 88-inch cyclotron at LBNL. Targets are two stacked, self-supporting, isotopically enriched ^{65}Cu foils (about 0.5 mg/cm^2). γ rays were detected with the early implementation phase of the Gammashpere array of 36 Compton-suppressed Ge detectors. Measured Eγ, Iγ, $\gamma\gamma$-coin, $\gamma\gamma\gamma$-coin, $\gamma\gamma(\theta)$(DCO). Deduced levels, J, π. Comparisons with shell-model calculations.

The level scheme including level energies and spins and placements of γ transitions differs significantly from the largely-extended decay scheme proposed by 2014Ku04 in ^{75}As(^{28}Si,2p3nγ), with the latter adopted in Adopted Levels and given in comments. It also differs significantly from that proposed by 1998Ch04 in ^{70}Ge(^{32}S,3pnγ).

Note that the level scheme proposed in 1998Gh07 is based on the 841 level which was proposed by 1983Be63 via (α,npγ) and (d,3nγ) based on the assumption of the 841γ proceeding to the (2)$^+$ ground state, while level energies and spins in Adopted Levels are based on the placement of 841γ to a level at E=56 with J^π=(5$^+$) proposed by 2014Ku04 in ^{75}As(^{28}Si,2p3nγ) based on their extended level scheme.

^{98}Rh Levels

E(level)[†]	J$^\pi$[@]	Comments
0.0[‡]	(2)$^+$[‡]	E(level): the ground state would not be seen as the 841γ proceeds to the isomer at 56 keV, according to the level scheme given in the Adopted dataset. J$^\pi$: from Adopted Levels.
841.6[‡] *4*	(4$^+$)[‡]	
1568.1[‡] *6*	(6$^+$)[‡]	
1947.1?[#] *9*		
2356.3?[#] *8*		
2563.4[‡] *7*	(8$^+$)[‡]	
2779.7?[#a] *8*	(9$^-$)	
2977.3[‡] *7*	(8$^+$)[‡]	
3243.1?[#a] *9*	(10$^-$)	
3543.6[‡&] *7*	(9$^+$)	J$^\pi$: (13$^+$) in Adopted Levels. Mult(980γ)=D is inconsistent with Q in 1998Ch04 and E2 in 2014Ku04.
3808.9[‡&] *7*	(10$^+$)[‡]	
4001.0?[#] *8*	(11$^+$)	
4035.6?[#a] *10*	(11$^-$)	
4358.7[‡&] *8*	(11$^+$)[‡]	
5416.6?[#a] *11*	(12$^-$)	
5483.9?[#] *9*	(12$^+$)	
5496.0[‡&] *9*	(13$^+$)[‡]	
5715.1?[#] *10*		
6349.7?[#a] *11*	(13$^-$)	
6624.5?[#] *11*	(13$^-$)	
6852.4?[#] *11*		
6859.9[‡&] *10*	(15$^+$)	
6963.5?[#] *15*	(14$^-$)	
7510.6 *10*	(17$^+$)	7558, (19$^+$) in Adopted Levels.
7697.1?[#a] *12*	(14$^-$)	
7717.0?[#] *10*	(16$^+$)	
7912.1?[#] *12*	(14$^-$)	
8293.1[&] *10*	(17$^+$)	8341 level in Adopted Levels; 8283, (16$^-$) level in 1998Ch04.
8400.3?[#] *11*	(19$^+$)	

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^{65}Cu(^{36}S,3nγ) 1998Gh07 (continued)

^{98}Rh Levels (continued)

E(level)[†]	Jπ[@]
8651.6?[#] *11*	(17$^+$)
8847.8?[#] *13*	
9184.6?[#a] *13*	(15$^-$)
9393.1?[#] *13*	
9496.4?[#] *12*	(21$^+$)

[†] From least-squares fit to γ-ray energies.
[‡] Level energies and spins in Adopted Levels are higher by about 56 keV and 3 units, respectively.
[#] Level is considered as questionable (by evaluators) since the deexciting transition was either placed differently or not seen in other studies in 2014Ku04 and 1998Ch04.
[@] Proposed by 1998Gh07 based on $\gamma\gamma$(DCO), unless otherwise noted. Evaluators have added brackets around firm assignments by 1998Gh07 for low-lying levels due to uncertain $J^\pi=(2)^+$ for the ground state.
[&] Seq.(A): γ cascade based on (9$^+$).
[a] Seq.(B): γ cascade based on (9$^-$).

γ(^{98}Rh)

E_γ[†]	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	Comments
207.1 *4*	5.0 *10*	2563.4	(8$^+$)	2356.3?			a 206.5γ placed from 3769, (12$^+$) level in Adopted Levels; not seen in 1998Ch04.
208.6[@&] *4*	≤1	9393.1?		9184.6?	(15$^-$)		
216.3[@] *4*	11.0 *10*	2779.7?	(9$^-$)	2563.4	(8$^+$)	D	DCO=1.2 *2* a 215.1γ placed from 4447, (14$^-$) level and a 215.2γ placed from 7552, (20$^-$) level in Adopted Levels; not seen in 1998CH04.
219.1[@&] *4*	4.0 *5*	5715.1?		5496.0	(13$^+$)		
265.2 *4*	23	3808.9	(10$^+$)	3543.6	(9$^+$)	D	DCO=1.6 *2*
379.0[@&]		1947.1?		1568.1	(6$^+$)		E_γ: from level energy difference.
409.2 *4*	≤1	2356.3?		1947.1?			a 409.1γ placed from 3563, (11$^+$) level and a 407.6γ placed from 2390, (8$^+$) level in Adopted Levels; not seen in 1998Ch04.
413.4 *4*	6.0 *6*	2977.3	(8$^+$)	2563.4	(8$^+$)		
457.4 *4*	8.5 *5*	4001.0?	(11$^+$)	3543.6	(9$^+$)	Q	DCO=2.2 *4* a 456.2γ placed from 5547, (16$^+$) level in Adopted Levels; from a 5489 level in 1998Ch04. Mult.: inconsistent with M1 from $\gamma\gamma$(DCO) and $\gamma\gamma$(pol) in 2014Ku04.
463.4 *4*	9.5 *10*	3243.1?	(10$^-$)	2779.7?	(9$^-$)	D	DCO=1.5 *3* a 462.7γ placed from 4232, (13$^-$) level in Adopted Levels; from 3022, (9$^+$) level in 1998Ch04.
549.5 *4*	23	4358.7	(11$^+$)	3808.9	(10$^+$)	D	DCO=1.5 *4*
650.7 *4*	10	7510.6	(17$^+$)	6859.9	(15$^+$)	Q	DCO=1.9 *3*
726.5 *4*	84.2	1568.1	(6$^+$)	841.6	(4$^+$)	Q	DCO=1.8 *3*
792.5 *4*	8.0 *22*	4035.6?	(11$^-$)	3243.1?	(10$^-$)	D	DCO=1.6 *3* a 792.0γ placed from 5024, (15$^-$) (E2) and a 792.3γ from 6404, (17$^-$) in Adopted Levels; from 3814, (11$^+$) in 1998Ch04. Mult.: inconsistent with Q from $\gamma\gamma$(DCO) in 1998Ch04

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^{65}Cu(^{36}S,3nγ) 1998Gh07 (continued)

γ(^{98}Rh) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	Comments
							and E2 from $\gamma\gamma$(DCO) and $\gamma\gamma$(pol) for 792.0γ in 2014Ku04.
815.4 *4*	30	4358.7	(11$^+$)	3543.6	(9$^+$)	Q	DCO=2.1 *5* Mult.: inconsistent with (D) from $\gamma\gamma$(DCO) in 1998Ch04 and M1 from $\gamma\gamma$(DCO) and $\gamma\gamma$(pol) in 2014Ku04.
831.4 *4*	18	3808.9	(10$^+$)	2977.3	(8$^+$)	Q	DCO=2.0 *4*
841.6 *4*	100	841.6	(4$^+$)	0.0	(2)$^+$	Q	DCO=1.9 *3*
857.1 *4*	4.0 *5*	7717.0?	(16$^+$)	6859.9	(15$^+$)		a 856.6γ placed from 6404, (17$^-$) level in Adopted Levels; from a 6345 level in 1998Ch04.
889.7 *4*	6.8 *10*	8400.3?	(19$^+$)	7510.6	(17$^+$)	Q	DCO=2.1 *4* a 889.6 placed from 1290, (7$^+$) level and a 888.4 from 2512, (9$^+$) level in Adopted Levels; not seen in 1998Ch04.
933.1 *4*	4.0 *10*	6349.7?	(13$^-$)	5416.6?	(12$^-$)	D	DCO=1.6 *3* a 933.6γ placed from 7337, (19$^-$) level in Adopted Level; from a 6127, (15$^+$) level in 1998Ch04. Mult.: inconsistent with Q from $\gamma\gamma$(DCO) in 1998Ch04 and E2 from $\gamma\gamma$(DCO) and $\gamma\gamma$(pol) in 2014Ku04.
934.6 *4*	4.0 *5*	8651.6?	(17$^+$)	7717.0?	(16$^+$)		a 933.6γ placed from 7337 level in Adopted Levels, not seen in 1998Ch04.
980.4 *4*	58	3543.6	(9$^+$)	2563.4	(8$^+$)	D	DCO=1.5 *3* Mult.: inconsistent with Q from $\gamma\gamma$(DCO) in 1998Ch04 and E2 from $\gamma\gamma$(DCO) and $\gamma\gamma$(pol) in 2014Ku04.
995.1 *4*	67	2563.4	(8$^+$)	1568.1	(6$^+$)	Q	DCO=2.0 *2*
1096.0 *4*	4.0 *10*	9496.4?	(21$^+$)	8400.3?	(19$^+$)		a 1096.1γ placed from 8655 level in Adopted Levels.
1125.2[@&] *4*	5.1 *6*	5483.9?	(12$^+$)	4358.7	(11$^+$)	D	DCO=1.6 *3*
1137.3 *4*	41	5496.0	(13$^+$)	4358.7	(11$^+$)	Q	DCO=2.1 *3*
1150.7 *4*	≤1	8847.8?		7697.1?	(14$^-$)		a 1151.7γ placed from 3769, (12$^+$) level in Adopted Level; from a 6346 level in 1998Ch04;
1207.9 *4*	2.5 *5*	6624.5?	(13$^-$)	5416.6?	(12$^-$)		a 1208.0γ placed from 7612 level in Adopted Levels; not seen in 1998Ch04.
1287.6 *4*	2.0 *8*	7912.1?	(14$^-$)	6624.5?	(13$^-$)		a 1288.2γ placed from 8900 level in Adopted Levels; not seen in 1998Ch04.
1347.4 *4*	2.0 *4*	7697.1?	(14$^-$)	6349.7?	(13$^-$)		a 1347.7γ placed from 8685, (21$^-$) level in Adopted Level; from a 7474, (17$^+$) level in 1998Ch04.
1363.9 *4*	26	6859.9	(15$^+$)	5496.0	(13$^+$)	Q	DCO=2.0 *3* E_γ: discrepant with 1361.9γ placed from 6909, (17$^+$) in Adopted Levels. Mult.: consistent with (Q) from $\gamma\gamma$(DCO) in 1998Ch04 but inconsistent with D in 2014Ku04.
1380.9 *4*	7.0 *10*	5416.6?	(12$^-$)	4035.6?	(11$^-$)	D	DCO=1.5 *2* a 1379.7γ placed from 6404, (17$^-$) level in Adopted Levels; from 5194, (13$^+$) level in 1998Ch04. Mult.: inconsistent with Q from $\gamma\gamma$(DCO) in 1998Gh07 and E2 from $\gamma\gamma$(DCO) and $\gamma\gamma$(pol) in 2014Ku04.
1409.4 *4*	13	2977.3	(8$^+$)	1568.1	(6$^+$)	Q	DCO=2.2 *4*
1433.1 *4*	4.0 *17*	8293.1	(17$^+$)	6859.9	(15$^+$)		
1435.9[@&] *4*	2.1 *5*	6852.4?		5416.6?	(12$^-$)		
1487.5 *4*	2.0 *12*	9184.6?	(15$^-$)	7697.1?	(14$^-$)		a 1486.2γ placed from 10171, (23$^-$) level in Adopted Level; from a 8960, (19$^+$) level in 1998Ch04.
1495 *1*	8.0 *10*	5496.0	(13$^+$)	4001.0?	(11$^+$)	Q	DCO=2.2 *4* a 1493.7γ placed from 5091, (15$^+$) in Adopted Levels; from a 5034 level in 1998Ch04.
1547[@&] *1*	2.0 *10*	6963.5?	(14$^-$)	5416.6?	(12$^-$)		

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^{65}Cu(^{36}S,3nγ) 1998Gh07 (continued)

γ(^{98}Rh) (continued)

† Note that most of values from 1998Gh07 are systematically higher by 0.5-1.5 keV than those from other γ-ray studies in 2014Ku04 and 1983Be63 and are not used in Adopted Gammas.
‡ Uncertainty is <10%, unless stated otherwise.
# From DCO ratios, mult=Q indicates ΔJ=2, quadrupole (most likely E2) transition and mult=D indicates ΔJ=1 (M1 or E1) transition (1998Gh07).
@ Transition is considered as questionable (by evaluators) since it was not seen in other γ-spectroscopy studies in 2014Ku04 and 1998Ch04.
& Placement of transition in the level scheme is uncertain.

^{65}Cu(^{36}S,3nγ) 1998Gh07

Level Scheme

Intensities: Relative I_γ

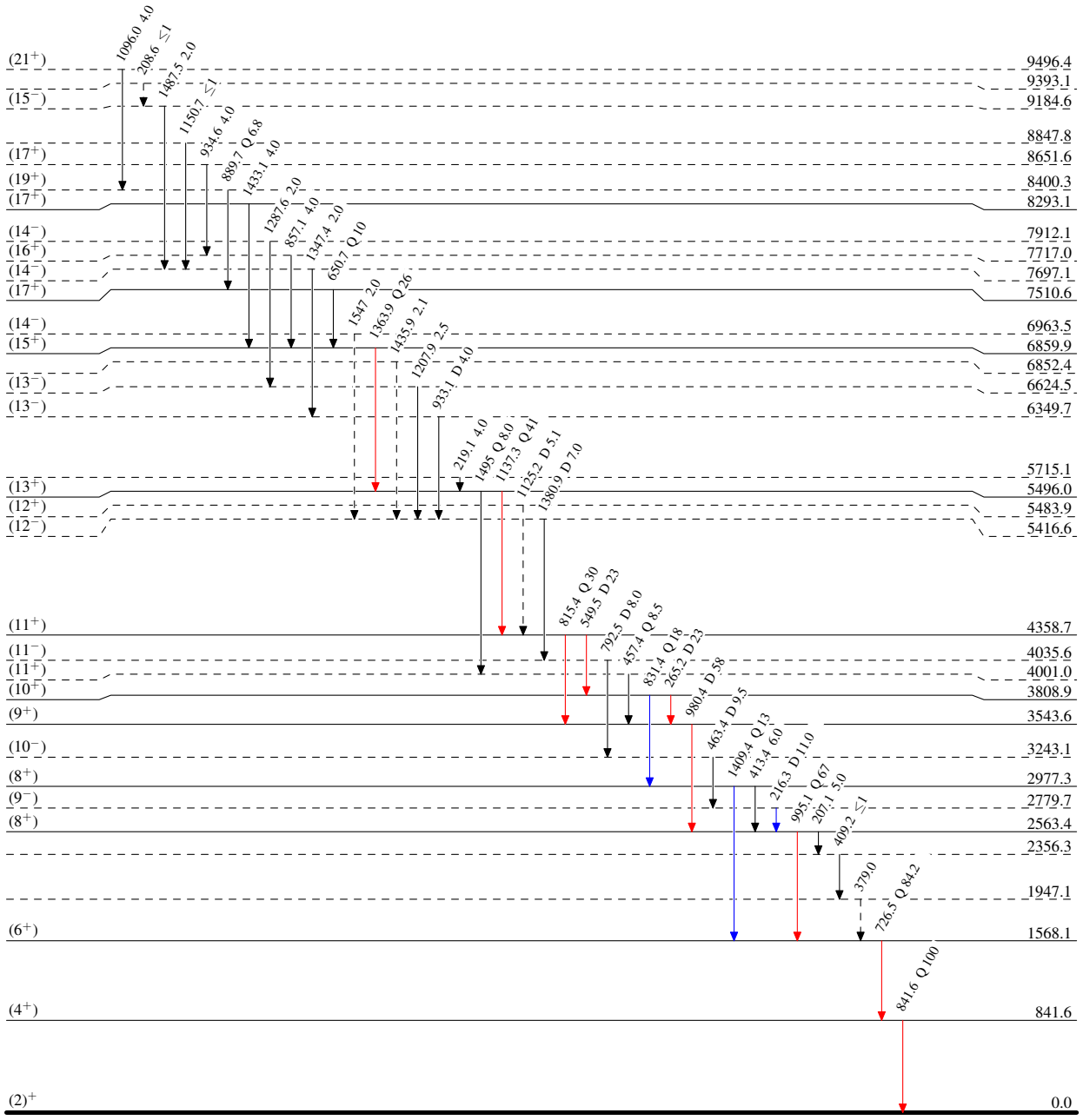
Legend

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

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

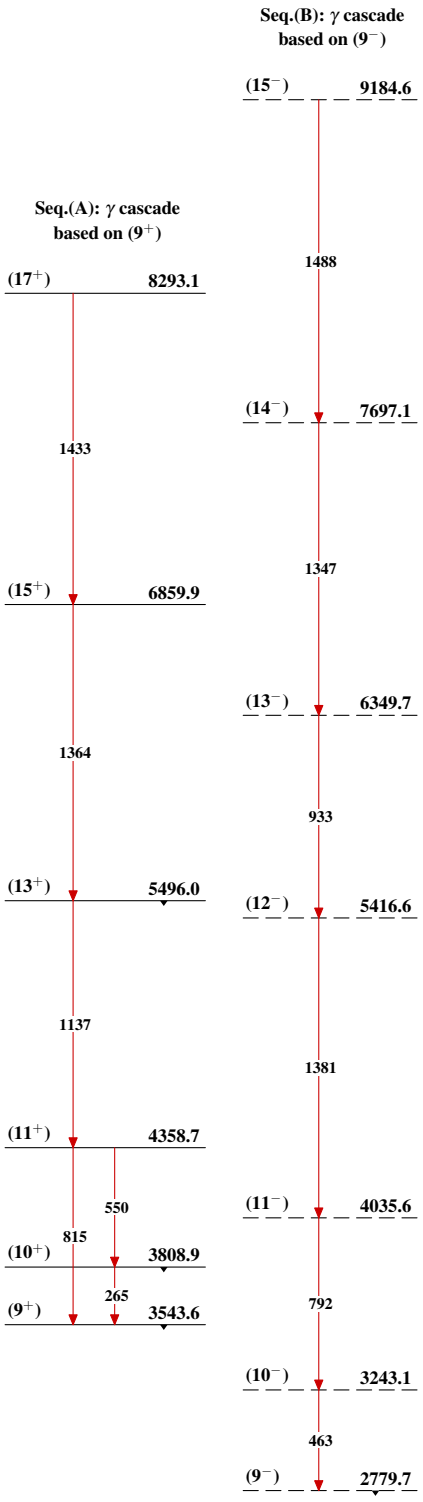
$I_\gamma > 10\% \times I_\gamma^{max}$

γ Decay (Uncertain)



$^{98}_{45}Rh_{53}$

^{65}Cu(^{36}S,3nγ) 1998Gh07



$^{98}_{45}Rh_{53}$