

⁵⁹Co(α ,n γ), ⁶⁰Ni(³He,p γ) 1977Ch04,1978ChZG

Type	Author	History	Citation	Literature Cutoff Date
Full Evaluation	Alan L. Nichols, Balraj Singh, Jagdish K. Tuli		NDS 113, 973 (2012)	15-Apr-2012

1977Ch04: E α =6-11 MeV, Ge(Li) singles and $\gamma\gamma$ coincidences as function of E α , n γ coincidences for E α =11 MeV as function of E(n) (tof), T_{1/2} by recoil-distance method.

1977Ch04: E(³He)=10.75-11.2 MeV, p γ coincidences, proton FWHM=16 keV, data on four γ rays associated with a p group corresponding to 2163 keV.

2831.9 level of 1977Ch04 (which should have been 2381.9 from 1683.6+698.3) withdrawn by 1978ChZG because the existence of this level was inferred from only one coincidence (1683.6 γ with 454.9 γ).

1974Hi06: (α ,n) E=14 MeV, $\sigma(\theta)$, deduced J-dependence of level density.

1974Gr34: (α ,n) E=14, 17.6 MeV, $\sigma(\theta,E(n))$, deduced energy and spin dependence of level density.

⁶²Cu Levels

E(level) [†]	J π [‡]	T _{1/2} [#]	Comments
0.0	1 ⁺		
40.90 17	2 ⁺		
243.68 17	2 ⁺		
288.3 3	1 ⁺ ,2 ⁺		
390.35 20	4 ⁺		
426.20 19	3 ⁺		
549.0 22	1 ⁺		
637.9 4	1 ⁺		
644.8 3	(2)		
675.25 21			
698.40 18	2 ⁺ ,3 ⁺		
727.57 20	2 ⁺		
755.63 25	(2)		
915.0 3			
983.2 3			
1023.15 23			
1051.9			
1078.1 22			
1141.88 24			
1248.11 23			
1285.4 3			
1346.6 4			
1367 3			
1370.3 3		<2 ps	
1403.5 18			
1410.7 4			
1427.8 4			
1485.1 3			
1504.8 4			E(level): 1507.4 if this level decays by the 832 γ , or 1504.9 if by the 777 γ ; within the uncertainties given by 1977Ch04, this level cannot decay by both of these γ rays. Possible doublet.
1511.3 2			
1568.2 3			
1677.76 24			E(level): 1977Ch04 propose a doublet because there are so many modes of deexcitation. 978.8 γ reported in Table 1 of 1977Ch04 should be deleted (1978ChZG).
1710.6 4			
1736.6 4			
1745.1 4			E(level): if E γ uncertainties estimated by 1977Ch04 are valid, this is a triplet with E=1743.4, 1745.0 and 1748.9 keV (1978ChZG). Only one of these possible levels has been adopted: level with the 1046.7 γ decay.
1820.6 4			
1827.6 4			

Continued on next page (footnotes at end of table)

⁵⁹Co(α ,n γ), ⁶⁰Ni(³He,p γ) **1977Ch04,1978ChZG (continued)**

⁶²Cu Levels (continued)

<u>E(level)[†]</u>	<u>E(level)[†]</u>	<u>T_{1/2}[#]</u>	<u>E(level)[†]</u>	<u>E(level)[†]</u>
1916.6 3	2154.7 4		2518.6 5	2889.1 6
1981.5 3	2160.8 3		2622.9 4	3025.1 6
2067.5 4	2239.7 4		2638.5 5	3578 3
2145.8 5	2293.5 5	16.4 ps 13	2740 3	
2148.5 4	2443.5 4		2827 3	

[†] From least-squares fit to E γ data, reduced $\chi^2=1.5$.

[‡] As proposed in Figure 5 of 1977Ch04.

[#] By recoil-distance Doppler-shift method. Effects of feeding from higher levels were minimized by choice of E α just above threshold.

γ (⁶²Cu)

<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}[†]</u>	<u>I_{γ}^{&}</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Comments</u>
40.90	2 ⁺	40.8 3		0.0	1 ⁺	
243.68	2 ⁺	243.4 3		0.0	1 ⁺	
288.3	1 ⁺ ,2 ⁺	247.4 3		40.90	2 ⁺	
390.35	4 ⁺	349.3 3		40.90	2 ⁺	
426.20	3 ⁺	385.3 3		40.90	2 ⁺	
549.0	1 ⁺	509 3		40.90	2 ⁺	
		548 3		0.0	1 ⁺	
637.9	1 ⁺	394 3		243.68	2 ⁺	
		597.0 3		40.90	2 ⁺	
644.8	(2)	644.8 3		0.0	1 ⁺	
675.25		285.0 3	5	390.35	4 ⁺	
		431.4 3	38	243.68	2 ⁺	
		634.4 3	57	40.90	2 ⁺	
698.40	2 ⁺ ,3 ⁺	272.0 3		426.20	3 ⁺	
		454.9 3		243.68	2 ⁺	
		657.5 3		40.90	2 ⁺	
		698.3 3		0.0	1 ⁺	
727.57	2 ⁺	484.4 3		243.68	2 ⁺	
		685.9 3		40.90	2 ⁺	
		727.8 3		0.0	1 ⁺	
755.63	(2)	755.9 3		0.0	1 ⁺	
915.0		489.2 3		426.20	3 ⁺	
		671.0 3		243.68	2 ⁺	
983.2		556.9 3	20	426.20	3 ⁺	
		592.9 3	35	390.35	4 ⁺	
		942 3	45	40.90	2 ⁺	
1023.15		385 ^{#a}		637.9	1 ⁺	
		779.5 3	≈40	243.68	2 ⁺	
		982 3	≈10	40.90	2 ⁺	
		1023.1 3	≈50	0.0	1 ⁺	
1051.9		376.6 3		675.25		
1078.1		687 3		390.35	4 ⁺	
		1038 3		40.90	2 ⁺	
1141.88		716.0 3	≈30	426.20	3 ⁺	
		751.7 3	≈50	390.35	4 ⁺	
		897.7 3	≈20	243.68	2 ⁺	
		1100 3		40.90	2 ⁺	I _{γ} : weak.
1248.11		573.2 3	10	675.25		

Continued on next page (footnotes at end of table)

$^{59}\text{Co}(\alpha, n\gamma), ^{60}\text{Ni}(^3\text{He}, p\gamma)$ **1977Ch04, 1978ChZG** (continued)

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

$E_i(\text{level})$	J_i^π	E_γ^\dagger	$I_\gamma \&$	E_f	J_f^π	Comments
1248.11		821.2 3	35	426.20	3 ⁺	
		857.4 3	≈5	390.35	4 ⁺	
		1006 3	≈5	243.68	2 ⁺	
		1207.9 3	45	40.90	2 ⁺	E_γ : from 1978ChZG; not 1209.1, as given in 1977Ch04.
1285.4		586.8 3		698.40	2 ⁺ , 3 ⁺	
		861.2		426.20	3 ⁺	ΔE : uncertainty > 0.3 keV (1978ChZG).
		997.1 3		288.3	1 ⁺ , 2 ⁺	
		1250 ^{#a} 3		40.90	2 ⁺	
1346.6		618 3		727.57	2 ⁺	
		667 ^{#a} 3		675.25		
		1102.9 3		243.68	2 ⁺	
		1303 ^{#a} 3		40.90	2 ⁺	
1367		1326 3		40.90	2 ⁺	
1370.3		979.3 3		390.35	4 ⁺	
1403.5		728 3		675.25		
		1013 3		390.35	4 ⁺	
		1363 3		40.90	2 ⁺	
1410.7		427.5 3		983.2		
1427.8		752.5 3		675.25		
		1392 3		40.90	2 ⁺	
1485.1		812.1 @a 3	≈20	675.25		
		1058.3 3	≈70	426.20	3 ⁺	
		1095.3 3	≈10	390.35	4 ⁺	
1504.8		777.2 3		727.57	2 ⁺	E_γ : listed incorrectly as 772.2 in Table 1 of 1977Ch04.
		832.3 @a 3		675.25		
1511.3		1086 3		426.20	3 ⁺	
		1120 3		390.35	4 ⁺	
		1469 ^{#a} 3		40.90	2 ⁺	
1568.2		892 3		675.25		
		1141.9 3		426.20	3 ⁺	
		1324.6 3		243.68	2 ⁺	
		1527 3		40.90	2 ⁺	
1677.76		429 3	9	1248.11		
		922.4 3	6	755.63	(2)	
		1002 3	15	675.25		
		1040 3	14	637.9	1 ⁺	
		1251.3 3	26	426.20	3 ⁺	
		1287.4 3	28	390.35	4 ⁺	
		1431 3	2	243.68	2 ⁺	E_γ : from 1978ChZG.
1710.6		1035 3	15	675.25		
		1284.4 3	85	426.20	3 ⁺	
1736.6		1061.3 3		675.25		
1745.1		1046.7 [‡] 3		698.40	2 ⁺ , 3 ⁺	
1820.6		1430.2 3		390.35	4 ⁺	
1827.6		1401.4 3		426.20	3 ⁺	
1916.6		545.6 3		1370.3		
		1491.1 3		426.20	3 ⁺	
		1877 3		40.90	2 ⁺	
1981.5		1306.0 3		675.25		
		1555.6 3		426.20	3 ⁺	
2067.5		1390 3		675.25		
		1641.3 3		426.20	3 ⁺	
2145.8		775.4 3		1370.3		
2148.5		1758.1 3		390.35	4 ⁺	
2154.7		1481 3	≈30	675.25		

Continued on next page (footnotes at end of table)

$^{59}\text{Co}(\alpha, n\gamma), ^{60}\text{Ni}(^3\text{He}, p\gamma)$ 1977Ch04, 1978ChZG (continued) $\gamma(^{62}\text{Cu})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^\dagger	$I_\gamma^\&$	E_f	J_f^π	$E_i(\text{level})$	J_i^π	E_γ^\dagger	E_f	J_f^π
2154.7		1728.5 3	≈ 70	426.20	3 ⁺	2622.9		2232.5 3	390.35	4 ⁺
2160.8		1462.5 3	≈ 90	698.40	2 ⁺ , 3 ⁺	2638.5		1268.1 3	1370.3	
		1917.0 3	≈ 10	243.68	2 ⁺	2740		1825 3	915.0	
2239.7		1849.3 3		390.35	4 ⁺	2827		534 3	2293.5	
2293.5		923.1 3		1370.3		2889.1		595.6 3	2293.5	
2443.5		1195.4 3		1248.11		3025.1		731.6 3	2293.5	
2518.6		1148.2 3		1370.3		3578		1285 3	2293.5	

[†] From 1977Ch04, except for the 978.8 γ , 1465 γ , and 1683.6 γ , which were rejected on recommendation of 1978ChZG.

[‡] From a possible triplet of levels near 1746 keV.

[#] Indicated as uncertain by 1977Ch04.

[@] In coincidence with 634.2 γ , indicating decay to the 675 level, but coincidences with other gammas from that level are weak or absent, making placement uncertain (1978ChZG).

[&] Branching ratios from Figure 5 of 1977Ch04.

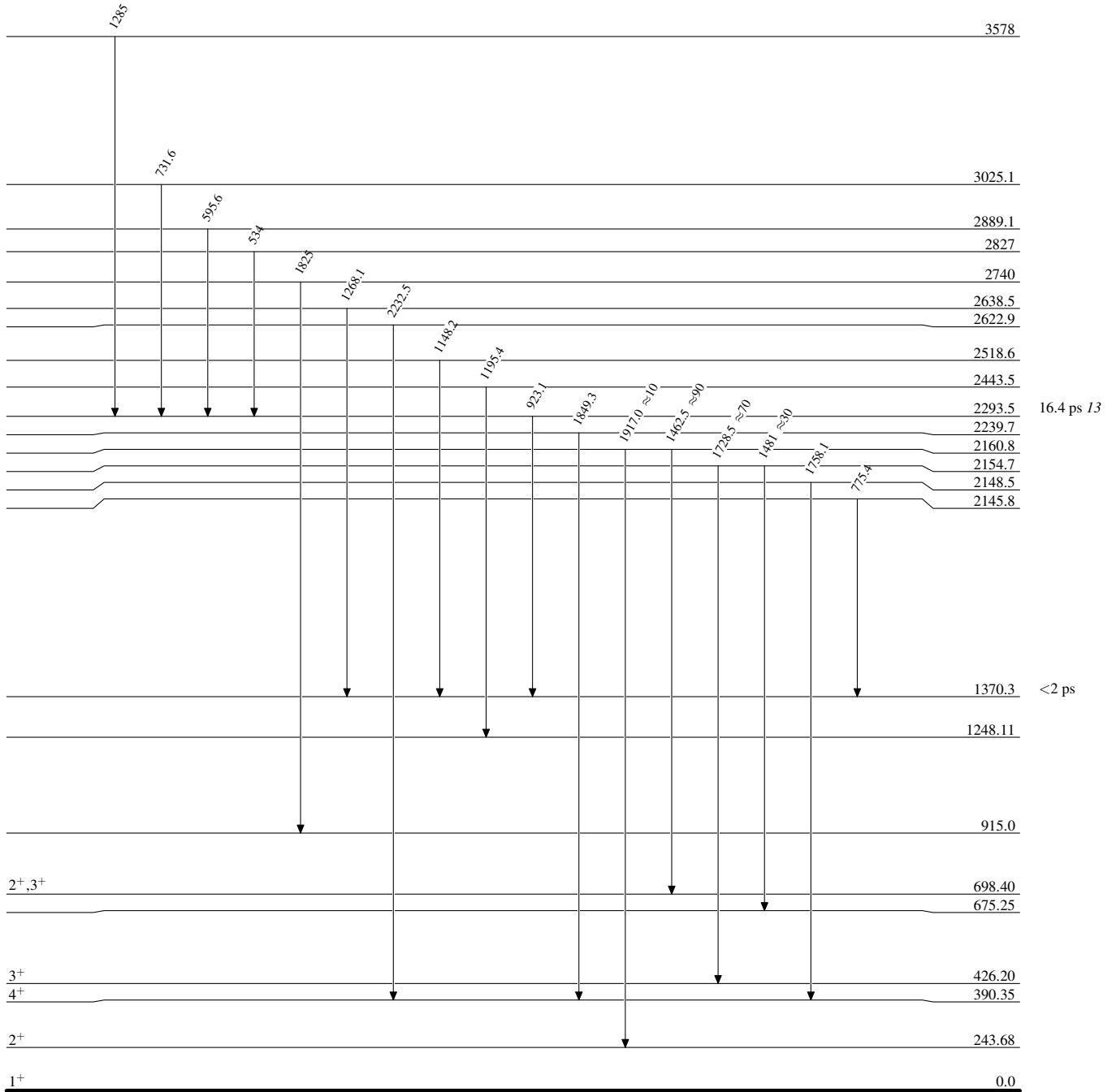
^a Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

$^{59}\text{Co}(\alpha, n\gamma), ^{60}\text{Ni}(^3\text{He}, p\gamma)$ 1977Ch04, 1978ChZG

Level Scheme

Intensities: % photon branching from each level

 $^{62}_{29}\text{Cu}_{33}$

$^{59}\text{Co}(\alpha,n\gamma), ^{60}\text{Ni}(^3\text{He,p}\gamma)$ 1977Ch04,1978ChZG

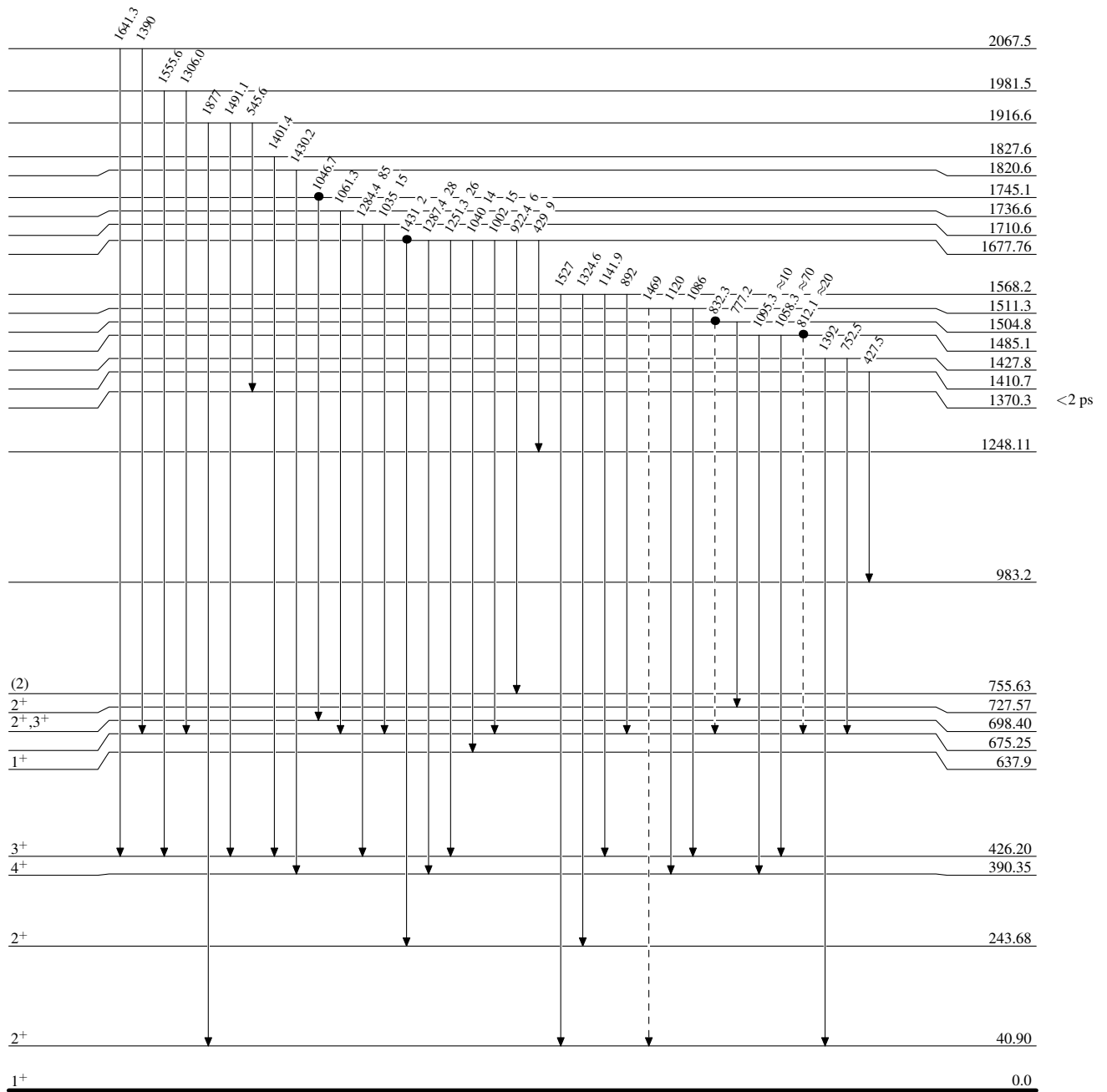
Legend

Level Scheme (continued)

Intensities: % photon branching from each level

-----▶ γ Decay (Uncertain)

● Coincidence



$^{62}_{29}\text{Cu}_{33}$

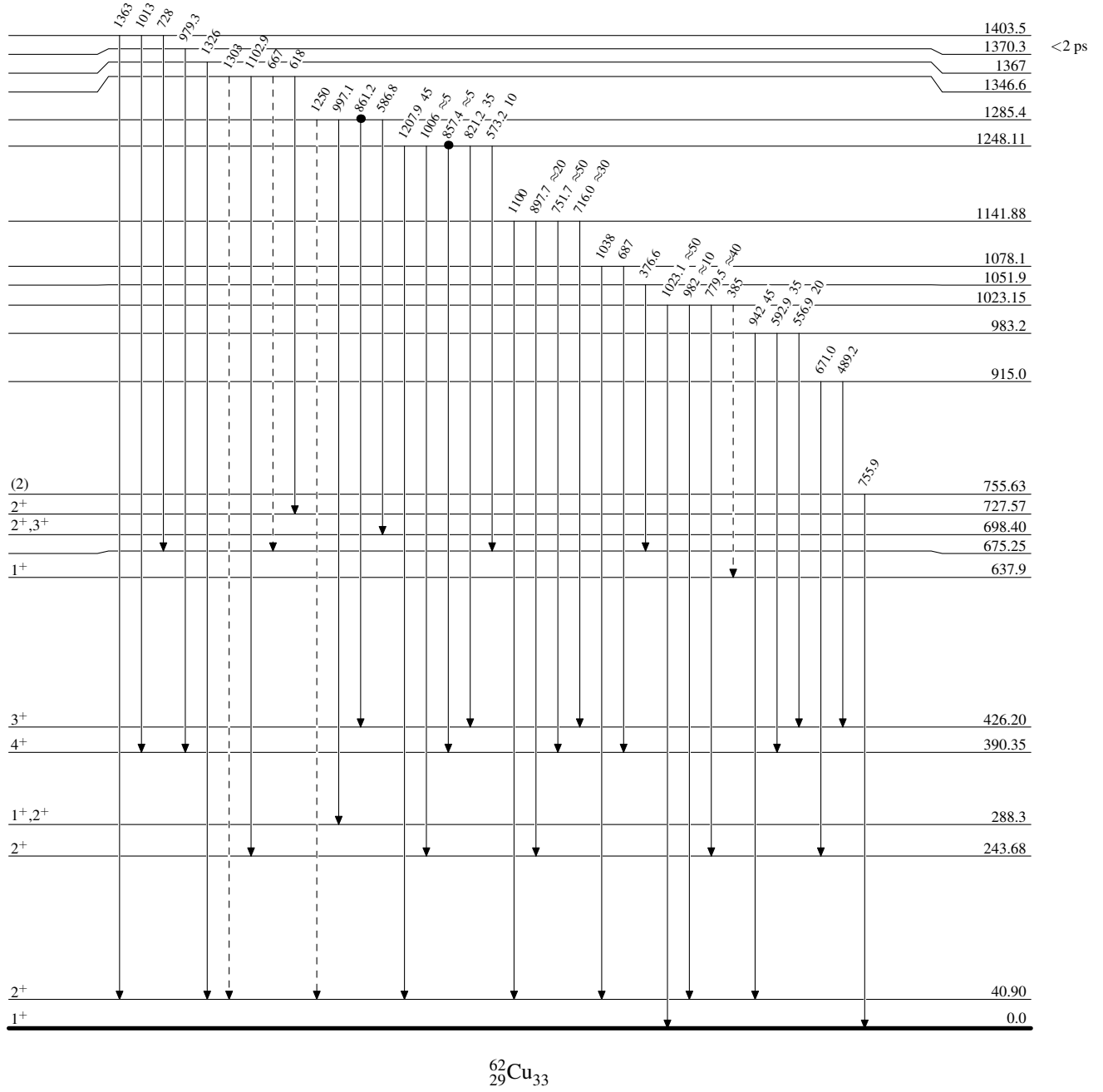
$^{59}\text{Co}(\alpha, n\gamma), ^{60}\text{Ni}(^3\text{He}, p\gamma)$ 1977Ch04, 1978ChZG

Legend

Level Scheme (continued)

Intensities: % photon branching from each level

-----▶ γ Decay (Uncertain)
 ● Coincidence



$^{62}_{29}\text{Cu}_{33}$

${}^{59}\text{Co}(\alpha,n\gamma), {}^{60}\text{Ni}({}^3\text{He},p\gamma)$ 1977Ch04,1978ChZG

Legend

Level Scheme (continued)

Intensities: % photon branching from each level

● Coincidence

