

Coulomb excitation 1972Ro21

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 202,59 (2025)	25-Feb-2025

($\alpha, \alpha' \gamma$):

1972Ro21: E=5.5-7.0 MeV α beams were produced from the ORNL 6-MeV Van de Graaff accelerator. Target was >97% enriched ⁶⁵Cu. γ rays were detected with a Ge(Li) detector and a NaI crystal. Measured E_γ , I_γ , $\gamma(\theta)$ and $\gamma\gamma(\theta)$. Deduced levels, γ -ray multipolarity, mixing ratio.

1964Ro10: E=4-8 MeV from Oak Ridge 5.5-MV Van de Graaff accelerator. Measured E_γ , γ -ray yields, $\gamma(\theta)$, $\gamma\gamma$ -coin. Deduced level, J , π , γ -ray mixing ratio, transition strengths.

1966Gu10: E=7.24, 7.85 MeV. Measured $\gamma(\theta)$. Deduced mixing ratio.

1956Te26: E=6 MeV. Measured γ -ray yield. Deduced transition strengths.

(¹⁶O, ¹⁶O' γ):

1964EI03: E=36 MeV. Measured E_γ , γ -ray yields, $\gamma(\theta)$. Deduced transition strengths, γ -ray mixing ratios.

1965Es01: E=36 MeV from Chalk River tandem. Measured E_γ , Doppler-shift attenuation. Deduced $T_{1/2}$, transition strengths.

1977Do16: E=35 MeV. Measured E_γ , Doppler-shift attenuation. Deduced level, $T_{1/2}$, transition strengths.

(p, p' γ):

1998Si25: E=2.0-4.5 MeV proton beams from the Variable Energy Cyclotron at Panjab University, Chandigarh. γ rays were detected with a Ge(Li) detector. Measured E_γ , I_γ , γ yield. Deduced levels, γ -ray transition strength.

(¹⁴N, ¹⁴N' γ):

1962Er05: E=36 MeV. Measured E_γ , γ -ray yields. Deduced transition strengths.

⁶⁵Cu Levels

Upper limits have been placed on B(E2) \uparrow for the 1623 level (B(E2)<0.003, **1964EI03**; B(E2)<0.005, **1964Ro10**) and the 1724 level (B(E2)<0.01, **1964Ro10**).

E(level) ^{†‡}	J π [#]	T _{1/2} [@]	Comments
0	3/2 ⁻		
770.8 5	1/2 ⁻	95 fs 25	B(E2) \uparrow =0.0099 5 J ^{π} : spin=1/2 from $\gamma(\theta)$ in 1964EI03,1964Ro10 . T _{1/2} : weighted average of 90 fs 25 (1965Es01) and 100 fs 26 (1977Do16), by DSAM. B(E2) \uparrow : weighted average of 0.0087 13 (1956Te26), 0.010 2 (1962Er05), 0.0102 11 (1964Ro10), and 0.0100 5 (1998Si25). Other: 0.0078 (1964EI03).
1115.3 4	5/2 ⁻	0.42 ps 8	B(E2) \uparrow =0.0305 21 T _{1/2} : weighted average of 0.37 ps 6 (1965Es01) and 0.55 ps 10 (1977Do16), by DSAM. B(E2) \uparrow : weighted average of 0.027 4 (1956Te26), 0.028 5 (1962Er05), 0.0345 38 (1964Ro10), and 0.0306 21 (1998Si25). Other: 0.026 1 includes only relative uncertainty (1964EI03).
1481.6 4	7/2 ⁻	0.53 ps 11	B(E2) \uparrow =0.037 6 J ^{π} : spin=7/2 from 1481.4 $\gamma(\theta)$ in 1964EI03 . T _{1/2} : from DSAM in 1965Es01 . Other: 0.36 ps +8-6 from B(E2) \uparrow =0.037 6 here. B(E2) \uparrow : weighted average of 0.034 6 (1962Er05) and 0.043 8 (1964Ro10). Other: 0.030 1 (1964EI03) includes only relative uncertainty.
1623.0 10			

[†] Additional information 1.

[‡] From a least-squares fit to γ -ray energies.

[#] From Adopted Levels. Supporting arguments from this reaction are indicated in comments.

[@] From values from DSAM, a 15% systematic uncertainty has been added in quadrature by the evaluator to account for uncertainty in the stopping power.

Coulomb excitation 1972Ro21 (continued)

								$\gamma(^{65}\text{Cu})$		
$E_i(\text{level})$	J_i^π	E_γ^\dagger	I_γ^\dagger	E_f	J_f^π	Mult.	δ	Comments		
770.8	1/2 ⁻	770.8 5	100	0	3/2 ⁻			A ₂ =-0.001 1 (1972Ro21), A ₄ =-0.005 18 (1964Ro10). A ₂ =-0.015 46, A ₄ =-0.100 55 (1964EI03).		
1115.3	5/2 ⁻	1115.5	100	0	3/2 ⁻	M1+E2	-0.24 5	E _γ : used for energy calibration in 1972Ro21. Mult.: D+Q from $\gamma(\theta)$ in all references listed in the δ comment below; E1+M2 ruled out by RUL. δ : weighted average of -0.24 13 (1964EI03), -0.22 6 (1964Ro10), -0.19 6 (1966Gu10) and -0.28 5 (1972Ro21). Others: -1.8 (1964Ro10) and -1.9 3 (1966Gu10), another solution from $\gamma(\theta)$; 0.59 +11-10 from adopted B(E2) [†] =0.0305 21 here and T _{1/2} =0.42 ps 8. A ₂ =-0.174 14 (1972Ro21), A ₄ =-0.142 16 (1964Ro10). A ₂ =-0.252 40, A ₄ =-0.040 47 (1964EI03). I _γ : other: 24 (1964EI03). Mult., δ : from $\gamma\gamma(\theta)$ at 0° and 90° (obtained using $\delta(1115\gamma)=-0.28 5$) and $\gamma(\theta)$ in 1972Ro21; E1+M2 ruled out by RUL. A ₂ =-0.28 9 (1972Ro21). I _γ : other: 76 (1964EI03). A ₂ =+0.222 14 (1972Ro21). A ₂ =+0.250 70, A ₄ =+0.016 94 (1964EI03). E _γ : from 1964EI03, very weak.		
1481.6	7/2 ⁻	366.7 7	15 2	1115.3	5/2 ⁻	M1+E2	-0.16 6			
		1481.4 5	85 2	0	3/2 ⁻	[E2]				
1623.0		1623		0	3/2 ⁻					

[†] From 1972Ro21, unless otherwise noted.

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Legend

Level Scheme

Intensities: % photon branching from each level

● Coincidence

