Adopted Levels, Gammas

History			
Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	ENSDF	25-Mar-2022

Q(β^-)=−13240 *SY*; S(n)=1507×10[1] *16*; S(p)=583 *6*; Q(α)=−6711 *8* 2021Wa16
Estimated ΔQ(β^-)=400 (2021Wa16).
Q(ε)=15278 *6*, Q(εp)=8111 *6*, S(2n)=33530 *400* (syst), S(2p)=5198 *6* (2021Wa16).
1987Po04: ^{56}Cu produced and identified in Ni,Al(^{58}Ni,X)),E=55 MeV/nucleon and fragments separated using LISE spectrometer at GANIL. A total of 1420 events were assigned to ^{56}Cu, and production rates were measured.
1998Ra15: ^{56}Cu produced in Si(^{32}S,X),E=148 MeV and fragments separated using separator at GSI facility. Measured half-life of decay of ^{56}Cu by $\beta\gamma$-coin decay curve. 2002Ro25 and 2002Ro16 are conference articles related to work reported in 1998Ra15.
2001Bo54: ^{56}Cu produced in ^{28}Si(^{32}S,X),E=148 MeV and fragments separated using separator at GSI facility. Measured half-life of decay of ^{56}Cu by γ-decay curves, and %β^+p decay branch.
2002Lo13 (also 2002Bl17): ^{56}Cu produced in ^{9}Be,C(^{78}Kr,X),E=73 MeV/nucleon and fragments separated using LISE separator at GANIL. Measured half-life of decay of ^{56}Cu from timing of correlated (implants)(decay) events.
2007Bl09: ^{56}Cu produced in Ni(^{70}Ge,X),E=71.6 MeV/nculeon and fragments separated using LISE-3 separator at GANIL. Measured production cross section of ^{56}Cu.
2017Ku12: ^{56}Cu isotope produced in fragmentation of 79 MeV/nucleon ^{64}Zn^{29+} beam with Ni target of 236 mg/cm^2 thickness. Fragments were selected with the LISE3 separator at GANIL and identified by time-of-flight and energy loss using silicon ΔE detector and implanted into a double-sided silicon strip detector (DSSSD). The implanted ions and charged-particle decays were detected by the DSSSD, which was surrounded by four HPGe Clover detectors (three EXOGAM clovers and a smaller Euroball clover) for γ-ray detection. Half-life of ^{56}Cu decay was measured by (^{56}Cu implants)β time-correlated decay events.
2020Gi02 (also 2017GoZT): ^{56}Cu produced at RIBF-RIKEN facility in ^{9}Be(^{78}Kr,X) reaction at E=345 MeV/nucleon, followed by selection of ions using BigRIPS separator and Zero degree spectrometer ZDS, and implanted in the detection system WAS3ABi, consisting of three highly-segmented 1 mm thick double-sided silicon detectors, a stack of ten segmented 1 mm thick single-sided silicon strip detectors. Measured half-life of ^{56}Cu from timing of correlated (implants)(decay) events.
Mass measurements: 2018Va01, 2018Zh29.

Theoretical structure and decay calculations: 17 primary references extracted from the NSR database (www.nndc.bnl.gov/nsr/) are listed in this dataset under 'document' records.
Additional information 1.

^{56}Cu Levels

Cross Reference (XREF) Flags

- A ^{56}Zn ε decay (32.4 ms)
- B ^{1}H(^{56}Ni,N)
- C ^{2}H(^{56}Ni,^{56}Cuγ)

E(level)†	J$^\pi$	T$_{1/2}$	XREF	Comments
0	(4$^+$)	80.4 ms *8*	ABC	%ε+%β^+=100; %εp=0.40 *12* (2001Bo54) XREF: B(?). T$_z$=−1. J$^\pi$: analogy to g.s., 4$^+$ in ^{56}Co mirror nucleus. T$_{1/2}$: from 2001Bo54. Others: 78 ms *15* (1998Ra15), 82 ms *9* (2002Bl17,2002Lo13). T$_{1/2}$: NRM weighted average of 80.2 ms *7* (2020Gi02,2017GoZT, correlated implants-decay events at RIBF-RIKEN); 80 ms *2* (2017Ku12, ^{56}Cu implants)β correlated decays at GANIL); 82 ms *9* (2002Lo13,2002Bl17, correlated implants-decays at GANIL); 93 ms *3* (2001Bo54, γ-decay curves at GSI); 78 ms *15* (1998Ra15, $\beta\gamma$-coin decay curve at GSI). In NRM weighted average, uncertainty in 2001Bo54 gets inflated to 5.4 ms from the stated uncertainty of 3 ms. Weighted average is 80.8 ms *13*, but reduced χ^2=4.4 is larger that the critical χ^2=2.4 at 95%

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Adopted Levels, Gammas (continued)

^{56}Cu Levels (continued)

E(level)[†]	J^π	XREF	Comments
			confidence level. Unweighted average is 82.6 ms *27*.
			Total number of ^{56}Cu implanted ions=1.77×10^5 in Ni(^{64}Zn,X), E=79 MeV/nucleon (2017Ku12).
166 *1*	(3^+)	C	J^π: analogy to 158, 3^+ level in ^{56}Co mirror nucleus.
572 *1*	(5^+)	C	J^π: analogy to 576, 5^+ level in ^{56}Co mirror nucleus.
826 *4*	(4^+)	C	J^π: analogy to 830, 4^+ level in ^{56}Co mirror nucleus.
<1×10^3[#]		B	E(level): excitation energy below the proton-decay threshold. This peak may have components of g.s and levels up to 1037, (2^+) level.
			J^π: L=2 in ^{56}Ni(p,n) inverse reaction suggests positive parity.
1037 *4*	(2^+)	C	J^π: analogy to 970, 2^+ level in ^{56}Co mirror nucleus.
1224 *4*	(3^+,5^+)	C	J^π: analogy to 1115, 3^+ and 1009, 5^+ levels in ^{56}Co mirror nucleus.
1414[‡] *12*	(0^+)	A	T=1
			J^π: analogy to 1451, 0^+ level in ^{56}Co mirror nucleus.
1714[‡] *12*	1^+	A	%p=34 *22* (2014Or04)
			T=1
			J^π: log *ft*=4.1 from 0^+ parent state.
2560[‡] *12*	(1^+)	A	%p=100
			T=1
			J^π: analogy to 2636, 1^+ level in ^{56}Co mirror nucleus.
2684[‡] *12*	1^+	A	%p=100
			T=1
			J^π: log *ft*=4.1 from 0^+ parent state.
3446[‡] *12*	1^+	A	%p=100
			T=1
			E(level): probable doublet, both with $J^\pi=1^+$.
			J^π: log *ft*=3.8 *1* from 0^+ parent state; analogy to 3432,1^+ and 3496,1^+ levels in ^{56}Co mirror nucleus, as reported in 2013Fu15 in (^{3}He,t). In ^{56}Co Adopted Levels in ENSDF database, corresponding two levels are 3436, 0^+,1^+ and 3510, (0^+).
3531[‡] *12*	0^+	A	%p=44 *6* (2014Or04)
			T=2
			T_z=−1.
			J^π: log *ft*=3.44 *11*, superallowed β decay from 0^+ parent state; isobaric analog state (IAS) of g.s. in ^{56}Zn.
5×10^3[#] *3*	1^+	B	E(level): two peaks at 2.8 and 4.8 MeV are visible in this energy range from Fig. 2e in 2011Sa52. Part of this structure may contain 3446, 1^+ level.
			J^π: from L=0, Gamow-Teller transition in ^{56}Ni(p,n) inverse reaction.
12×10^3[#] *3*		B	J^π: L=1 in ^{56}Ni(p,n) inverse reaction suggests negative parity.

[†] From Eγ data unless otherwise stated.
[‡] From ^{56}Zn ε decay.
[#] From ^{1}H(^{56}Ni,n).

γ(^{56}Cu)

E_i(level)	J_i^π	E_γ	I_γ	E_f	J_f^π
166	(3^+)	166[‡] *1*	100[‡]	0	(4^+)
572	(5^+)	572[‡] *1*	100[‡]	0	(4^+)
826	(4^+)	660[‡] *3*	100[‡]	166	(3^+)
1037	(2^+)	871[‡] *3*	100[‡]	166	(3^+)

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Adopted Levels, Gammas (continued)

γ(^{56}Cu) (continued)

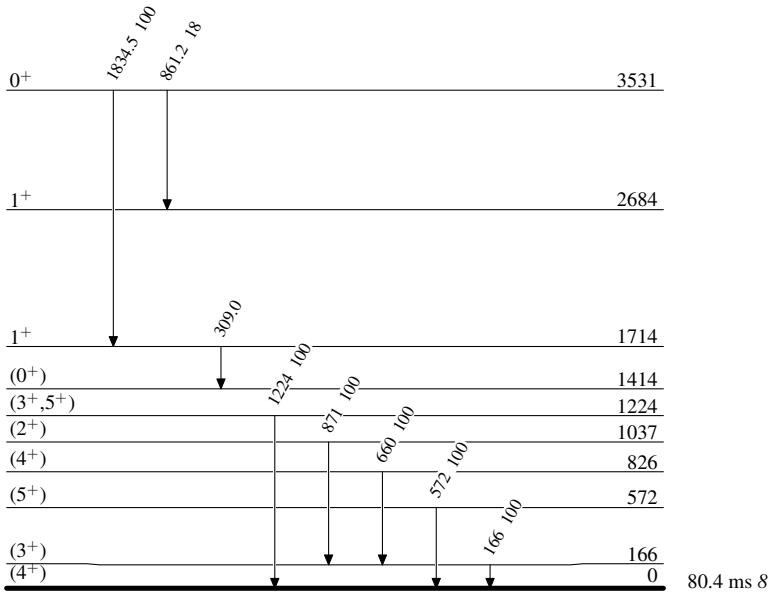
E_i(level)	J_i^π	E_γ	I_γ	E_f	J_f^π
1224	$(3^+,5^+)$	1224‡ *4*	100‡	0	(4^+)
1714	1^+	309.0† *10*		1414	(0^+)
3531	0^+	861.2† *10*	18† *6*	2684	1^+
		1834.5† *10*	100† *30*	1714	1^+

† From ^{56}Zn ε decay.
‡ From ^{2}H(^{56}Ni,^{56}Cuγ).

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level



$^{56}_{29}Cu_{27}$