^{56}Zn ε decay (32.4 ms) 2014Or04,2016Or03

History

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

Parent: ^{56}Zn: E=0.0; $J^\pi=0^+$; $T_{1/2}$=32.4 ms *11*; Q(ε)=13240 *SY*; %ε+%$β^+$ decay=100.0

^{56}Zn-T=2; $T_z=-2$.

^{56}Zn-$T_{1/2}$: From ^{56}Zn Adopted Levels.

^{56}Zn-Q(ε): 13240 *400* (syst, 2021Wa16).

^{56}Zn-%ε+%$β^+$ decay: Measured %$β^+$p=88.5 *26* (2014Or04), authors ascribe missing 11.5% *26* branching to γ decay from 1691 level in analogy with decay of a level in mirror nucleus ^{56}Co. Adopted %εp=88.0 *26* in ^{56}Zn Adopted Levels, from 2014Or04 and 2007Do17.

2016Or03, 2014Or04 (also conference papers from the same experimental group: 2017RuZX, 2016Ru04, 2016OrZY, 2015Or02, 2014Ru08, 2014Or03, 2014OrZZ, 2012OrZY): ^{56}Zn from fragmentation of ^{58}Ni beam, E=74.5 MeV/nucleon, on a 200 μm thick natural Ni target at LISE3 facility at GANIL. Fragments were selected by LISE3 separator and implanted into a double-sided silicon strip detector (DSSSD), surrounded by four EXOGAM Ge clovers for γ ray detection; An implantation was defined by simultaneous signals in both a ΔE and DSSSD detectors and identified by combining energy loss in ΔE and time-of-flight. Measured Eγ, Iγ, E_p, I_p, ^{56}Zn half-life, proton-γ coincidences. Deduced levels, J^π, Fermi and Gammow-Teller strengths. FWHM 70 keV for protons. A total of 8900 ^{56}Zn nuclei was implanted. 2016Ru04 is from the same group. Considering the isospin mixing in ^{56}Cu, observation of γ deexcitation from IAS in competition with much faster allowed proton decay ($t_{1/2}\approx 1$ as) has been noted as an interesting and puzzling situation. From IMME analysis for T=2 multiplet using mass excess of ^{56}Fe, and those for the IAS in ^{56}Ni, ^{56}Co and ^{56}Cu, the last determined from the present work, 2014Or04 and 2016Or03 conclude that IMME deduced mass excess of ^{56}Zn=−25911 *20* agrees better with −25730 *260* in 2003Au03 than with −25580 *500* from 2012Wa38. For this reason 2016Or03 used Q(ε) and S(p)(^{56}Cu) value from 2003Au03. Note that in 2021Wa16 and 2017Wa10, mass excess for ^{56}Zn is −25390 *400* from systematic trend.

2016Sm01: theoretical analysis of isospin mixing for the decay of ^{56}Zn; calculated half-life of ^{56}Zn g.s., $T_z=-1$ energy levels and J^π, lowest 0^+ states in ^{56}Cu, T=2 IAS in ^{56}Cu, Iβ of the IAS, isospin mixing in the IAS, spectroscopic factor for proton emission from ^{56}Zn decay.

^{56}Cu Levels

E(level)†	J^π‡	$T_{1/2}$	Comments
0.0	(4^+)	80.4 ms *8*	$T_z=-1$. J^π,$T_{1/2}$: from the Adopted Levels; $J^\pi=4^+$ g.s. in mirror nucleus ^{56}Co.
1414 *12*	(0^+)		T=1 E(p)=831 *10*, I(p)=3.0 *4*. E(level): this level corresponds to 1450.7, 0^+ in ^{56}Co mirror nucleus; level from ^{56}Co Adopted Levels in ENSDF database.
1714 *12*	1^+		%p=34 *22* (2014Or04) T=1 Estimated %γ=66 *22* from this level (2014Or04), which probably accounts for 11.5% *26* missing branching ratio. E(p)=1131 *10*, I(p)=23.8 *11*. E(level): this level correspondence to 1720.2, 1^+ in ^{56}Co mirror nucleus; level from ^{56}Co Adopted Levels in ENSDF database.
2560 *12*	(1^+)		%p=100 T=1 E(p)=1977 *10*, I(p)=4.6 *8*. E(level): this level may correspond to 2635.6, 1^+ in ^{56}Co mirror nucleus; level from ^{56}Co Adopted Levels in ENSDF database and also from 2013Fu15 in (^{3}He,t), although the energy difference of 76 keV *12* seems somewhat large.
2684 *12*	1^+		%p=100 T=1 E(p)=2101 *10*, I(p)=17.1 *9*. E(level): this level corresponds to 2729.9, 1^+ in ^{56}Co mirror nucleus, level from ^{56}Co Adopted

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^{56}Cu Levels (continued)

E(level)†	Jπ‡	Comments
		Levels in ENSDF database and also from 2013Fu15 in (^{3}He,t).
3446 *12*	1+	%p=100 T=1 E(p)=2863 *10*, I(p)=21.2 *10*. E(level): this peak is broader in the spectrum than the other peaks. 2014Or04 suggest that this group corresponds to three states at 3432,1+, and 3496,1+ seen by 2013Fu15 in the mirror nucleus ^{56}Co. In ^{56}Co Adopted Levels in ENSDF database, corresponding two levels are 3436, 0+,1+ and 3510, (0+). 2014Or04 included 3527,0+ level in ^{56}Co also in this group, but this level is now considered to correspond to the 3531 level in ^{56}Cu.
3531 *12*	0+	%p=44 *6* (2014Or04) T=2 T_z=−1. Estimated %γ=56 *6* from this level (2014Or04), but only 45% is accounted for by 861.2 and 1834.5 γ rays; remaining 11% (≈5 units of absolute photon intensity) must be associated with unobserved gamma-rays from 3510 level. E(p)=2948 *10*, I(p)=18.8% *10*. E(level): Isobaric Analogue State (IAS). This level corresponds to 3527, 0+ in ^{56}Co mirror nuclide; level from 2013Fu15 in (^{3}He,t) and also in ^{56}Co Adopted Levels in ENSDF database).

† 2014Or04 and 2016Or03 deduced level energies using $S_p(^{56}Cu)$=560 *140* (syst,2003Au03)+E_p(c.m.). Excitation energies deduced using $S_p(^{56}Cu)$=190 *200* (syst,2012Wa38) and listed in column 5 of Table II in 2014Or04 are listed under comments. Using S(p)(^{56}Cu)=583 *6* in 2021Wa16, and E(p) from 2016Or03 (and 2014Or04) evaluator has deduced the level energies. E(p) values listed in Table I of 2014Or04 and Table V of 2016Or03 are in the c.m system. Levels listed here in ^{56}Cu are identified as mirror partners of corresponding levels in ^{56}Co based on S(p)=583 *6* from 2021Wa16.

‡ Assignments are based on those in 2014Or04 and 2016Or03 from log *ft* values and correspondence with mirror states in ^{56}Co.

ε,β+ radiations

B(GT) and B(F) are transition strengths for allowed Gamow-Teller and Fermi β transitions, respectively.

E(decay)	E(level)	Iβ+ †	Iε†	Log *ft*	I(ε+β+)†	Comments
(9709 *SY*)	3531	43 *5*	0.040 *8*	3.44 *11*	43 *5*	av Eβ=4.13×10^3 *20*; εK=0.00083 *13*; εL=9.0×10^{-5} *14*; εM+=1.58×10^{-5} *24* B(F)=2.7 *5* and 2.5 *5* using 2003Au03 and 2012Wa38, respectively. 2016Or03 give value using only 2003Au03.
(9794 *SY*)	3446	21 *1*	0.019 *3*	3.8 *1*	21 *1*	av Eβ=4.17×10^3 *20*; εK=0.00081 *12*; εL=8.8×10^{-5} *13*; εM+=1.53×10^{-5} *23* B(F)=1.3 *5* and 1.2 *5* using 2003Au03 and 2012Wa38, respectively. 2016Or03 give value using only 2003Au03. Deduced B(F) has isospin impurity of 33% *10* from 3508, IAS, similar to the value obtained in ^{56}Co mirror nuclei by 2013Fu15. B(Gamow-Teller)≤0.32 and ≤0.31 using 2003Au03 and 2012Wa38, respectively. 2016Or03 give value using only 2003Au03. The log *ft* value is for combined β feeding to a possible triplet of states.
(10556 *SY*)	2684	14 *1*	0.0100 *15*	4.1 *1*	14 *1*	av Eβ=4.54×10^3 *20*; εK=0.00063 *9*; εL=6.9×10^{-5} *10*; εM+=1.20×10^{-5} *17* B(Gamow-Teller)=0.34 *6* and 0.31 *6* using 2003Au03 and

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ϵ,β+ radiations (continued)

E(decay)	E(level)	Iβ+ †	Iε†	Log *ft*	I(ε+β+)†	Comments
						2012Wa38, respectively. 2016Or03 give value using only 2003Au03.
(11526 *SY*)	1714	22 *6*	0.012 *4*	4.1 *2*	22 *6*	av Eβ=5.03×10^3 *20*; εK=0.00047 *6*; εL=5.1×10^{-5} *7*; εM+=9.0×10^{-6} *11* B(Gamow-Teller)=0.30 *9* and 0.28 *8* using 2003Au03 and 2012Wa38, respectively (2014Or04). 2016Or03 give value using only 2003Au03.

† Absolute intensity per 100 decays.

γ(^{56}Cu)

Eγ	Iγ†	Ei(level)	J^π_i	Ef	J^π_f
309.0 *10*		1714	1+	1414	(0+)
861.2 *10*	2.9 *10*	3531	0+	2684	1+
1834.5 *10*	16.3 *49*	3531	0+	1714	1+

† Absolute intensity per 100 decays.

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Decay Scheme

Intensities: Iγ per 100 parent decays