^{113}Sn ε decay (115.09 d)

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jean Blachot	NDS 111, 1471 (2010)	1-May-2009

Parent: ^{113}Sn: E=0; J^π=1/2$^+$; $T_{1/2}$=115.09 d *3*; Q(ε)=1036.6 *27*; %ε+%β^+ decay=100.0

^{113}Sn-J^π: From 1998Bl04 evaluation.

^{113}Sn-$T_{1/2}$: 115.09 d *3* from weighted average of 115.2 d *8* (1972Em01), 115.07 d *10* (1972La14), 115.09 d *4* (1980Ho17), 115.12 d *13* (1982RuZV), and 115.08 d *8* (1992Un01). The reduced-χ^2=0.03. Because this set of values is consistent, the Limited Relative Statistical Weight method does not increase the uncertainty for the 1980Ho17 value even though it contributes 66% of the relative weight. If the 1980Ho17 uncertainty were increased from 0.04 to 0.056 in order decrease its relative weight to 50%, the weighted average average would still be 115.09 with an uncertainty of 0.04. The very small reduced-χ^2 value suggests that the reported uncertainties are overestimated. It also means that the Rajeval and Normalized Residual methods give the same result. Others: 107 d (1959Bu08) and 115.06 d *7* (1982HoZJ, replaced by 1992Un01).

In addition to the 3 excited levels populated in this decay scheme, there is a level below the decay energy in ^{113}In at 1024 (J^π=5/2$^+$). The β^- decay to this level will be negligible.

Decay data evaluated by R. G. Helmer, August 1996 with minor editing done in July 1998. This evaluation was done under the collaboration which includes evaluators from Laboratoire Primaire des Rayonnments Ionisants (LPRI) in France; Physikalisch-Technische Bundesanstalt (PTB) in Germany; Imperial College in the United Kingdom; and Brookhaven National Laboratory (BNL), Lawrence Berkeley National Laboratory (LBNL), and Idaho National Engineering Laboratory (INEL) in the United States. This evaluation was reviewed and accepted by evaluators in this collaboration.

The main γ ray of 391 keV depopulates a level with a $T_{1/2}$ of 99 min, so the ratio of its emission rate to the ^{113}Sn decay rate will vary with time. After a sufficient time, about five half-lives for the level, the ratio of the ^{113}In (99 min) and ^{113}Sn activities remains constant and is $T_{1/2}$(^{113}Sn)/[$T_{1/2}$(^{113}Sn)-$T_{1/2}$(113min)]=1.0006.

The total average radiation energy released by ^{113}Sn is 1035.5 keV *5* (calculated by evaluators using the computer program radlst). This value agrees remarkably well with Q(ε)=1036.6 keV *27* (2003Au03) and confirms the quality of the decay scheme.

α: Additional information 1.

^{113}In Levels

E(level)	J^π †	$T_{1/2}$	Comments
0.0	9/2$^+$	stable	
391.699 *3*	1/2$^-$	99.476 min *23*	$T_{1/2}$: From weighted average of 99.3 min *2* (1967Ok02), 99.2 min *6* (1969Va04), 99.48 min *3* (1970Go48), 99.48 min *8* (1970Le07), 99.8 min *2* (1970Ro29), 99.47 min *7* (1971Ha18), 99.2 min *6* (1971Oo01), 99.78 (18) (1971Em01), 102 min *2* (1975Bu24), 99.21 min *13* (1982HoZJ), 99.49 min *6* (1982RuZV), 99.45 min *7* (1984Iw06), and 99.6 min *3* (1987Ne01). In the Limited Relative Statistical Weight method, the uncertainty for the 1970Go48 value is increased from 0.03 to 0.0316 to reduce its relative weight from 53% to 50%. For either weighting, the results are the same, with the internal uncertainty of 0.022 and the reduced-χ^2=1.07. Since these data are consistent, the Rajeval and Normalized Residual methods give the same result. Others: 105 min *10* (1939Ba03), 104 min *2* (1940La07), 102 min *2* (1958Gi06), 114 min (1965Ca13), 102.4 min (1975Ku10), and 99.8 min *7* (1997We13). From the presence of Cd K x rays from a ^{113}In (99 min) source, 1970Ra05 (and 1969RaZP) reported ε decay of this level with I(ε)=0.07% 1. Such a transition to ^{113}Cd would be 1st forbidden, 1/2$^-$ to 1/2$^+$, and would have a log *ft* of 5.1. This ε intensity is unlikely since the log *ft* systematics (1973Ra10) indicate that such transitions have log *ft*'s of>5.9. Also, 1970De22 (see also 1969De25) repeated the experiment and placed a limit of<0.0036% on this ε transition for which the log *ft* is>6.5. Such an electron capture branch is therefore negligible and has not been included in this scheme.
646.833 *10*	3/2$^-$		
1029.73 *8*	1/2$^+$,3/2$^+$	0.33 ns *3*	$T_{1/2}$: From Adopted Level data in 1998Bl04 evaluation.

† From 1998Bl04 evaluation.

^{113}Sn ε decay (115.09 d) (continued)

ε,β^+ radiations

The electron-capture decay from the 1/2$^+$ parent to the ground state (9/2$^+$) is 4th forbidden. From log *ft* systematics (1973Ra10), one expects this log *ft* value to be$\geq$22, with a corresponding I(ε)$\leq$1.E−12%. For the unpopulated level at 1024 keV, the decay is 2nd forbidden, with an expected log *ft* value of>11.0. The corresponding I(ε) is<2.E−7%; so this branch is also completely negligible.

εK, εL, εM: Calculated from tables of 1995ScZY.

E(decay)	E(level)	Iε†	Log *ft*	Comments
(7 *3*)	1029.73	0.00103 *4*	6.5 *8*	εL=0.3 *3*; εM+=0.54 *20*
(390 *3*)	646.833	2.21 *8*	8.20 *2*	εK=0.849; εL=0.121; εM+=0.0254
(645 *3*)	391.699	97.79 *8*	7.010 *4*	εK=0.855; εL=0.116; εM+=0.0241

† Absolute intensity per 100 decays.

^{113}Sn ε decay (115.09 d) (continued)

$\gamma(^{113}In)$

E_γ	I_γ †‡@	E_i(level)	J^π_i	E_f	J^π_f	Mult.#	δ#	α	Comments
255.134 *10*	2.11 *8*	646.833	$3/2^-$	391.699	$1/2^-$	M1+E2	0.7 *6*	0.046 *6*	α(K)=0.039 *5*; α(L)=0.0054 *11*; α(M)=0.00105 *22*; α(N)=0.00019 *4*; α(O)=1.27×10^{-5} *14* α(N+..)=0.00020 *4* E_γ: Based on value of 255.126 *10* (1973In06) scaled by the evaluator by the ratio $E\gamma$(391,here)/$E\gamma$(391,1973In06). I_γ: From $I\gamma(255)/I\gamma(392)$=0.0325 *12* from Limited Relative Statistical Weight analysis of 0.0333 *13* (1973In06), 0.0285 *9* (1978He08), 0.0337 *8* (1993Mu14), and 0.0327 *8* (1994DeZX). Others: 0.030 *3* (1958Gi06), 0.027 *2* (1959Bu08), 0.028 *1* (1961Gr11), 0.029 *3* (1967Bo18), 0.0322 (1968Fo07), and 0.0285 *7* (1976De35 from same data as 1978He08).
382.90 *8*	0.000060 *3*	1029.73	$1/2^+,3/2^+$	646.833	$3/2^-$				E_γ: Calculated from level energies; γ not observed in this decay. I_γ: From $I\gamma(382)/I\gamma(638)$=6.2/100 from Adopted γ data in 1998Bl04 evaluation and based on observed decay of this level in ^{113}Cd(p,nγ) (1976Di03,1974Ki02).
391.698 *3*	64.97 *17*	391.699	$1/2^-$	0.0	$9/2^+$	M4		0.551	α(K)=0.444 *7*; α(L)=0.0862 *12*; α(M)=0.01750 *25*; α(N)=0.00316 *5*; α(O)=0.000194 *3* α(N+..)=0.00335 *5* B(M4)(W.u.)=8.31 *9* E_γ: From 1997HeZZ. I_γ: From $I\gamma(391)$=[100.0 − Ti(646)] / [1 + α(391)]; the uncertainty is all from the 0.26% uncertainty in (1 + α). α: α(K) and α are from 1985HaZA evaluation of measured values; these values average 3% lower than the theoretical values of 1978Ro21. The α(L) and α(M) were then computed as 3% lower than the corresponding theoretical values.
638.03 *8*	0.00097 *4*	1029.73	$1/2^+,3/2^+$	391.699	$1/2^-$	E1		0.001294 *19*	α=0.001294 *19*; α(K)=0.001130 *16*; α(L)=0.0001331 *19*; α(M)=2.57×10^{-5} *4* α(N)=4.69×10^{-6} *7*; α(O)=3.44×10^{-7} *5*; α(N+..)=5.04×10^{-6} B(E1)(W.u.)=3.2×10^{-6} *4* E_γ,I_γ: From 1978He08. Mult.: from ^{113}Cd(p,nγ). α: Theoretical value from 1968Ha54.
646.830 *10*	4×10^{-6} *2*	646.833	$3/2^-$	0.0	$9/2^+$	[E3]		0.00865 *13*	α(K)=0.00730 *11*; α(L)=0.001089 *16*; α(M)=0.000214 *3*; α(N)=3.85×10^{-5} *6*; α(O)=2.50×10^{-6} *4* α(N+..)=4.10×10^{-5} *6* E_γ: Calculated from level energy. I_γ: From 1978He08.

$\gamma(^{113}In)$ (continued)

† Values are with ^{113}In in equilibrium (i.e., at long decay times).
‡ I(Kα_2 x ray)=27.85 *22*, I(Kα_1 x ray)=52.2 *4*, I(Kβ x ray)=17.44 *14* calculated by radlst.
# From 1998Bl04 evaluation.
@ Absolute intensity per 100 decays.

$^{113}_{49}In_{64}$-4

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Decay Scheme

Intensities: I_γ per 100 parent decays