## Adopted Levels, Gammas

| Type | Author | History Citation | Literature Cutoff Date |
|---|---|---|---|
| Full Evaluation | Jun Chen | NDS 146, 1 (2017) | 30-Sep-2017 |

Q($\beta^-$)=9360 *SY*; S(n)=3140 *SY*; S(p)=16760 *CA*; Q($\alpha$)=−7120 *CA* 2017Wa10
$\Delta$Q($\beta^-$)=1180, $\Delta$S(n)=640, $\Delta$S(p)=710, $\Delta$Q($\alpha$)=640 (2017Wa10).
Q($\beta^-$n)=7130 *510*, S(2n)=5100 *590*, Q($2\beta^+$)=20840 *500* (syst,2017Wa10), S(2p)=31430 (theory,1997Mo25).
First identification of $^{138}$Sn nuclide by 2010Oh02 via Be($^{238}$U,F).
2010Oh02: $^{138}$Sn nuclide identified in Be($^{238}$U,F) and Pb($^{238}$U,F) reactions with a $^{238}U^{86+}$ beam energy of 345 MeV/nucleon produced by the cascade operation of the RBIF accelerator complex of the linear accelerator RILAC and four cyclotrons RRC, fRC, IRC and SRC. Identification of $^{138}$Sn nuclei was made on the basis of magnetic rigidity, time-of-flight and energy loss of the fragments using BigRIPS fragment separator. Experiments performed at RIKEN facility. Based on A/Q spectrum and Z versus A/Q plot, 23 counts were assigned to $^{138}$Sn isotope. (Q=charge state).
2015Lo04: $^{138}$Sn ions were produced at RIBF-RIKEN facility in $^{9}$Be($^{238}$U,F) reaction at E=345 MeV/nucleon with an average intensity of $6\times10^{10}$ ions/s. Identification of $^{138}$Sn was made by determining atomic Z and mass-to-charge ratio A/Q, where Q=charge state of the ions. The selectivity of ions was based on magnetic rigidity, time-of-flight and energy loss. The separated nuclei were implanted at a rate of 50 ions/s in a stack of eight double-sided silicon-strip detector (WAS3ABi), surrounded by EURICA array of 84 HPGe detectors. Correlations were recorded between the implanted ions and $\beta$ rays. The half-life of $^{138}$Sn isotope was measured from the correlated ion-$\beta$ decay curves and maximum likelihood analysis technique as described in 2014Xu07. Comparison of measured half-lives with FRDM+QRPA, KTUY+GT2 and DF3+CQRPA theoretical calculations.
2007ArZQ (thesis): $^{138}$Sn possibly identified in bombardment of $UC_x$ target with 1 GeV protons followed by selective ionization with the Resonance Ionization Laser Ion Source (RILIS) and high-resolution mass separator (HRS) at ISOLDE-CERN facility. Measured delayed neutrons to deduce half-life and $P_n$ (delayed neutron emission probability). Identification in this work should be considered as tentative since in later formal publication of this work in 2011Ar18, $^{138}$Sn was not discussed.
Theoretical nuclear structure calculations:
2017Ja09, 2015Na10: calculated binding energies, B(E2), energy levels, J, $\pi$.
2012Ca27: calculated levels, J, $\pi$, B(E2), B(E3).
2010Sa14, 2008Sa32: calculated binding energies, levels, J, $\pi$, B(E2), configuration mixing, magnetic dipole moments, electric quadrupole moments.
2008Ma17: calculated odd-even mass staggering, binding energies, two-neutron separation energies, pairing gaps.
2007Ji05, 2007Ji14: calculated levels, J, $\pi$, B(E2), B(M1), g factors.
2007Ka40: calculated binding energies, single and two neutron separation energies, level energies, J, $\pi$, B(E2).
2004Sh46: calculated level energies, B(E2), quadrupole matrix elements, g factors.
Consult NSR database for additional about 30 theoretical papers.
Additional information 1.

### $^{138}$Sn Levels

Cross Reference (XREF) Flags

A $^{138}$Sn IT decay (210 ns)

| E(level) | $J^{\pi}$ † | $T_{1/2}$ | XREF | Comments |
|---|---|---|---|---|
| 0 | $0^+$ | 140 ms *+30−20* | A | %$\beta^-$=100; %$\beta^-$n=36 *12* (2007ArZQ); %$\beta^-$2n=?<br>Theoretical %$\beta^-$n=83.3, %$\beta^-$2n=3.9 (2003Mo09).<br>$T_{1/2}$: measured by 2015Lo04 from the analysis of the (implanted ions)$\beta$ correlated decay curve in time and position. Other: 261 ms *57* (preliminary value from 2007ArZQ based on neutron decay curve). Theoretical values: 460 ms (2002Pf04), 336 ms (2003Mo09).<br>Measured $\sigma$=600 pb (2010Oh02), systematic uncertainty≈30%.<br>%$\beta^-$n: preliminary value is 36 *12* (2007ArZQ). Theoretical values: %$\beta^-$n=100 (2002Pf04), 83.3 (2003Mo09), 70.3 (2014Mi23); %$\beta^-$2n=3.9 (2003Mo09), 0.2 (2014Mi23). |

Continued on next page (footnotes at end of table)

## Adopted Levels, Gammas (continued)

### $^{138}$Sn Levels (continued)

| E(level) | Jπ† | $T_{1/2}$ | XREF | Comments |
|---|---|---|---|---|
| 715 *1* | (2+) | | A | |
| 1176 *2* | (4+) | | A | |
| 1344 *2* | (6+) | 210 ns *45* | A | %IT=100<br>Dominant $\nu f^2_{7/2}$ configuration (2014Si18).<br>$T_{1/2}$: from ($^{136}$Sn ions)γ(t) in $^{138}$Sn IT decay (2014Si18). |

† From shell-model predictions (2014Si18) and systematics of even-even semi-magic nuclei.

### γ($^{138}$Sn)

| $E_i$(level) | $J^\pi_i$ | $E_\gamma$† | $I_\gamma$ | $E_f$ | $J^\pi_f$ | Mult. | α‡ | Comments |
|---|---|---|---|---|---|---|---|---|
| 715 | (2+) | 715 *1* | 100 | 0 | 0+ | [E2] | 0.0028 | |
| 1176 | (4+) | 461 *1* | 100 | 715 | (2+) | [E2] | 0.0093 | |
| 1344 | (6+) | 168 *1* | 100 | 1176 | (4+) | [E2] | 0.255 *7* | B(E2)(W.u.)=0.36 *8* |

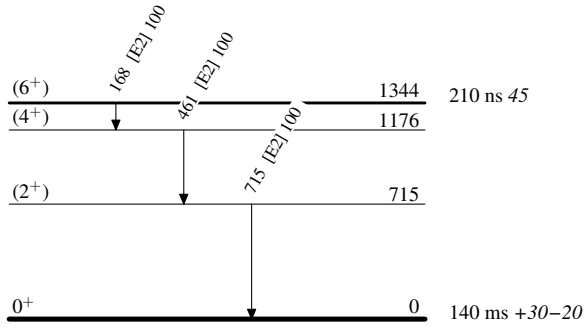
† From $^{138}$Sn IT decay.

‡ Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

## Adopted Levels, Gammas

### Level Scheme

Intensities: Relative photon branching from each level




$^{138}_{50}Sn_{88}$