^{127}Sb - Comments on evaluation of decay data

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Evaluation Procedure

Limitation of Relative Statistical Weight Method (LWM) was applied to average the measured decay data when appropriate.

Decay Scheme

A reasonably complex decay scheme was constructed from the gamma-ray studies of 1967Ra13 and 1967Ta05. An earlier study involved the use of low-resolution NaI(Tl) detectors (1962Uh01), and these data have been set aside from consideration in this particular evaluation. The gamma-ray emission probabilities were expressed in terms of the emission probability of the 685.09-keV gamma ray (100 %), and weighted mean data were derived as appropriate. ^{127}Sb undergoes beta decay to both ^{127m}Te (defined as level 2, with a half-life of 106.1 days) and the ground state of ^{127}Te (half-life of 9.35 hours) – under these circumstances, the recommended ^{127}Sb decay scheme is rightly defined as ending effectively with the population of these two particular nuclear levels, while the subsequent IT and beta decay of ^{127m}Te are not included in the data file.

Nuclear Data

^{127}Sb undergoes beta decay to various nuclear levels of ^{127}Te, populating both ^{127m}Te (beta branch of 16.8 (6) %) and the ^{127}Te ground state (beta branch of 83.2 (6) %), latter more specifically by gamma decay only. These two daughter states possess significant half-lives of 106.1 days (^{127m}Te) and 9.35 hours (^{127}Te), and therefore their recommended decay data have been assembled as separate files.

Half-life (^{127}Sb)

The recommended half-life has been determined from the measurements of Sleight and Sullivan (1950Sl17), Bosch and Munczek (1957Bo96), Dropesky and Orth (1962Dr01), Uhler *et al.* (1962Uh01), Hagebø (1967Ha27), Takemoto *et al.* (1967Ta05), and Panontin and Sugarman (1972Pa13). A value of 3.85 days was derived in terms of LWM, with the uncertainty increased to the lowest experimental value of ± 0.07 days.

Half-life measurements (^{127}Sb).

Reference	Half-life (days)
1939Ab02	3.3* (80 h)
1946Gr06	4.0* (95 h)
1950Sl17	3.9 ± 0.1 (93 ± 3 h)
1957Bo96	3.7 ± 0.1 (88 ± 2 h)
1962Dr01	3.89 ± 0.07 (93.4 ± 1.7 h)
1962Uh01	3.9 ± 0.1 (94 ± 2 h)
1967Ha27	3.80 ± 0.08† (91.2 ± 0.3 h)
1967Ta05	3.75 ± 0.10
1972Pa13	3.91 ± 0.07 (93.8 ± 1.6 h)
Recommended value	3.85 ± 0.07‡

* no uncertainty quoted – not included in LWM analysis.
† possible systematic error proposed by 1967Ha27 – author suggests that the measured half-life may be too long by as much as 2 %; other measurements indicate this possibility may not be the case, although the uncertainty has been adjusted from ± 0.013 to ± 0.08 days as a sensible precaution.
‡ uncertainty increased from ± 0.03 to the lowest experimental value of ± 0.07 days.

Q values

Q^- to the ^{127}Te ground state of 1582 (5) keV was adopted from the evaluated tabulations of 2011AuZZ, which compares with a value of 1581 (5) keV from 2003Au03. A value of 88.23 (7) keV was adopted for the energy of the ^{127m}Te nuclear level (2011Ha31), and was used to derive Q^- to ^{127m}Te of 1494 (5) keV.

Gamma Rays

<u>Energies</u>
Although gamma-ray energies have been measured to good accuracy by 1967Ra13 and 1967Ta05, the determination of the nuclear-level energies of ^{127}Te from a combination of decay data and the emissions from seven nuclear reactions are judged to be more robust (2011Ha31). Therefore, gamma transition energies were calculated from the structural details of the proposed decay scheme. The nuclear level energies of 2011Ha31 were adopted, and used to determine the energies of the gamma-ray transitions between the depopulating-populating levels.

Adopted energies, spins and parities of the nuclear levels of ^{127}Te.

Nuclear level number	Nuclear level energy (keV)	Spin and parity
0	0.0	3/2 +
1	61.161 ± 0.019	1/2 +
2	88.23 ± 0.07 (^{127m}Te)	11/2 −
3	340.87 ± 0.06	(9/2 −)
4	473.26 ± 0.04	5/2 +
5	501.928 ± 0.010	3/2 +
6	631.40 ± 0.06	7/2 −
7	685.09 ± 0.07	7/2 +
8	762.64 ± 0.05	3/2 +
9	782.62 ± 0.03	5/2 +
10	786.13 ± 0.06	7/2 −
11	924.02 ± 0.18	7/2 +
12	1077.13 ± 0.17	5/2, 7/2, 9/2
13	1140.20 ± 0.07	5/2 +
14	1154.70 ± 0.09	5/2 +
15	1206 ± 5*	3/2 +, 5/2 +
16	1289.79 ± 0.08	5/2 +
17	1309.25 ± 0.07	3/2 +, 5/2+
18	1323.4 ± 0.8	
19	1378.58 ± 0.07	5/2 +

* Value of (1206.3 ± 0.7) keV adopted from the energy of the proposed depopulating γ transition (423.7 (7) keV) to the 782.62 (3)-keV nuclear level.

A number of gamma rays with very low emission probabilities have been observed only by 1967Ta05, and four of these particular transitions cannot be placed in the proposed decay scheme: 74.6-, 405.0-, 675.6- and 789.5-keV gamma rays. After inspection of the spectra (1967Ta05), these particular gamma rays have not been included in the recommended set of decay data.

Gamma-ray energies.

transition	E_γ (keV)		
	1967Ra13	1967Ta05	Recommended
$\gamma_{1,0}$ (Te)	61.0 (3)	61.1 (1)	61.16 (2)
–	–	74.6 (7)	unplaced/rejected
$\gamma_{10,6}$ (Te)	154.3 (5)	154.4 (7)	154.7 (1)
$\gamma_{3,2}$ (Te)	252.4 (3)	252.5 (5)	252.64 (9)
$\gamma_{9,5}$ (Te)	280.4 (5)	280.5 (10)	280.7 (1)
$\gamma_{6,3}$ (Te)	290.8 (5)	290.3 (15)	290.5 (1)
$\gamma_{11,6}$ (Te)	293.3 (9)	–	292.6 (2)
$\gamma_{9,4}$ (Te)	310.0 (7)	309.0 (10)	309.4 (1)
$\gamma_{12,7}$ (Te)	391.8 (5)	391.5 (7)	392.0 (2)
–	–	405.0 (10)	unplaced/rejected
$\gamma_{4,1}$ (Te)	412.1 (5)	411.6 (2)	412.10 (5)
$\gamma_{15,9}$ (Te)	–	423.7 (7)	423.7 (7)
$\gamma_{5,1}$ (Te)	441.0 (9)	440.7 (7)	440.77 (2)
$\gamma_{10,3}$ (Te)	445.1 (5)	444.9 (3)	445.3 (1)
$\gamma_{11,4}$ (Te)	451.0 (7)	451 (1)	450.8 (2)
$\gamma_{13,7}$ (Te)	–	456 (1)	455.1 (1)
$\gamma_{4,0}$ (Te)	473.0 (4)	473.0 (2)	473.26 (4)
$\gamma_{5,0}$ (Te)	502.8 (6)	501.5 (15)	501.93 (1)
$\gamma_{6,2}$ (Te)	543.3 (5)	543.0 (2)	543.2 (1)
$\gamma_{11,3}$ (Te)	584.2 (11)	–	583.2 (2)
$\gamma_{12,4}$ (Te)	603.5 (5)	603.6 (2)	603.9 (1)
$\gamma_{17,7}$ (Te)	–	624.0 (10)	624.2 (1)
$\gamma_{13,5}$ (Te)	637.8 (5)	638.5 (7)	638.3 (1)
$\gamma_{14,5}$ (Te)	652.3 (9)	653.5 (7)	652.8 (1)
$\gamma_{13,4}$ (Te)	667.5 (9)	666.9 (3)	666.9 (1)
–	–	675.6 (5)	unplaced/rejected
$\gamma_{14,4}$ (Te)	682.3 (10)	–	681.4 (1)
$\gamma_{7,0}$ (Te)	685.7 (5)	685.2 (3)	685.09 (7)
$\gamma_{10,2}$ (Te)	698.5 (5)	698.5 (3)	697.9 (1)
$\gamma_{9,1}$ (Te)	722.2 (5)	723.4 (7)	721.5 (1)
$\gamma_{19,6}$ (Te)	745.9 (5)	745.4(15)	747.2 (1)*
$\gamma_{8,0}$ (Te)	763.7 (8)	–	762.7 (1)
$\gamma_{9,0}$ (Te)	783.7 (5)	783.8 (3)	782.6 (1)
–	–	789.5 (15)	unplaced/rejected
$\gamma_{16,4}$ (Te)	817.0 (6)	817.3 (5)	816.5 (1)
$\gamma_{18,5}$ (Te)	820.6 (6)	820.1 (3)	821.5 (8)
$\gamma_{11,0}$ (Te)	924.4 (9)	923.5 (7)	924.0 (2)
$\gamma_{13,0}$ (Te)	1141.6 (8)	1141.2 (7)	1140.2 (1)
$\gamma_{14,0}$ (Te)	–	1155.2 (10)	1154.7 (1)
$\gamma_{16,0}$ (Te)	1290.3 (8)	1291.5 (15)	1289.8 (1)
$\gamma_{19,0}$ (Te)	1377.9 (9)	–	1378.6 (1)

* Significant adjustment has been made from 745.5 to 747.2 keV to give a recommended energy that can be satisfactorily placed in the proposed decay scheme.

Emission Probabilities

Although judged to be a rather limited data set, a reasonably consistent decay scheme was derived from the relative gamma-ray emission probabilities measured by Ragaini *et al*. (1967Ra13) and Takemoto *et al*. (1967Ta05). These relative emission probabilities were normalised to the 685.09-keV gamma ray (100 %).

Although the 61.16-keV gamma ray has been quantified by both 1967Ra13 and 1967Ta05, the assignment of this gamma transition in the decay scheme permits an accurate relative emission probability to be calculated from the gamma population-depopulation balance of the 61.161-keV nuclear level (with no populating beta transition). However, the observed gamma depopulation of the 762.64-keV nuclear level ($3/2^+$) is problematic, since no β^- or γ feeding of this level has been proposed – this unsatisfactory situation needs to be addressed in future experimental studies.

Nuclear-level studies by means of the ^{126}Te(n,γ) and (d,p) reactions have provided additional insight into the γ depopulation of many of the proposed ^{127}Te nuclear levels (2005Ho15). Thus, there is strong evidence for the depopulation of the 685.09-keV nuclear level by 212.2- and 183.7-keV gamma rays along with the main 685.09-keV gamma emission, but no detection of an equivalent 623.9-keV M3 gamma transition. The measurements of 2005Ho15 have been used to support the placing of gamma transitions and introduction of nuclear-level assignments throughout the proposed decay scheme.

Relative gamma-ray emission probabilities.

transition	**E$_\gamma$ (keV)**	P_γ^{rel}		
		1967Ra13	**1967Ta05**	**Recommended***
$\gamma_{1,0}$ (Te)	61.16 (2)	3.9 (3)	3.22 (4)	3.22 (4)†
–	74.6 (7)	–	0.11 (7)	unplaced/rejected
$\gamma_{10,6}$ (Te)	154.7 (1)	0.4 (2)	0.32 (7)	0.33 (7)
$\gamma_{3,2}$ (Te)	252.64 (9)	23.1 (9)	23.5 (4)	23.4 (4)
$\gamma_{9,5}$ (Te)	280.7 (1)	1.8 (4)	1.5 (1)	1.5 (1)
$\gamma_{6,3}$ (Te)	290.5 (1)	5.5 (3)	5.1 (2)	5.2 (2)
$\gamma_{11,6}$ (Te)	292.6 (2)	0.8 (4)	–	0.8 (4)
$\gamma_{9,4}$ (Te)	309.4 (1)	0.7 (3)	0.57 (10)	0.58 (10)
$\gamma_{12,7}$ (Te)	392.0 (2)	2.6 (2)	2.7 (3)	2.6 (2)
–	405.0 (10)	–	0.32 (5)	unplaced/rejected
$\gamma_{4,1}$ (Te)	412.10 (5)	10.4 (11)	9.6 (5)	9.7 (5)
$\gamma_{15,9}$ (Te)	423.7 (7)	–	0.28 (10)	0.28 (10)
$\gamma_{5,1}$ (Te)	440.77 (2)	1.9 (9)	0.7 (3)	1.9 (9)‡
$\gamma_{10,3}$ (Te)	445.3 (1)	11.8 (3)	11.8 (5)	11.8 (3)
$\gamma_{11,4}$ (Te)	450.8 (2)	0.5 (2)	1.1 (6)	0.6 (2)
$\gamma_{13,7}$ (Te)	455.1 (1)	–	0.3 (2)	0.3 (2)
$\gamma_{4,0}$ (Te)	473.26 (4)	70.1 (19)	70.1 (32)	70.1 (19)
$\gamma_{5,0}$ (Te)	501.93 (1)	2.1 (7)	1.7 (3)	1.8 (3)
$\gamma_{6,2}$ (Te)	543.2 (1)	8.0 (12)	7.4 (3)	7.4 (3)
$\gamma_{11,3}$ (Te)	583.2 (2)	0.9 (5)	–	0.9 (5)
$\gamma_{12,4}$ (Te)	603.9 (2)	12.1 (3)	11.7 (3)	11.9 (3)
$\gamma_{17,7}$ (Te)	624.2 (1)	–	0.18 (6)	0.18 (6)
$\gamma_{13,5}$ (Te)	638.3 (1)	1.2 (4)	1.0 (1)	1.0 (1)
$\gamma_{14,5}$ (Te)	652.8 (1)	1.0 (2)	0.7 (1)	0.8 (1)
$\gamma_{13,4}$ (Te)	666.9 (1)	2.0 (2)	1.0 (1)	1.5 (5)

transition	E_γ (keV)	P_γ^{rel}		
		1967Ra13	1967Ta05	Recommended*
–	675.6 (5)	–	0.18 (9)	unplaced/rejected
$\gamma_{14,4}$ (Te)	681.4 (1)	1.5 (7)	–	1.5 (7)
$\gamma_{7,0}$ (Te)	685.09 (7)	100	100.0	100
$\gamma_{10,2}$ (Te)	697.9 (1)	9.9 (2)	9.0 (2)	9.5 (5)
$\gamma_{9,1}$ (Te)	721.5 (1)	5.1 (3)	4.9 (2)	5.0 (2)
$\gamma_{19,6}$ (Te)	747.2 (1)	0.4 (2)	0.3 (1)	0.3 (1)
$\gamma_{8,0}$ (Te)	762.7 (1)	0.2 (1)	–	0.2 (1)
$\gamma_{9,0}$ (Te)	782.6 (1)	41.1 (9)	42.4 (12)	41.6 (9)
–	789.5 (15)	–	0.23 (4)	unplaced/rejected
$\gamma_{16,4}$ (Te)	816.5 (1)	1.1 (5)	0.75 (8)	0.76 (8)
$\gamma_{18,5}$ (Te)	821.5 (8)	0.6 (3)	0.32 (6)	0.33 (6)
$\gamma_{11,0}$ (Te)	924.0 (2)	1.4 (2)	1.29 (7)	1.30 (7)
$\gamma_{13,0}$ (Te)	1140.2 (1)	1.0 (2)	1.1 (3)	1.0 (2)
$\gamma_{14,0}$ (Te)	1154.7 (1)	–	0.11 (6)	0.11 (6)
$\gamma_{16,0}$ (Te)	1289.8 (1)	1.0 (3)	0.97 (9)	0.97 (9)
$\gamma_{19,0}$ (Te)	1378.6 (1)	0.2 (1)	–	0.2 (1)

* LWM of the measurements of 1967Ra13 and 1967Ta05, with the uncertainty increased to the lowest measured value when necessary.

† adopted on the basis of the γ population-depopulation balance of the 61.161-keV nuclear level, with no β− transition.

‡ adopted from 1967Ra13, and in agreement with γ population-depopulation balance of the 501.93-keV nuclear level, with no β^- transition.

Multipolarities, Internal Conversion Coefficients and Internal-Pair Formation Coefficients

The nuclear level scheme specified by Hashizume (2011Ha31) has been used to define the multipolarities of the gamma transitions on the basis of known spins and parities. A significant number of important gamma-ray transitions possess (M1 + E2) multipolarity, and somewhat disparate studies have been undertaken to determine many of their mixing ratios (1972Kr15, 1974So03, 1985De04). Furthermore, assessments have been made of a more limited number of these mixing ratios by Krane (1977Kr13). These various data have been assessed by the evaluator, and specific selections have been made as follows:

61.16-keV gamma ray, 80.6%M1 + 19.4%E2, as derived from consideration of γ population-depopulation of the 61.161-keV nuclear level; 154.7-keV gamma ray, 92%M1 + 8%E2; 252.64-keV gamma ray, 18%M1 + 82%E2; 280.7-keV gamma ray, 99.2%M1 + 0.8%E2; 290.5-keV gamma ray, 86%M1 + 14%E2; 292.6-keV gamma ray, 98.5%E1 + 1.5%M2; 309.4-kev gamma ray, 99%M1 + 1%E2; 392.0-keV gamma ray, 97.8%M1 + 2.2%E2; 440.77-keV gamma ray, 80%M1 + 20%E2; 445.3-keV gamma ray, 50%M1 + 50%E2;
450.8-keV gamma ray, 67%M1 + 33%E2; 473.26-keV gamma ray, 96%M1 + 4%E2;
501.93-keV gamma ray, 89.6%M1 + 10.4%E2; 603.9-keV gamma ray, 98%M1 + 2%E2; 638.3-keV gamma ray, 85%M1 + 15%E2; 652.8-keV gamma ray, 94.6%M1 + 5.4%E2; 782.6-keV gamma ray, 95.8%M1 + 4.2%E2; 1140.2-keV gamma ray, 98%M1 + 2%E2; and
1289.8-keV gamma ray, 99.96%M1 + 0.04%E2.

Additional (M1 + E2) gamma transitions were arbitrarily assigned a mixing ratio of 1.0 ± 0.5 (50%M1 + 50%E2) in this reasonably comprehensive exercise (423.7, 455.1, 624.2, 666.9, 681.4, 762.7 and 816.5 keV). The 583.2- and 747.2-keV gamma rays were identified as E1 transitions, while the 412.10-, 543.2-, 685.09-, 697.9-, 721.5- and 924.0-keV gamma rays were defined as E2 transitions. These data were used to determine recommended internal conversion coefficients from the frozen orbital approximation of Kibédi *et al.* (2008Ki07), based on the theoretical tabulations of Band *et al.* (2002Ba25, 2002Ra45). Internal-pair formation coefficients were calculated by means of the methodology described by Kibédi *et al.* (2008Ki07).

Gamma-ray emissions: measured mixing ratios of (M1 + E2) transitions and (E1 + M2) transition.

E_γ (keV)	δ				
	1972Kr15	**1974So03**	**1977Kr13**	**1985De04**	**Recommended**
M1 + E2 transitions					
154.7 (1)	–	–	–	0.34 ± 0.21 or $-2.30^{+0.81}_{-2.02}$	0.3 ± 0.2
252.64 (9)	− 0.56 ± 0.10 or − 1.53 ± 0.24	− 1.61 ± 0.39	− 1.55 ± 0.20	− 0.31 ± 0.03 or − 2.55 ± 0.20	− 2.1 ± 0.5*
280.7 (1)	–	–	–	− 0.09 ± 0.02 or 7.80 ± 1.20	− 0.09 ± 0.02
290.5 (1)	$0.27^{+0.21}_{-0.13}$ or 6^{+68}_{-3}	1.87 ± 0.51	1.9 ± 0.5	0.40 ± 0.03	0.40 ± 0.03
309.4 (1)	–	–	–	0.10 ± 0.03 or − 2.13 ± 0.30	0.10 ± 0.03
392.0 (2)	$0.55^{+0.51}_{-0.19}$ or $2.8^{+2.5}_{-1.5}$ if J^π(1077) = 5/2$^+$ − 0.29 ± 0.14 or – 2.1 ± 0.7 if J^π(1077) = 9/2$^+$	–	–	0.15 ± 0.02 − 0.31 ± 0.02	0.15 ± 0.02
440.77 (2)	–	–	–	$0.51^{+0.38}_{-0.22}$ or $-18.30^{+14.30}_{-\infty}$	0.5 ± 0.3
445.3 (1)	0.4 ± 0.2	− 3.14 ± 0.76	− 1.0 ± 0.3	− 1.16 ± 0.30	− 1.0 ± 0.5
450.8 (2)	–	–	–	$0.65^{+0.76}_{-0.12}$ or $1.16^{+0.22}_{-0.63}$	0.7 ± 0.5
473.26 (4)	− 0.29 ± 0.06 or − 1.56 ± 0.19	–	− 0..29 ± 0.06	− 0.10 ± 0.01 or − 2.50 ± 0.05	− 0.20 ± 0.10†
501.93 (1)	–	–	–	0.34 ± 0.08 or 1.50 ± 0.22 $0.34^{+0.90}_{-0.24}$ or $2.13^{+0.38}_{-0.90}$	0.34 ± 0.08
603.9 (1)	0.00 ± 0.07 or 1.65 ± 0.25 if J^π(1077) = 5/2$^+$ pure E2 if J^π(1077) = 9/2$^+$	–	–	0.14 ± 0.08 or − 2.32 ± 0.50 if J^π(1077) = 5/2$^+$ 0.05 ± 0.08	0.14 ± 0.08
638.3 (1)	–	–	–	− 0.42 ± 0.03 or – 5.50 ± 0.84	− 0.42 ± 0.03
652.8 (1)	–	–	–	0.24 ± 0.07 or $2.08^{+0.26}_{-0.43}$	0.24 ± 0.07
697.9 (1)	− 0.21 ± 0.03 or $-3.3^{+0.7}_{-0.3}$	–	–	–	defined as 100% E2
782.6 (1)	0.21 ± 0.01 or − 11.7 ± 0.9	–	0.21 ± 0.01	–	0.21 ± 0.01
1140.2 (1)	$-0.14^{+0.14}_{-0.11}$ or $-2.2^{+0.9}_{-0.6}$	–	–	–	− 0.14 ± 0.12
1289.8 (1)	$0.02^{+0.07}_{-0.09}$ or $-3.6^{+1.6}_{-0.9}$	–	–	–	$0.02^{+0.07}_{-0.09}$
E1(+M2) transition					
292.6 (2)	–	–	–	0.12 ± 0.13	0.12 ± 0.13

* LWM of 1972Kr15, 1974So03 and 1985De04 measurements.
† LWM of 1972Kr15 and 1985De04 measurements.

Gamma-ray emissions: recommended energies, multipolarities, theoretical internal conversion coefficients (frozen orbital approximation), and internal-pair formation coefficients.

E_γ (keV)	Multipolarity	α_K	α_L	α_{M+}	α_{IPF}	α_{tot}
61.16 (2)	80.6%M1 +19.4% E2 δ = 0.49 (6)‡	2.93 (12)	0.99 (14)	0.28 (4)	−	4.2 (2)
154.7 (1)	92%M1 + 8%E2 δ = 0.3 (2)	0.182 (14)	0.026 (5)	0.006	−	0.214 (20)
252.64 (9)	(18%M1 + 82% E2) δ = − 2.1 (5)	0.0541 (12)	0.0090 (4)	0.0021	−	0.0652 (17)
280.7 (1)	99.2%M1 + 0.8%E2 δ = − 0.09 (2)	0.0351 (5)	0.00445 (7)	0.00115	−	0.0407 (6)
290.5 (1)	(86%M1 + 14%E2) δ = 0.40 (3)	0.0326 (5)	0.00430 (7)	0.0010	−	0.0379 (6)
292.6 (2)	98.5%E1(+ 1.5%M2) δ = 0.12 (13)	0.0103 (60)	0.00136 (16)	0.000326	−	0.012 (7)
309.4 (1)	99%M1 + 1%E2 δ = 0.10 (3)	0.0273 (4)	0.00345 (5)	0.00085	−	0.0316 (5)
392.0 (2)	(97.8%M1 + 2.2%E2) δ = 0.15 (2)	0.01490 (21)	0.00187 (3)	0.00045	−	0.01722 (25)
412.10 (5)	E2	0.01210 (17)	0.001775 (25)	0.000435	−	0.01431 (20)
423.7 (7)	50%M1 + 50%E2 δ = 1.0 (5)	0.0117 (4)	0.00158 (4)	0.00042	−	0.0137 (4)
440.77 (2)	80%M1 + 20%E2 δ = 0.5 (3)	0.0109 (3)	0.001395 (22)	0.000305	−	0.0126 (3)
445.3 (1)	50%M1 + 50%E2 δ = − 1.0 (5)	0.0102(4)	0.001369 (23)	0.000431	−	0.0120 (4)
450.8 (2)	67%M1 + 33%E2 δ = 0.7 (5)	0.0101 (4)	0.001318 (20)	0.000382	−	0.0118 (4)
455.1 (1)	50%M1 + 50%E2 δ = 1.0 (5)	0.0097 (4)	0.001287 (19)	0.000313	−	0.0113 (4)
473.26 (4)	96%M1 + 4%E2 δ = − 0.20 (10)	0.00928 (14)	0.001159 (17)	0.000281	−	0.01072 (16)
501.93 (1)	89.6%M1 + 10.4%E2 δ = 0.34 (8)	0.00795 (13)	0.000997 (14)	0.000243	−	0.00919 (14)
543.2 (1)	E2	0.00553 (8)	0.000761 (11)	0.000189	−	0.00648 (9)
583.2 (2)	E1	0.001622 (23)	0.000196 (3)	0.000052	−	0.00187 (3)
603.9 (1)	(98%M1 + 2%E2) δ = 0.14 (8)	0.00513 (8)	0.000634 (10)	0.000156	−	0.00592 (9)
624.2 (1)	(50%M1 + 50%E2) δ = 1.0 (5)	0.0043 (3)	0.000550 (24)	0.000150	−	0.0050 (4)
638.3 (1)	85%M1 + 15%E2 δ = − 0.42 (3)	0.00438 (7)	0.000544 (8)	0.000136	−	0.00506 (8)
652.8 (1)	94.6%M1 + 5.4%E2 δ = 0.24 (7)	0.00423 (7)	0.000522 (8)	0.000128	−	0.00488 (8)
666.9 (1)	50%M1 + 50%E2 δ = 1.0 (5)	0.0037 (3)	0.000464 (23)	0.000036	−	0.0042 (3)
681.4 (1)	50%M1 + 50%E2 δ = 1.0 (5)	0.00347 (25)	0.000440 (22)	0.00009	−	0.0040 (3)

E_γ (keV)	Multipolarity	α_K	α_L	α_{M+}	α_{IPF}	α_{tot}
685.09 (7)	E2	0.00303 (5)	0.000399 (6)	0.000091	−	0.00352 (5)
697.9 (1)	E2	0.00289 (4)	0.000380 (6)	0.000090	−	0.00336 (5)
721.5 (1)	E2	0.00266 (4)	0.000348 (5)	0.000082	−	0.00309 (5)
747.2 (1)	E1	0.000951 (14)	0.0001142 (16)	0.0000278	−	0.001093 (16)
762.7 (1)	50%M1 + 50%E2 δ = 1.0 (5)	0.00265 (20)	0.000332 (19)	0.000078	−	0.00306 (22)
782.6 (1)	95.8%M1 + 4.2%E2 δ = 0.21 (1)	0.00277 (4)	0.000339 (5)	0.000081	−	0.00319 (5)
816.5 (1)	50%M1 + 50%E2 δ = 1.0 (5)	0.00225 (17)	0.000282 (17)	0.000068	−	0.00260 (19)
821.5 (8)	−	−	−	−	−	−
924.0 (2)	E2	0.001491 (21)	0.000189 (3)	0.000045	−	0.001725 (25)
1140.2 (1)	98%M1 + 2%E2 δ = − 0.14 (12)	0.001179 (20)	0.0001427 (23)	0.0000348	0.00000150 (2)	0.001358 (23)
1154.7 (1)	M1 + E2	−	−	−	−	−
1289.8 (1)	99.96%M1 + 0.04%E2 $\delta = 0.02^{+0.07}_{-0.09}$	0.000901 (13)	0.0001087 (16)	0.0000265	0.0000188 (3)	0.001055 (15)
1378.6 (1)	M1 + E2	−	−	−	−	−

‡ adopted on the basis of the required transition probability in order to achieve γ population-depopulation balance for the 61.161-keV nuclear level.

A normalisation factor of 0.354 (4) was calculated from the internal conversion coefficients and relative emission probabilities of the gamma-ray transitions populating the 88.23-keV metastable (^{127m}Te) and ground (^{127g}Te) states, summed in conjunction with direct beta feeding to the 88.23-keV metastable state of (2.0 ± 0.5) %, as measured by 1967Ta05 (direct beta feeding to the ^{127}Te ground state was assumed to be zero on the basis of spin and parity considerations):

$$\left[\sum^{88.23\ keV} P^{rel}_{\gamma+ce} \;+\; \sum^{0.0\ keV} P^{rel}_{\gamma+ce}\right] x\ F \;+\; \beta_{0,2} \;=\; 100\ \%$$

$$[41.8\ (7) + 235.25\ (238)]\ F \;+\; 2.0\ (5)\ \% \;=\; 100\ \%$$

$$F \;=\; 98.0\ (5)\ /\ 277.05\ (248) \;=\; 0.354 \pm 0.004$$

Beta-particle Emissions

<u>Energies and emission probabilities</u>

Beta-particle energies were calculated from the structural detail of the proposed decay scheme. Nuclear-level energies adopted from Hashizume (2011Ha31) and a Q_{β^-} value of 1582 (5) keV from the evaluated tabulations of 2011AuZZ were used to determine the energies and uncertainties of the beta-particle transitions.

The emission probability of the highest-energy beta-particle was measured by 1967Ta05 to be (2.0 ± 0.5) %, and this value was adopted to calculate the normalization factor of the relative gamma-ray emission probabilities. Direct beta population of the 762.64-, 501.93-, 61.161- and 0.0-keV nuclear levels of ^{127}Te were defined as zero on the basis of spin and parity considerations. All other beta-particle emission probabilities were calculated on the basis of achieving population-depopulation balances with the relevant relative gamma transition probabilities, as derived from the relative gamma-ray emission probabilities, internal conversion coefficients, and normalization factor of 0.354 ± 0.004.

Beta-particle emission probabilities per 100 disintegrations of ^{127}Sb.

Transition	E_β (keV)	P_β	Transition type	log*ft*
$\beta^-_{0,19}$	203 ± 5	0.18 ± 0.04	allowed	7.42 ± 0.11
$\beta^-_{0,18}$	259 ± 5	0.12 ± 0.02	[allowed]	7.93 ± 0.08
$\beta^-_{0,17}$	273 ± 5	0.06 ± 0.02	(allowed)	8.30 ± 0.15
$\beta^-_{0,16}$	292 ± 5	0.61 ± 0.04	allowed	7.39 ± 0.04
$\beta^-_{0,15}$	376 ± 5	0.10 ± 0.04	(allowed)	8.53 ± 0.18
$\beta^-_{0,14}$	427 ± 5	0.85 ± 0.25	allowed	7.79 ± 0.13
$\beta^-_{0,13}$	442 ± 5	1.35 ± 0.21	allowed	7.64 ± 0.07
$\beta^-_{0,12}$	505 ± 5	5.17 ± 0.14	(allowed)	7.251 ± 0.021
$\beta^-_{0,11}$	658 ± 5	1.27 ± 0.25	allowed	8.26 ± 0.09
$\beta^-_{0,10}$	796 ± 5	7.72 ± 0.21	1st forbidden non-unique	7.766 ± 0.018
$\beta^-_{0,9}$	799 ± 5	17.2 ± 0.3	allowed	7.425 ± 0.015
$\beta^-_{0,7}$	897 ± 5	34.4 ± 0.4	allowed	7.304 ± 0.013
$\beta^-_{0,6}$	951 ± 5	4.00 ± 0.21	1st forbidden non-unique	8.33 ± 0.03
$\beta^-_{0,4}$	1109 ± 5	22.6 ± 0.8	allowed	7.826 ± 0.019
$\beta^-_{0,3}$	1241 ± 5	2.4 ± 0.3	(1st forbidden non-unique)	8.98 ± 0.06
$\beta^-_{0,2}$	1494 ± 5	2.0 ± 0.5	1st forbidden unique	10.21 ± 0.11
		$\sum$ 100.03		

The proposed decay scheme is heavily dependent upon the absolute emission probability of the highest-energy β^- decay to the 88.23-keV ^{127m}Te nuclear level, as measured by Takemoto et al. (1967Ta05) to be (2.0 ± 0.5) %. There are also a number of gaps and uncertainties concerning some of the gamma-ray emissions. Under such unsatisfactory circumstances, spectroscopic measurements of the absolute γ-ray emission probabilities would assist greatly in addressing these specific issues, and so provide the means of deriving an evaluated decay scheme with much greater confidence.

Branching Fractions

^{127}Sb(β^-)^{127m}Te: summation of the γ and $\beta^-_{0,2}$ transitions populating the 88.23-keV metastable state.

BF(^{127}Sb(β^-)^{127m}Te) =

$$\sum_{i=1}^{M}\left[P_\gamma^{rel}(697.9\ keV)(1+\ \alpha)\ +\ P_\gamma^{rel}(543.2\ keV)(1+\ \alpha)\ +\ P_\gamma^{rel}(252.64\ keV)(1+\ \alpha)\right] x\ F\ +\ \beta_{0,2}$$

= {41.8 (7) x 0.354 (4)} + 2.0 (5) % = 14.8 (3) % + 2.0 (5) % = 16.8 (6) % [0.168 (6)]

^{127}Sb(β^-)^{127}Te: summation of the γ transitions populating the 0.0-keV ground state (no direct population of the ground state by β^- decay).

BF(^{127}Sb(β^-)^{127}Te) =

$$\sum_{i=1}^{M}\left[P_\gamma^{rel}(1+\ \alpha)\right] x\ F$$

= 235.25 (238) x 0.354 (4) = 83.3 (13) % [0.833 (13)]

But lower value of 83.2 % [0.832] and uncertainty of ± 0.6 % [± 0.006] adopted to achieve a precise balance with the equivalent BF for $^{127}Sb(\beta^-)^{127m}Te$. BF($^{127}Sb(\beta^-)^{127}Te$) = 83.2 (6) % [0.832 (6)].

Atomic Data

The X-ray and Auger electron data have been calculated using evaluated X-ray data (1999ScZX, 2003De44), gamma-ray data, and atomic data from 1977La19, 1996Sc06 and 1998ScZM. Both the X-ray and Auger-electron emission probabilities were determined by means of the EMISSION computer program (version 4.01, 28 January 2003). This program incorporates atomic data from 1996Sc06 and the evaluated gamma-ray data.

K and L X-ray emission probabilities per 100 disintegrations of ^{127}Sb.

			Energy (keV)	Photons per 100 disint.
XL		(Te)	3.335 – 4.829	0.462 (23)
	XL_l	(Te)	3.335	0.0089 (4)
	XL_α	(Te)	3.759 – 3.770	0.235 (10)
	XL_η	(Te)	3.605	0.00355 (19)
	XL_β	(Te)	4.030 – 4.302	0.184 (7)
	XL_γ	(Te)	4.572 – 4.829	0.0248 (10)
XK_α	$XK_{\alpha2}$	(Te)	27.2020 (2)	1.11 (4)
	$XK_{\alpha1}$	(Te)	27.4726 (2)	2.06 (7)
$XK'_{\beta1}$	$XK_{\beta3}$	(Te)	30.9446 (3)	)
	$XK_{\beta1}$	(Te)	30.9960 (4)	) 0.591 (21)
	$XK''_{\beta5}$	(Te)	31.236	)
$XK'_{\beta2}$	$XK_{\beta2}$	(Te)	31.7008 (5)	)
	$XK_{\beta4}$	(Te)	31.774	) 0.128 (6)
	$XKO_{2,3}$	(Te)	31.812	)

Electron energies were determined from electron binding energies tabulated by Larkins (1977La19) and the evaluated gamma-ray energies. Absolute electron emission probabilities were calculated from the evaluated absolute gamma-ray emission probabilities and associated internal conversion coefficients.

Data Consistency

Q_{β^-} values of 1582 (5) and 1494 (5) keV have been adopted for the β^- decay of ^{127}Sb to the ground and metastable states of ^{127}Te, respectively, based on the atomic mass evaluation of Audi and Wang (2011AuZZ) and the nuclear-level energy of ^{127m}Te (2011Ha31). An effective Q-value derived from these data has been compared with the Q-value calculated by summing the contributions of the individual emissions to the ^{127}Sb beta-decay process (i.e. β^-, electron, γ, etc.):

$$\text{effective Q-value} = \sum (Q_i \times BF_i) = 1567\ (13)\ \text{keV}$$

$$\text{calculated Q-value} = \sum (E_i \times P_i) = 1560\ (15)\ \text{keV}$$

The percentage deviation from the effective Q-value is (0.5 ± 1.3) %, which supports the derivation of a consistent decay scheme.

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