^{124}I – Comments on evaluation of decay data

By B. E. Zimmerman

This evaluation was completed in October 2016 with the same literature cutoff date. It was later updated to include the references 2021PI01 and 2021WA16.

The Limitation of Relative Statistical Weights Method (LWM) was applied to average the decay data when appropriate (unless otherwise stated) by use of the LWEIGHT Excel add-in. All uncertainties are given as the combined uncertainty to one standard deviation.

Prior to this work, the most recent evaluation of decay data from ^{124}I was published in the 2008 Evaluated Nuclear Structure Data File (ENSDF) by Katakura and Wu [2008Ka21].

1 Decay scheme

Iodine-124 decays by electron capture (EC) and β^+ emission to a total of 28 levels in ^{124}Te. The ^{124}Te decay daughter is stable. Level energies are taken from the ENSDF Adopted Levels tables [2008KA21].
As with the ENSDF evaluation, level spins and parities, transition multipolarities and mixing ratios, as well as gamma-ray placements in this evaluation are based on the level scheme proposed by Warr, *et al.* [1998WA18], with additional levels and transitions from the work of Ragaini, *et al.* [1969RA31] and Ghiţă, *et al.* [2008GH04]. In the latter cases, the placement and multipolarity assignments were taken from the respective references. Only those transitions actually placed into the respective level schemes are included in this evaluation. For transitions in which no published multipolarities are given, assignments were made by the evaluator on the basis of selection rules.

The level scheme as presented is complete and consistent. This is demonstrated by agreement between Q_{Calc} = 3145 (19) keV obtained from sum of the average energies and probabilities of all the transitions and Q_{Tot} = 3159.6 (19) keV from the most recent atomic mass evaluation of Wang, et al. [2021WA16]. The difference between the summation of all decay out of the levels and the feeding into them by β^+ and EC decay was 0.84%.

Of particular note in this evaluation is the treatment of the level at 2039.3 keV, which is purported to be a doublet of states at 2039.293 keV and 2039.421 keV with spins and parities of 3^+ and 2^+, respectively. The presence of a doublet state was first reported by Berendakov, *et al.* [1990BE50] based on data from the (n,n') reaction on ^{124}Te. The data that provide the evidence for the doublet are only available in the form of an unpublished conference proceedings, so it is difficult to judge their quality. The level scheme proposed in [1998WA18] continued to promote the idea of a doublet state at this energy based on the lack of coincidences in the fairly intense 2039 keV γ-ray gate in their ^{122}Sn(α,2n)^{124}Te reaction data. This led them to suggest a level at an energy at about 2039 keV separate from the one already established through coincidence relationships between several other γ-rays. It should be noted, however, that the tabulated value for this γ-ray, 2038.43 (8) keV, is inconsistent with the energies assigned to either of the proposed levels near 2039 keV, suggesting that the observed transition is in fact not a ground state transition from either of these states.

Their data from ^{124}I decay, published in the same reference, indicate a coincidence relationship between the 2039 keV γ-ray and first excited state transition at 603 keV, suggesting that the 2039 keV γ-ray depopulates the level at 2641 keV. This same coincidence relationship was also observed earlier by Ragaini, *et al.* [1969RA31], who proposed that the 2039 keV state could be the 3^+ member of the *n*=3 phonon multiplet. This is supported by systematics of the locations of the 3^+ 3rd-phonon states in the neighboring Te nuclei.

The main evidence for a doublet comes from the resolved splitting of the 1437 keV γ-ray that proceeds from the 2039 keV state to the 603 keV first excited state observed by Doll, *et al.* [2000DO11], which is interpreted as a splitting of the 2039 keV level. There are, however, no supporting coincidence data to support placement of the transitions. If the 2039 keV level is a doublet and the two levels de-excite according to the scheme proposed by Doll, *et al.* [2000DO11], it would require the three transitions that de-excite the level (714 keV, 791 keV, and 1437 keV) to all be doublets in addition to the 2039 keV γ-ray being doubly placed. This has not yet been reported.

From a practical perspective, there are currently no data to enable the calculation of feeding intensities in and out of a 2039 keV doublet, as the partitioning of observed intensity has yet to be reported. With this information in hand, this evaluator proposes that the level at 2039 keV be considered to be populated *in decay* as a singlet state with spin and parity 3^+.

This is obviously an area in which additional spectroscopic studies from ^{124}I decay are needed. With the appropriate coincidence (perhaps higher than 2-fold) data and high resolution spectroscopy, the nature of this state can hopefully be resolved. Within the current levels of uncertainty, however, the level scheme and associated data as reported here are internally consistent.

2 Nuclear data

2.1 Half-life

Only experimentally-determined, published half-life values with associated uncertainties were considered in this evaluation. These are given in Table 1 and lead to an evaluated half-life of **4.1760 (29) d**.

The data from Ruan *et al.* [1967RU04] were excluded as an outlier based on the Chauvenet criteria.

The bulk of the weight is carried by the two of the most recent results [1992WO03 and 2016LUAA], with the former having a lower uncertainty than for latter by a factor of more than 4 and a factor of 100 from the next lowest reported uncertainty.

Table 1. Experimental half-life determinations of ^{124}I considered in this evaluation.

Reference	$T_{1/2}$ (d)	Uncertainty (d)
1958DY58	4.24	0.05
1959GI59	4.1	0.1
1965AN05	4.15	0.03
1967RU04[a]	4.3	0.08
1968JO02	4.1	0.2
1973KA45	4.15	0.08
1992WO03	4.1760	0.0003
2016LUAA	4.1758	0.0014
2021Pi01	4.179	0.006
Recommended[b]	**4.1760**	**0.00029**
LWEIGHT χ^2 = 0.54 (χ^2 Critical = 2.80)		

[a]Rejected by LWEIGHT by the Chauvenet principle.
[b]The recommended half-life is the weighted mean of all the above values, with the exception of [1967RU04]. Most of the weight (99.98 %) is from [1992WO03] and [2016LUAA] due to their small uncertainties. The uncertainty on the recommended half-life is the standard deviation of the weighted values.

2.2 Gamma transitions

Gamma ray energies and intensities

High-resolution gamma-ray spectroscopy data were considered from six primary sources: [1969RA31], [1992WO03], [1998WA18], [2008Gh04], [2016LUAA] and [2021PI01]. To within their respective uncertainties, all of the data sets are consistent with one another. The γ-ray intensity data of Bechvarzh, *et al.* [1969BE70] were found to be inconsistent with the other data sets and were therefore not included in the calculation of recommended values. Regarding the γ-ray intensity data from [1968LA21], a systematic deviation from the other measurements can be noticed above 1500 keV. Besides, if the dataset is included in the evaluation, the intensities of fifteen transitions from [1968LA21] are rejected by the Chauvenet criterion (80% of the total rejections). As a consequence it has been decided to not include the data from [1968LA21] in the present work.
The list of the published γ-ray intensities included in this evaluation is given in Table 2, along with their recommended values. The transition energies are from [1998WA18] unless otherwise noted. With the exception of [2016LUAA], the conversion of relative γ-ray intensities to absolute intensities was done by applying the factor of 0.0629 (6) that was determined by Woods, *et al.* [1992WO03] from observed photon emission rates and an absolute activity measurement. The absolute intensities published in Luca, *et al.* [2016LUAA] were based on photon emission rates and an independent absolute activity measurement and were used without further adjustment.

Table 2. List of evaluated absolute γ-ray probabilities (per 100 decays) in the decay of ^{124}I.

	Pγ, per 100 decays													
Energy (keV)	**1969RA31**	**s**	**1992WO03**	**s**	**1998WA18**	**s**	**2008GH04**	**s**	**2016LUAA**	**s**	**2021PO01**	s	**Recommended**	**s**
166.04					0.0077	0.0028							**0.0077**	**0.0028**
307.34	0.019	0.009			0.0202	0.0024	0.0125	0.0025					**0.0165**	**0.0027**
335.67	0.018	0.009			0.0176	0.0030	0.017	0.006					**0.0175**	**0.0025**
351.47					0.0224	0.0034	0.0100	0.0025	0.024	0.010	0.014	0.006	**0.0147**	**0.0019**
370.4[1]							0.0025	0.0012					**0.0025**	**0.0012**
402.8					0.0143	0.0031	0.0112	0.0044					**0.0133**	**0.0025**
443.88	0.034	0.009	0.047	0.011	0.0376	0.0034			0.034	0.013	0.035	0.006	**0.0366**	**0.0027**
46.8[1]							0.0075	0.0044					**0.0075**	**0.0044**
490.9[1]							0.0280	0.0031					**0.028**	**0.0031**
517.8					0.0237	0.003	0.019	0.006					**0.0228**	**0.0027**
525.45	0.0368	0.0187	0.039	0.011	0.0324	0.0024	0.0206	0.0031			0.024	0.009	**0.0281**	**0.003**
541.19	0.193	0.007	0.213	0.004	0.2126	0.0035	0.202	0.0037	0.202	0.012	0.206	0.011	**0.2067**	**0.0032**
550.75					0.007	0.022							**0.007**	**0.022**
557.14					0.0083	0.0024	0.041	0.006					**0.024**	**0.016**
592.34	0.042	0.009	0.131	0.008	0.1136	0.0026	0.1065	0.0027	0.089	0.010	0.099	0.012	**0.1104**	**0.0035**
602.73	62.9	0.6	62.9	0.6	62.9	0.7	62.9	0.6	62.7	2.1	61.1	0.8	**62.3**	**0.6**
609.92					0.153	0.005	0.1445	0.0029	0.160	0.010	0.158	0.005	**0.1493**	**0.0022**
645.85	0.972	0.033	0.989	0.012	0.987	0.011	0.969	0.010	0.973	0.035	0.965	0.013	**0.977**	**0.006**
661.04[1]							0.0112	0.0019					**0.0112**	**0.0019**
662.1	0.0561	0.0038	0.055	0.008	0.0551	0.0017	0.052	0.006	0.049	0.007	0.048	0.0027	**0.0533**	**0.0013**
678.3[1]							0.0037	0.0012					**0.0037**	**0.0012**
707.46	0.069	0.031	0.112	0.008	0.0912	0.0024	0.0910	0.0021	0.091	0.010	0.091	0.002	**0.0915**	**0.0014**
709.36	0.044	0.019			0.0457	0.0022	0.0430	0.0019	0.043	0.007	0.048	0.003	**0.0448**	**0.0013**
713.75	0.112	0.013	0.076	0.003	0.0775	0.0020			0.068	0.007	0.084	0.009	**0.0768**	**0.0016**
722.78	10.28	0.21	10.34	0.13	10.26	0.12	10.27	0.10	10.36	0.34	10.13	0.02	**10.24**	**0.06**
735.8[1]							0.013	0.008			0.0053	0.0013	**0.006**	**0.001**
743.19	0.0168	0.0044			0.012	0.001	0.0131	0.0025	0.018	0.006	0.0132	0.002	**0.0128**	**0.0008**
766.09					0.0048	0.0012							**0.0048**	**0.0012**
776.1	0.0137	0.0037			0.012	0.001	0.0131	0.0019	0.008	0.008	0.0078	0.0042	**0.0121**	**0.0008**
790.76	0.029	0.008	0.027	0.004	0.0257	0.0011			0.024	0.008	0.026	0.0029	**0.0254**	**0.001**
794.7							0.0025	0.0006					**0.0025**	**0.0006**

	Pγ, per 100 decays													
Energy (keV)	1969RA31	s	1992WO03	s	1998WA18	s	2008GH04	s	2016LUAA	s	2021PO01	s	Recommended	s
795.63	0.0449	0.0031	0.035	0.004	0.0368	0.0011			0.033	0.007	0.0364	0.005	**0.0366**	**0.001**
797.1[1]							0.0037	0.0019					**0.0037**	**0.0019**
846.8	0.0025	0.0012			0.0057	0.0014					0.0044	0.0051	**0.004**	**0.0011**
876.97	0.027	0.006	0.02	0.004	0.0232	0.0011	0.0218	0.0019	0.022	0.009	0.0209	0.0038	**0.0226**	**0.0009**
899.43	0.031	0.017			0.0220	0.0011	0.0218	0.0019	0.029	0.007	0.0221	0.0033	**0.0221**	**0.0009**
928.07[2]	0.0022	0.0009									0.0031	0.0025	**0.002**	**0.001**
961.84	0.0231	0.0025			0.0168	0.0012	0.0187	0.0019	0.013	0.007	0.0183	0.0024	**0.0181**	**0.001**
968.19	0.424	0.007	0.444	0.007	0.440	0.006	0.439	0.005	0.465	0.021	0.425	0.015	**0.4375**	**0.0035**
976.35	0.10+	0.013	0.103	0.004	0.1033	0.0020	0.0916	0.0026	0.105	0.010	0.0972	0.004	**0.0996**	**0.0023**
984.4[2]	0.0143	0.0031											**0.0143**	**0.0031**
998.3[1]							0.0255	0.0019			0.0277	0.0064	**0.026**	**0.002**
1045.11	0.436	0.031	0.441	0.011	0.4339	0.0059	0.422	0.005	0.436	0.022	0.4166	0.0072	**0.4264**	**0.0036**
1054.54	0.125	0.006	0.127	0.008	0.1233	0.0023	0.1221	0.0028	0.117	0.015	0.1194	0.0034	**0.1223**	**0.0015**
1086.4	0.019	0.006			0.0151	0.0014	0.0156	0.0025			0.0145	0.0044	**0.0153**	**0.0012**
1128.58	0.0449	0.0008	0.05	0.006	0.0461	0.0017	0.0473	0.0031	0.035	0.011	0.0457	0.004	**0.0452**	**0.0007**
1196	0.019	0.007			0.0047	0.0022	0.0029	0.0012			0.0078	0.0024	**0.0038**	**0.0018**
1205.44	0.0193	0.0007			0.0216	0.0033	0.0305	0.0025	0.010	0.006	0.026	0.005	**0.0224**	**0.0031**
1315.67	0.0355	0.0044			0.0280	0.0018	0.0274	0.0025			0.03	0.003	**0.0288**	**0.0012**
1325.52	1.477	0.051	1.56	0.01	1.562	0.021	1.579	0.016	1.55	0.06	1.478	0.024	**1.556**	**0.014**
1355.2	0.044	0.007			0.0363	0.0015	0.0336	0.0031	0.029	0.011	0.036	0.005	**0.036**	**0.0013**
1368.18	0.293	0.019	0.303	0.009	0.2961	0.0044	0.2897	0.0047	0.274	0.020	0.288	0.006	**0.2926**	**0.0026**
1376.09	1.713	0.025	1.77	0.02	1.772	0.024	1.761	0.018	1.80	0.07	1.709	0.025	**1.751**	**0.012**
1392.7[1]							0.0143	0.0034			0.012	0.006	**0.014**	**0.003**
1436.64	0.069	0.019	0.09	0.03	0.0759	0.0023			0.057	0.016	0.071	0.006	**0.0749**	**0.0021**
1445.17	0.034	0.011	0.068	0.013	0.0388	0.0019	0.0318	0.0031	0.044	0.015	0.039	0.004	**0.0372**	**0.0015**
1488.92	0.187	0.006	0.208	0.006	0.2089	0.0041	0.1956	0.0036	0.185	0.018	0.189	0.005	**0.1984**	**0.0038**
1509.36	3.078	0.039	3.23	0.05	3.222	0.046	3.187	0.031	3.11	0.20	3.102	0.045	**3.16**	**0.026**
1560.53	0.168	0.025	0.165	0.006	0.1657	0.0030	0.136	0.015	0.137	0.016	0.156	0.004	**0.1616**	**0.003**
1586.1					0.0058	0.0012					0.012	0.002	**0.009**	**0.003**
1622.22	0.058	0.014	0.053	0.003	0.0500	0.0013	0.0430	0.0019	0.040	0.009	0.048	0.004	**0.0484**	**0.0016**
1637.43	0.1994	0.0126	0.214	0.01	0.2075	0.0035	0.1969	0.0031	0.179	0.018	0.197	0.004	**0.2007**	**0.0027**
1658.1[a]														
1663.7[1]							0.0025	0.0006					**0.0025**	**0.0006**
1675.6	0.112	0.025	0.112	0.008	0.1118	0.0024	0.1009	0.0027	0.101	0.012	0.106	0.004	**0.1068**	**0.0022**
1690.96	10.72	0.16	11.2	0.3	11.04	0.17	10.97	0.11	10.8	0.8	10.71	0.14	**10.89**	**0.07**

	Pγ, per 100 decays													
Energy (keV)	**1969RA31**	**s**	**1992WO03**	**s**	**1998WA18**	**s**	**2008GH04**	**s**	**2016LUAA**	**s**	**2021PO01**	s	**Recommended**	**s**
1705.63	0.0143	0.0025			0.0083	0.0010					0.011	0.005	**0.0092**	**0.0015**
1720.21	0.1744	0.0126	0.17	0.04	0.181	0.006	0.202	0.004	0.180	0.017	0.196	0.004	**0.1934**	**0.0036**
1752.51	0.052	0.006			0.0532	0.0012	0.0498	0.0019	0.049	0.007	0.053	0.003	**0.0522**	**0.001**
1851.37	0.212	0.025			0.2139	0.0038	0.2124	0.0032	0.188	0.019	0.209	0.005	**0.2122**	**0.0022**
1918.56	0.162	0.019			0.1741	0.0032	0.1626	0.0029	0.173	0.018	0.164	0.004	**0.1671**	**0.0027**
2038.43	0.349	0.019			0.356	0.006	0.336	0.004	0.362	0.032	0.353	0.007	**0.3443**	**0.0047**
2078.67	0.355	0.013			0.356	0.006			0.326	0.028	0.0357	0.007	**0.3556**	**0.0043**
2090.94	0.586	0.008			0.617	0.011	0.589	0.006	0.596	0.049	0.606	0.01	**0.596**	**0.006**
2098.77	0.143	0.006			0.1526	0.0015	0.1489	0.0024	0.146	0.015	0.153	0.003	**0.1515**	**0.0011**
2144.21	0.112	0.006			0.1047	0.002	0.1003	0.0016	0.103	0.011	0.105	0.003	**0.1027**	**0.0014**
2214.8[1]							0.0056	0.0006			0.008	0.001	**0.006**	**0.001**
2232.03	0.586	0.014			0.549	0.010	0.594	0.014	0.65	0.05	0.607	0.013	**0.579**	**0.029**
2256.7[1]							0.0031	0.0012			0.005	0.002	**0.0036**	**0.0011**
2283.06	0.679	0.032			0.525	0.01	0.643	0.007	0.66	0.05	0.676	0.016	**0.65**	**0.008**
2294.4[2]	0.0106	0.0019							0.008	0.002	0.016	0.003	**0.0104**	**0.002**
2385.1	0.0199	0.0025			0.0127	0.0005	0.0174	0.0006	0.015	0.005	0.021	0.002	**0.0153**	**0.0026**
2453.9[2]	0.069	0.019							0.049	0.009	0.054	0.003	**0.0538**	**0.0028**
2681.5[2]	0.0312	0.0125							0.032	0.0046	0.031	0.002	**0.0312**	**0.0018**
2746.93[2]	0.4753	0.0192							0.454	0.038	0.505	0.011	**0.495**	**0.012**
2987.6[2]	0.0081	0.0037							0.008	0.003	0.0089	0.001	**0.0087**	**0.0009**

[a]E0 transition

[1]Energy from 2008Gh04

[2]Energy from 1969Ra18

Multipolarities and internal conversion coefficients

Gamma-ray multipolarities were assigned based on the spins and parities of the initial and final states. Mixing ratios, when available, were taken from Warr, *et al.* [1998WA18]. Internal conversion coefficients were calculated using BrIcc [2008KI07] with the frozen orbital approximation. Experimental mixing ratios were used in the calculations when available. When unknown, equal mixing between the multipolarities (i.e., δ = 1) was assumed (since all the cases were M1+E2). The calculated α_K values are given in Table 3, along with the experimental results of Bechvarzh, *et al.* [1969BE70], Grigorev, *et al.* [1968GR24].

The minor disagreement in the calculated α_K for the 1325 keV transition between this work (0.77 (8)) and the ENSDF evaluation (0.693 (10), [2008KA21]) lies primarily in the assignment of multipolarity. The experimental α_K values given by both Bechvarzh, *et al.* [1969BE70] and Grigorev, *et al.* [1968GR24] are higher than the theoretical value given in the ENSDF evaluation that was based on the assumption of a pure E2 transition. If the transition is treated as having mixed M1+E2 nature, which is reasonable given the initial and final level spins and parities, the higher calculated theoretical α_K is in much better agreement with experiment.

For the case of the 1851 keV γ-ray, Warr, *et al.* [1998WA18] suggest that the transition is of M1+E2 character and report a mixing ratio of δ = 0.039 (1) from their ^{122}Sn(α,2n)^{124}Te data (i.e., not from ^{124}I decay). However, the calculated α_k from these parameters is not consistent with the measured value of Bechvarzh, *et al.* [1969BE70] that assumes M2+E3. Both proposed multipolarities are plausible from the existing level spin and parity assignments. However, better agreement between theoretical and experimental α_k is achieved with the M2+E3 assignment. The result calculated with this assumption is adopted in this evaluation.

2.3 Beta and electron capture transitions

Maximum positron energies were calculated from the adopted Q-value and the level energies in the ^{124}Te decay daughter, appropriately accounting for the annihilated positron and electron rest masses. Transition probabilities were deduced from the imbalance in total intensities of the gamma-rays feeding into and out of each level. Where energetically possible, the relative fractions of β^+ and EC decay for each level were calculated with the BetaShape program (based on the work of X. Mougeot, [2019MO35]), as were the log *ft* values for each level.

The calculated β^+ endpoint energies and emission rates are compared with published experimental values in Table 4. In general, the currently available experimental data are of relatively poor quality (and outdated) and could benefit from new measurements with higher-resolution instrumentation, particularly with regards to the characterization of the two weakest β^+ branches and spectral shapes for all the β^+ transitions.

Electron capture P_K, P_L, (P_{L1}, P_{L2}, P_{L3}) P_M and P_o probabilities were calculated using the BetaShape program.

Table 3. Comparison of experimental and theoretical α_K values for gamma transitions observed in the decay of ^{124}I.

Energy (keV)	[1969BE70][a]		[1968GR24][b]		Recommended	
	$\alpha_{K,exp} \cdot 10^3$	Multipolarity	$\alpha_{K,exp} \cdot 10^3$	Multipolarity	$\alpha_{K,exp} \cdot 10^3$	Multipolarity
335.67					6.13 (9)	E1
443.88					9.73 (14)	E2
525.45					6.6 (6)	M1+E2
602.73	4.31	E2	4.2	E2	4.20 (6)	E2
645.85	3.22 (60)	E2	3.4 (3)	E2	3.51 (5)	E2
709.36					3.49 (5)	M1+E2
713.75			2.4 (4)	M1+E2	2.73 (4)	E2
722.78	2.46 (55)	M1+E2	2.6 (3)	M1+E2	2.71 (4)	M1+E2
790.76			2.0 (5)	M1+E2	2.13 (5)	E2
968.19			0.62 (13)	E1	0.569 (9)	E1+M2
976.35					1.56 (3)	M1+E2
1045.11	0.73 (30)	E1+M2	0.49 (10)	E1	0.494 (9)	E1+M2
1054.54					1.11 (2)	E2
1325.52	0.86 (20)	M1+E2	0.78 (20)	E2	0.77 (8)	M1+E2
1355.2			0.69 (13)	M1+E2	0.92 (20)	E2+M3
1368.18	0.47 (15)	E1	0.31 (6)	E1	0.303 (5)	E1+M2
1376.09	0.35 (4)	E1			0.300 (5)	E1+M2
1436.64			0.54 (12)	M1+E2	0.591 (9)	E2
1445.17					0.29 (4)	E1+M2
1488.92	unresolved		0.70 (15)	M1+E2	0.659 (14)	M1+E2
1509.36	0.30 (5)	E1			0.256 (4)	E1
1560.53					0.28 (10)	E1+M2
1658				E0	-	E0
1675.6					0.48 (4)	M1+E2
1690.96	0.20 (2)	E1	0.21 (3)	E1	0.213 (3)	E1+M2
1720.21	0.47 (15)	M1+E2			0.484 (1)	M1+E2
1851.37	0.62 (15)	E3+M2			0.416 (6)	M1+E2
2038.43	0.31 (5)	M1+E2			0.323 (19)	M1+E2
2078.67	0.35 (5)	M1+E2			0.327 (5)	M1+E2
2090.94	0.20 (5)	E1	0.14 (5)	E1	0.1522 (23)	E1+M2
2232.03	0.15 (4)	E1			0.138 (5)	E1+M2
2283.06	0.13 (4)	E1			0.1341 (22)	E1+M2
2453.9					0.219 (3)	E2

[a]The gamma-ray energies, E_γ, given in this reference appear to suffer from a poor energy calibration. Data are provided only for transitions in which the E_γ unambiguously agrees with the recommended values. [b]Transitions are populated from the decay of ^{124}Sb. The gamma-rays at 707.46 keV and 709.36 keV are unresolved in this work, thus the authors' reported $\alpha(K)_{exp}$ for their observed transition at 708.9 keV is not given here.

Table 4. Comparison of recommended and experimental β^+ endpoint energies and emission probabilities.

		This evaluation		[1959MI22]		[1959GI59]		[1967RU04]		[1969BE70]		[1992WO03]		[2007QA07]	
Transition	Level, keV	$E_{\beta+,max}$, keV	$I_{\beta+}$, %	$E_{\beta+,max}$, keV	$I_{\beta+}$, %[1]	$E_{\beta+,max}$, keV	$I_{\beta+}$, %[1]	$E_{\beta+,max}$, keV	$I_{\beta+}$, %	$E_{\beta+,max}$, keV	$I_{\beta+}$, %[1]	$E_{\beta+,max}$, keV	$I_{\beta+}$, %[2]	$E_{\beta+,max}$, keV	$I_{\beta+}$, %
$\beta+_{0,0}$	0.0	2137.6 (19)	10.32 (13)	2130 (20)	13.1		11 (3)	2146 (15)		2136 (10)	10.9	2138.3 (21)	10.59 (21)		
$\beta+_{0,1}$	602.7271	1534.9 (19)	11.45 (15)	1531 (30)	13.3		14 (4)	1542 (20)		1520 (15)	10.5	1543.7 (65)	10.71 (25)		
$\beta+_{0,2}$	1248.5811	889.0 (19)	1.88 (16) x 10^{-4}				0.5 (5)[3]								
$\beta+_{0,3}$	1325.5131	812.1 (19)	0.287 (10)	786 (50)	2.2			800[1]		790 (30)	< 0.5	753 (50)	0.32 (9)		
$\beta+_{0,4}$	1657.283	480.3 (19)	1.21 (10) x 10^{-4}												
		$I_{\beta+,Total+}$ =	22.06 (22)	$I_{\beta+,Total+}$ =	28.6	$I_{\beta+,Total+}$ =	26.5 (35)			$I_{\beta+,Total+}$ =	21.4	$I_{\beta+,Total+}$ =	21.62 (41)	$I_{\beta+,Total+}$ =	22.1 (5)

[1]No uncertainty provided.

[2]Calculated from total β^+ probability and relative intensities

[3]Authors indicate that intensity is distributed among three levels between 1350 keV and 1248 keV.

3 Atomic data

Fluorescence yields were calculated within the SAISINUC program [2008DUZX] using the data of Schönfeld [1996SC06] and give values of ω_k = 0.875 (4), average ω_L = 0.0862 (35), and η_{KL} = 0.917 (4). X-ray and Auger electron energies were calculated within the SAISINUC program using the data from [1999SCZX and 1998SCZM], respectively.

The X-ray and Auger electron emission intensities were calculated using the 2013 version of the EMISSION code, described in [2000SC47], as implemented in SAISINUC and are based on the adopted γ-ray emission probabilities and conversion coefficients.

4 References

1958DY88 A.Dyson, Phys.In Med.Biol 3 (1958), 111
[Positron branching ratios, half-life]

1959GI59 R.K.Girgis, Physica 25 (1959), 133
[Total positron emission probabilities]

1959MI22 A.C.G.Mitchell, Phys.Rev. 113 (1959), 628
[Positron branching ratios, logft]

1965AN05 G.Andersson, Ark.Fys. 28 (1965), 37
[Half-life, total positron branching]

1967RU04 J.-Z.Ruan, J.Phys.Soc.Japan 23 (1967), 481
[Positron branching ratios, logft, internal conversion coefficients]

1968GR24 E.P.Grigorev, Bull. Acad. Sci. USSR 32 (1969), 711
[Experimental ICCs]

1968JO02 G.G.Jonsson, Nucl.Phys.A 107 (1968), 52
[Half-life]

1968LA21 J.-M.Lagrange, Comp. Rend. Acad. Sci. (Paris) 267B (1968), 1354|
[Gamma placements, gamma energies and intensities]

1969BE70 F.Bechvarzh, Bull. Acad. Sci. USSR 33 (1970), 1228
[Gamma energies and intensities, internal conversion coefficients]

1969RA31 R.C.Ragaini, Phys.Rev. 187 (1969), 1721
[Level energies, spins and parities; gamma placements, energies, and emission probabilities; logft]

1971BO01 H.M.W.Booij, Nucl.Phys. A 160 (1971), 337
[Logft, beta spectrum shapes]

1973KA45 H.M.A.Karim, Radiochim.Acta 19 (1973), 1
[Half-life]

1977BA48 W.Bambynek, Rev. Mod. Phys. 49 (1977), 77
[EC/positron ratios]

1977BA48 W.Bambynek, Erratum Rev. Mod. Phys. 49 (1977) 961
[EC/positron ratios]

1977LA19 F.P.Larkins, At. Data Nucl. Data Tables 20 (1977) 311
[Auger electron energies]

1990BE50 S.A.Berendakov, Sov. J. Nucl. Phys. 52 (1990), 389
[Spins and parities]
1992WO03 D.H.Woods, Appl.Radiat.Isot. 43 (1992), 551
[Gamma emission probabilities, positron branching ratios, half-life]
1996FIZX R.B.Firestone, Table of Isotopes 8th Ed., John Wiley and Sons Inc., N.Y. 2 (1996)
[Electron binding energies]
1996SC06 E.Schönfeld, Nucl. Instrum. Methods Phys. Res.A 369 (1996), 527
[Atomic data]
1998SCZM E.Schönfeld, Report PTB-6.11-98-1, Braunschweig (1998), 1
[Auger electron energies]
1998WA18 N.Warr, Nucl.Phys.A 636 (1998), 379
[Level energies, spins and parities; gamma placements, energies, and emission probabilities; logft]
1999SCZX E.Schönfeld, Report PTB-6.11-1999-1, Braunschweig (1999), 1
[X-ray energies and emission probabilities]
2000DO11 C.Doll, Nucl.Phys.A 672 (2000) 3
[Interpretation of 2039 keV level]
2000SC47 E.Schönfeld, Appl. Radiat. Isot. 52 (2000), 595
[X-ray and Auger electron emission probabilities]
2002BA85 I.M.Band, At. Data Nucl. Data Tables 81 (2002), 1
[Theoretical ICCs]
2006RA03 S.Raman, At. Data Nucl. Data Tables 92 (2006), 207
[Compilation of ICCs]
2007QA02 S.M.Qaim, Radiochim. Acta 95 (2007), 67
[Total positron emission probability]
2008DUZX C.Dulieu, Proc. Intern. Conf. Nuclear Data for Science and Technology (2008), 97
[SAISINUC software]
2008GH04 D.G.Ghita, Int. J. Mod. Phys.E 17 (2008), 1453
[Gamma emission probabilities, level spins and parities]
2008KA21 J.Katakura, Nucl. Data Sheets 109 (2008), 1655
[ENSDF evaluation]
2008KI07 T.Kibédi, Nucl. Instrum. Methods Phys. Res.A 589 (2008), 202
[Theoretical ICCs]
2016LU16 A.Luca, Appl. Radiat. Isot. 109 (2016), 146
[Gamma emission probabilities, half-life]
2019MO35 X.Mougeot. Appl. Rad. Isotopes 154 (2019), 108884
[Emission calculations for beta+ and electron capture , logft, ratio]
2021WA16 M.Wang, Chin. Phys. C 45 (2021), 030003
[ATOMIC MASSES A=1-295; compiled, evaluated atomic masses data]