Gamma and conversion electron measurements in ^{122}Te

Premaditya Chhetri[1], T.S. Vignesh[1], K. Vijay Sai[1], S. Deepa[2], Dwarakarani Rao[2]
R.Gowrishankar, S. Kailas[3] and K. Venkataramaniah[1*]

[1]*Department of Physics, Sri Sathya Sai Institute of Higher Learning, Prasanthinilayam 515134*
[2]*Deptartment of Physics, Sri Sathya Sai Institute of Higher Learning, Anantapur*
[3] *Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai 400085*
** email: vrkamisetti@gmail.com*

Introduction

Even though ^{122}Sb decays with a relatively long half life of 2.7250 days, except for a detailed beta spectral shape studies [1] of the most intense 1980 and 1414 kev beta transitions to the ground and first excited states of ^{122}Te, not much work has been reported regarding the gamma transition energies and intensities and the internal conversion coefficients of the transitions. The only experimental conversion coefficient determination is that of the most intense 564 keV gamma transition by Glaubmann [2] using peak to beta spectrum method with an experimental error of 8%. Even the multipolarities of the transitions involved were also derived from the adopted gammas. The NDS108 [3] adopted gamma energies and intensities are also from a conference report. Since the ground state of ^{122}Sb is 2^- and spectral shapes of the beta feedings to the ground and first excited state of ^{122}Te showed unique first forbidden linear spectral shapes respectively, the spin of the 563 keV level was confirmed as 2^+. However the spin and parities of the higher1179, 1256, 1257 and 1752 levels have not been confirmed experimentally. Since the Q of this decay is 1983.9 keV levels up to 1752 keV can be populated and hence be studied from the beta decay of ^{122}Sb. In view of the very scarce spectroscopic information available on the decay of ^{122}Sb, an extensive electron and gamma spectroscopic investigation has been carried out using our large volume HPGe gamma detector and a high transmission magnetic spectrometer.

Experiment

The radioactive ^{122}Sb source were produced by thermal neutron irradiation of ^{121}Sb enriched isotope at Bhabha Atomic Research Centre, Mumbai with a neutron flux of 10^{17} n m^{-2} s^{-1} . For the intensity measurements in the low energy region thin and uncovered sources were prepared by drying the source solution on a thin mylar foil. The count rates of the sources were kept <500 counts/sec.

Measurements were performed using a large volume 60 cc HPGe detector optimized for the detection of weak gamma rays and coupled to a PC based 8K MCA for the gamma spectra. A Mini-Orange electron transporter [4] coupled to a LN_2 cooled Si(Li) detector optimized for the required energy range was used for recording the conversion electron spectra. The details of the electron and gamma spectroscopic systems have been discussed elsewhere. These systems have been proved and used for precision spectroscopic measurements [5]. FIT and GAMMA VISION have been used for spectral analysis and GTOL for level scheme. Table I gives the results on the gamma energies and their relative intensities in comparison with the NDS108 adopted values. It can be seen that the gamma energies and intensities are being reported with a better precision compared to the adopted values of NDS108.

Results and Discussion

Internal conversion coefficients for four of the transitions have been determined for the first time. The internal conversion coefficients have been determined using NPG method normalizing the electron intensities with respected to the k-line of the 564.27 keV gamma with a BRICC [6] value of 0.004994 for E2 multipolarity. A total of three K-conversion and three L-conversion coefficients have been determined with high

precision. Table II shows the experimental K and L conversion coefficients along with the BRICC values for M1 and E2 multipolarities for all the four transitions. The energies of four of the five levels have been obtained as almost the same as those of NDS data except for the 1357.6 keV (NDS), the GTOL [7] has given a value of 1358.68 keV. Also the 794.41 keV transition connecting this level with the 2^+ level at 564.27 keV has been found from its K conversion coefficient to be of E2 character. This confirms the spin and parity of the 1358.68 keV level as 0^+. Using the present α_K value of the 692 keV transition and the theoretical M1 and E2 BRICC values we have calculated the M1-E2 mixing ratio δ^2 has been determined as 1.234(1).

In Table III we have presented the energies of the levels of ^{122}Te and their respective log ft values calculated using the experimental data on the gamma intensities in comparison with those of NDS108.

A new decay scheme of ^{122}Sb decaying to ^{122}Te is being proposed with precision data on the seven gamma transitions connecting six excited states along with seven conversion coefficients of which three K and three L being reported for the first time. Multipolarity of the 794.4 transition has been established as E2 and the spin of the 1358.68 keV level has been established.

Table I

Gamma energy E_γ (keV)		GammaIntensity I_γ	
Present	NDS 108	Present	NDS108
564.269 2	564.24 4	100	100
614.36 8	615.0 4	0.011 3	0.016 6
692.68 1	692.65 4	5.47 13	5.45 18
794.41 5	793.3 4	0.163 3	0.023 6
1187.77 10	1188 1	0.0071 6	0.006 1
1256.21 5	1256.93 4	1.14 6	1.15 6
1752.35 3	1752.4 15	0.011 2	0.013 2

Table II

E_γ (keV)	ICC α_i (i = K, L)	BRICC E2	BRICC M1
564.27	K 0.004994 L 0.000713 38	0.004994 0.000682	0.000607 0.000749
692.68	K 0.00329 83 L 0.000397 37	0.002944 0.000388	0.003717 0.000456
794.41	K 0.00214 59	0.002112	0.002695
1256.2	K 0.000577 91 L 0.000145 43	0.000773 0.000095	0.000955 0.000115

Table III

Level Energy (keV)		Log ft		J Ex pt.
Present work	NDS 108	Present work	NDS 108	
Ground	Ground	9.65 1	9.65	0^+
564.271 2	564.26	7.62 1	7.61	2^+
1178.63 8	1179.3	10.831	10.83	4^+
1256.925 10	1256.92	7.70 1	7.70	2^+
1358.68 5	1357.6	10.311	10.52	0^+
1752.36 3	1752.3	8.56 1	8.6	2^+

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