Precision Electron-Gamma spectroscopic studies in ^{111}Cd

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

[1]*Department of Physics, Sri Sathya Sai Institute of Higher Learning, Prasanthinilayam 515134*

[2] *Department of Physics, Sri Sathya Sai Institute of Higher Learning, Anantapur 515001*

[3] *Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai 400085*

[*] *email:vrkamisetti@gmail.com*

Introduction

The energy levels of ^{111}Cd have formerly been considered in terms of the states available to the 63rd neutron which is in the $3s_{1/2}$ sub-shell.. Kisslinger and Sorensen have used the pairing-plus-quadrupole model to predict the energy levels. In the Coulomb excitation experiment[1] only five levels have been excited. The decay of ^{111}Ag has been investigated only by few workers, Burmistov and Didorenko [2], Shevlev et al [3] and Goswamy et al [4]. The previous data on level energies, gamma energies and intensities differ considerably even for intense gamma transitions. There has been no detailed study of the internal conversion spectrum.. There have been no multipolarity assignments for some of the transitions.. An extensive experimental investigation of the gamma and conversion electron spectra has been undertaken to provide precision spectroscopic information on the low lying levels of ^{111}Cd from the beta decay of ^{111}Ag.

Experiment

The radioactive liquid source of ^{111}Ag in the form of silver nitrate in nitric acid solution was procured from BRIT, Bhabha Atomic Research Centre, Mumbai, India. It was prepared by neutron irradiation of palladium enriched in ^{110}Pd in the CIRUS reactor by means of the reaction $^{110}Pd(n,\gamma)^{111}Pd \rightarrow {}^{111}Ag$. For the intensity measurements in the low energy region, thin and uncovered sources were prepared by drying the source solution on to a thin mylar foil. The count rates of the sources were kept <500 counts/sec for conversion electron measurements. The sources, covered with mylar foils were used for measurements with co-axial HPGe detector and these sources yielded about 1500 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 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. 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 NDS110 [5] 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 NDS110.

Results and Discussion

The precision data on relative gamma and internal conversion electron intensities have been used to calculate the respective K and L internal conversion coefficients (ICCs), α_K and α_L of the gamma transitions using Normalized Peak to Gamma (NPG) method. The K-conversion coefficient of the 245.48 keV pure E2 transition from BRICC , 0.053 is taken for normalization. Out of the fourteen gammas, we report here, K-conversion coefficient measurements for eleven transitions and L-conversion coefficients for five transitions.. From a comparison with theoretical BRICC values, we could assign multipolarities for the 374.36, 522.58, 753.54 keV transitions for which there were no multipolarity assignments in the NDS110. Also the multipolarities of the 622.86, 865.07 and 866.73 transitions have been confirmed as M1+E2. We have calculated the M1-E2 mixing ratios for all the mixed transitions. The experimental data on gamma energies and intensities have been used to fit a new decay scheme using GTOL. In Table I we have compared our results on gamma energies and relative gamma intensities with those of NDS110. The modified decay scheme incorporating the present precision data on level energies, gamma transition energies and intensities, log ft values and multipolarities for the transitions would be presented .

Table I

Gamma Energy E_γ (keV)		Relative Gamma Intensity I_γ	
Present work	NDS 110	Present work	NDS 110
96.73 2	96.75 2	1.508 19	1.73 9
245.48 2	245.40 2	16.234 16	19.9 6
278.78 2	278.3 4	0.018 3	0.008 2
342.18 6	342.13 2	100.00 1	100
374.36 1	374.6 2	0.092 20	0.047 2
509.98 9	509.4	0.041 4	0.02
522.58 1	522.4 4	0.031 3	0.014 2
524.84 7	524.3 4	0.067 4	0.031 2
619.08 3	619.3 4	0.0032 9	0.008 4
620.20 5	620.3 4	0.131 6	0.164 12
622.86 2	622.0 4	0.042 3	0.09 3
753.75 1	754.6	0.063 5	0.04
865.07 1	865.1 4	0.084 5	0.023 4
866.73 1	867.0 4	0.067 4	0.054 4

In Table II we give our conversion coefficient measurements compared with the corresponding theoretical BRICC values from where we could assign the multipolarities for various transitions uniquely.

Table II

Energy E_γ keV	Internal Conversion Coefficient (ICC) α_i (i = K and L)		
Present	Present Experiment	BRICC E2	BRICC M1
96.73	K 0.118 15 L 0.029 12	1.25 0.34	0.441 0.0553
245.48	K 0.0533 8 L 0.0052 10	0.0533 0.0083	- -
342.18	K 0.0106 11 L 0.0014 9	0.018 0.00255	0.0148 0.0179
374.36	K 0.0113 20 L 0.0021 9	0.0135 0.0019	0.018 0.00143
522.58	K 0.0087 31	0.0051	0.0052
524.84	K 0.0020 10	0.005	00051
620.20	K 0.0026 4 L 0.00013 8	0.00317 0.00040	- -
622.86	K 0.0019 7	0.0031	0.0034
753.75	K 0.0024 14	0.00192	0.0022
865.07	K 0.0019 10	0.00132	0.0016
866.73	K 0.0012 7	0.00137	0.0016

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