Precision Internal Conversion Coefficient measurements in ^{192}Pt following ^{192}Ir β^-- decay

K. Vijay Sai [1*], S. Shankar Subramanian [1], S. Deepa [1], R. Gowrishankar [1], M. Sainath [2] and K. Venkataramaniah [1]

[1]*Department of Physics, Sri Sathya Sai Institute of Higher Learning, Prasanthinilayam (A.P) 515134*
[2]*Methodist College of Engineering and Technology, Abids, Hyderabad (A.P) 500001*
** email: vjsai.phy.psn@sssu.edu.in*

Introduction

^{192}Ir decays by β^- to ^{192}Pt and by orbital electron capture to ^{192}Os. Here, the interesting thing to note is that, these three nuclides lie in the transition region between deformed and spherical nuclei. The beta and gamma rays which accompany the decay have been studied by several previous investigators [1]. However, the conversion electron measurements have not been many; mostly sub-shell ratios for the low energy transitions have been reported. Earlier studies of the internal conversion spectrum of ^{192}Pt leave much to be desired. For instance, even though multipolarities for various transitions in ^{192}Pt have been assigned, no adopted values for the α_L and α_M have been reported in the latest Nuclear Data Sheets [2]. With the availability of a well calibrated high transmission Mini-Orange Magnetic filter for high precision measurements at the Department of Physics, Sri Sathya Sai Institute of Higher Learning, it has been felt that experimental determination of internal conversion coefficients of the K, L and if possible M shells, would be of great use to establish the spin and parities of some of the excited states both in ^{192}Pt and ^{192}Os. The long lived decay of ^{192}Ir ($t_{1/2}$ ~ 74 d) has been taken up with i) A mini-orange magnetic filter coupled to a Si(Li) detector to record the internal conversion spectrum, and ii) a 60 cc HPGe detector for the gamma spectra.

Experiment

^{192}Ir is obtained as Sodium Chloroiridate (Na_2IrCl_6) in HCl solution from BARC, Mumbai, by the irradiation of Iridium metal with thermal neutrons. The sources are allowed to cool for about 25 days to remove ^{194}Ir (half-life of 17hr) activity present. The sources for the present investigation are prepared by allowing a drop of liquid on a mylar foil of 200μg/cm^2 to evaporate to dryness. A drop of insulin has aided the uniform spreading of the source. The sources are of 100 μg/cm^2 thickness and 2mm in diameter.

The gamma spectroscopy system consisting of 60 cc HPGe detector coupled to a PC based 8K Multichannel Analyser of ORTEC make along with the gamma spectrum analysis software GAMMA VISION has been used to determine the relative gamma intensities with very high precision. For the internal conversion electron spectra, a mini-orange type electron transport system [3] coupled to a cooled Si (Li) and optimized for its best performance conditions has been employed.

We use the Normalized Peak to Gamma [NPG] method for determining the internal conversion co-efficients (α's). For normalization, we have used α_K = 0.0534 (BRICC) for the 316.51 keV E2 transition in ^{192}Pt. Our conversion co-efficient values for transitions are listed in the Table 1 below. The BRICC calculator [4] has been used to interpolate the theoretical Internal conversion coefficients for the assignment of multipolarities of different transitions.

Results

Our results enable us to deduce multipolarities for these transitions. These data have also been used for estimating the M1, E2 mixing ratios (δ^2) for the 296, 308 and 604 keV transitions and also for arriving at the reduced transition probabilities B(E2) based on the knowledge of the corresponding theoretical

conversion co-efficients [4] and the lifetimes of the involved levels. These results on the mixing ratios and the transition probabilities are expected to provide more accurate experimental data for comparison with the various model predictions. ***All the 6 L- and 2 M- conversion co-efficients measured in our study are being reported for the first time.***

Authors would like to acknowledge the financial support provided by DAE-BRNS through Research Project: No.2007/37/33/BRNS

References

[1] N. Voinova et al., Nucl. Phys A235 (1974) 123.
[2] C. M. Baglin, Nuclear Data Sheets 84 (1998) 712.
[3] D. Rani Rao et al., Appl. Radiat. and Isot. 66 (2008) 377.
[4] BRICC calculator for theoretical Internal Conversion Coefficients, http://physics.anu.edu.au/nuclear/bricc/ .

.

Table 1. Gamma energies, gamma and electron intensities, and our K-, L- and M- conversion coefficients in the beta decay of ^{192}Ir to the levels of ^{192}Pt, in comparison with the BRICC theoretical ICC values [4]. Experimental and theoretical ICC values are given in the 4th and the last 2 columns respectively.

E_γ (in keV)	I_γ	I_e	α (exp)	BRICC	
				M1	E2
295.95 (2)	28.72 (14)	K 0.394 (14)	α_K 0.0612 (22)	0.2615	0.06317
		L 0.443 (7)	α_L 0.0295 (5)	0.04267	0.02976
308.45(2)	29.68 (15)	K 0.271 (7)	α_K 0.0403 (11)	0.2337	0.057
		L 0.250 (10)	α_L 0.0161 (6)	0.04267	0.02549
316.51(1)	82.71 (21)	K 1.00 (4)	α_K 0.0534 (23)	0.215	0.05348
		L 1.00 (3)	α_L 0.0231 (8)	0.0355	0.02317
		M 1.00 (19)	α_M 0.0057 (11)	0.0082	0.005787
468.06 (2)	47.81 (24)	K 0.2200 (9)	α_K 0.0203 (9)	0.0767	0.02118
		L 0.176 (6)	α_L 0.0070 (2)	0.01236	0.006065
		M 0.262 (17)	α_M 0.0026 (1)	0.00285	0.001479
588.58 (3)	4.517 (22)	K 0.0134 (5)	α_K 0.0131 (5)	0.0421	0.01282
		L 0.0058 (13)	α_L 0.0024 (5)	0.00674	0.003055
604.41 (3)	8.2 (4)	K 0.0388 (9)	α_K 0.0210 (5)	0.0364	0.01212
		L 0.0170 (5)	α_L 0.0039 (1)	0.005755	0.002834
612.46 (3)	5.34 (8)	K 0.0157 (2)	α_K 0.0131 (5)	0.0380	0.01179
		L 0.0052 (11)	α_L 0.0018 (4)	0.00608	0.002731
884.53 (5)	0.291 (7)	K 0.0011 (6)	α_K 0.017 (10)	0.01483	0.005614