Precision Electron-Gamma Spectroscopic measurements in ^{166}Er

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Introduction

The ground state (gs) decay of ^{166}Ho ($t_{1/2}$ ~ 27h) populates the gs and five excited states of the even-even deformed nucleus ^{166}Er. The spectrum of the gamma rays resulting in the decay of this isotope was extensively studied using (i) a 60 cc HPGe detector (FWHM: 1.8 keV at 1.33 MeV) coupled to an 8K PC based multichannel anlyser. And for electron spectrum (ii) a Si(Li) detector (FWHM: 180 eV at 5.9 keV) coupled to a mini-orange electron transporter. The gamma and electron spectrums were analysed using some of the standard computer codes such as FIT and GAMMAVISION.

The present study aims at performing more accurate measurements of the relative gamma and electron intensities and hence the conversion co-efficients (which give a very valuable information on assigning, and or, confirming the spin-parities of the transitions). Also, an attempt has been made to search for the possible existence of weak gamma rays hitherto unobserved in the decay of this isotope.

Experiment

The stable isotope of Holmium (which has a thermal neutron capture cross-section of about 65 barns) was irradiated at the Research reactor at Mumbai. The isotope was supplied in liquid form as Holmium chloride in HCl solution by the Isotope divison, BARC, Mumbai with a specific activity of 1Ci/gm.

The detector was calibrated for relative photopeak efficiency using gamma rays from ^{152}Eu and ^{124}Sb; this data was used to deduce the relative photon intensities. In this, the absolute intensity of the 1387 keV transition was assumed from the accurate earlier measurement of Cline et al. [1]. The α_K and K/L ratio of the 80 keV transition was taken from the latest [2] Nuclear Data Sheets (NDS) for A=192 and used in calculating its transition intensity.

No new gamma rays were observed following the decay of 27hr ^{166}Ho. A careful search made for the presence of possible weak gamma rays corresponding to the decay of the 1830 keV state to the 1460 and 1663 keV state, too was in vain.

The intensities of β-branchings are deduced from the present relative gamma intensities assuming a 0.93% decay of ^{166}Ho (0^-) gs to the 0^+ excited state at 1460 keV. The log ft values of the β-transitions are calculated using the recent tabulations. The present results failed to locate a β-branch of observable intensity to the 2^+ state at 787 keV. The present log ft values of the different β-feedings are consistent with the established characters of the ground, 80 keV, 264 keV, 1460 keV and 1663 keV. The log ft values of the β-transitions leading to the two 0^+ states are quite different. Further, the log ft value of the β-branch to the 1830 keV state is indicative of an allowed nature, thus establishing the 1^- assignment of the 1830 state.

Earlier studies of the internal conversion spectrum of ^{166}Er leave much to be desired. No adopted values for the α_K, α_L and α_M have been reported in the latest NDS, except for the α_K of the most intense 80 keV transition. A careful and precise determination of the K, L

and if possible M conversion lines has been taken up in our laboratory. For the internal conversion measurements, a mini-orange type electron transport system [3] coupled to a cooled Si (Li) and optimized for its best performance conditions has been employed. Relative conversion electron intensities were determined using this detector configuration.

We use the Normalized Peak to Gamma [NPG] method for determining the internal conversion co-efficients (α's). For normalization, we used α_K = 1.672 for the 80.576 keV E2 transition in ^{166}Er.

α_K for 6 of the transitions in ^{166}Er: 80.57, 184.4, 674.18, 705.33, 785.89 and 1379.44 keV, and α_L for two of the transitions 80.57 and 184.4 keV and α_M for the 80.57 keV transition are measured precisely and compared with the BRICC [4] theoretical conversion co-efficients. Except for the ICCs of 80.57 and 1379.44 keV transitions, all the other ICCs are being measured and reported for the first time. The latest NDS for A = 166 reports the experimental ICCs only for those two mentioned transitions.

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