Evolution of collectivity in ^{160}Yb

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Introduction

The N = 90 Yb nucleus is one of the most suitable candidates for displaying the octupole collectivity with an asymmetric λ = 3 shape [1]. The strong theoretical predictions in this direction sets a challenging task for obtaining the related experimental signature which are expected to be very weak compared to that of the quadrupole collectivity in this nucleus. Experiment with conventional gamma spectroscopy has been performed using AFRODITE array in search of the said signature [2]. However, the experimental results lack the detailed information on the interband parity changing transitions which indeed carry the most prominent signatures of such deformations.

The nucleus has been experimentally studied by several groups with different dimensions of gamma detector arrays in order to study the evolution of quadrupole collectivity. The lifetime measurements have been carried out for several states of the yrast and the negative parity side bands using both Recoil Distance and Doppler Shift Attenuation techniques [3,4]. These measurements have suggested a constant quadrupole collectivity towards lower spin followed by a reduction in quadrupole collectivity as a function of angular frequency. The observation of an intermittent increase of transition quadrupole moment, however, could not be understood by several theoretical calculations [4]. In the present work, ^{160}Yb has been studied using the gamma ray spectroscopic techniques using Indian National Gamma Array (INGA). Lifetime measurement has been carried out using Doppler Shift Attenuation technique.

Experiment and Data Analysis

The excited states of ^{160}Yb nucleus have been populated by ^{148}Sm (^{16}O, 4n) reaction with E_{beam} = 90 MeV. The 900 µg/cm^2 thick Sm target (97% enriched) was electro-deposited on a 3 mg/cm^2 Pb backing foil. Twenty Compton suppressed Clover detectors of INGA array, arranged in the angles of 23^o, 40^o, 65^o, 90^o, 115^o, 140^o and 157^o with respect to the beam direction, were used for the detection of gamma radiations. The details of the data collection and sorting have been described in ref. [5]. The level scheme of ^{160}Yb has been significantly modified in the present work by the analysis of doubles and triples gamma coincidence, DCO, ADO and IPDCO analyses. The polarization measurement has been carried out for the first time for several transitions in order to assign the parity of the excited levels. The plot for DCO vs. IPDCO ratio has been shown in figure 1 which is indicative for the multipolarity assignment of the de-exciting γ rays in ^{160}Yb. The Doppler broadened shapes have been observed in several transitions of the yrast band and the negative parity side bands. The angle dependent matrices were produced for projecting observed shapes at different angles by putting a gate from below and

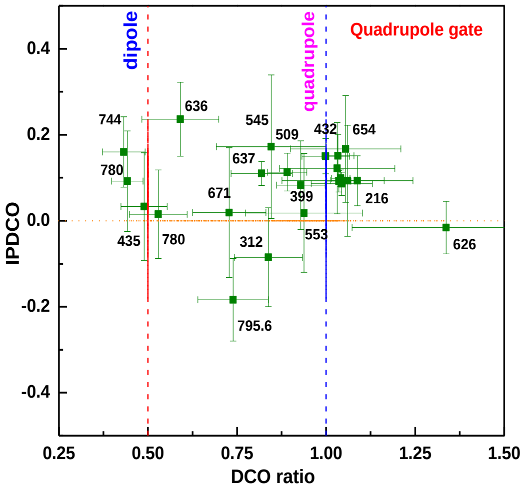

Figure 1: DCO vs IPDCO plot for ^{160}Yb

on a transition which decays after the recoil has come to complete rest. Lifetime measurement with DSAM technique has been carried out by using the LINESHAPE code [6,7] as well as Differential Decay Curve Method (DDCM) as outlined in ref.[8,9]. The former code in its original form cannot handle the stopping of recoiling nuclei in a compound target. In order to account for the change in the velocity profile in the used oxide target, compared to that of elemental Sm target, the stopping was calculated using SRIM code [10]. The original densities of Sm (7.52 g/cc) and Sm_2O_3 (7.6 g/cc) were taken from the CRC handbook of Chemistry and Physics [11]. The results of the calculation show that the effect of Sm_2O_3 including its crystal structure can be accounted for by modifying the density of Sm as 9.8 g/cc. Hence the analysis with LINESHAPE code was carried out by using the modified density as the target. In the DDCM analysis the stopping was calculated by using the code DESASTOP [9] which is capable of handling the stopping in a compound target. The experimental and the fitted lineshape for the 664 keV transitions of the yrast band, obtained with LINESHAPE code has been shown in figure 2.

Results and Summary:

The preliminary results on transition quadrupole moments Q_t and the reduced transition probabilities B(E2) indicate an increased quadrupole collectivity in the yrast band of ^{160}Yb compared to that observed in the previous works. The B(E2)/B(E1) ratios have been calculated for the decay of negative parity side bands to the positive parity yrast and side bands revealing the information on the involved structure of the negative parity side bands in ^{160}Yb.

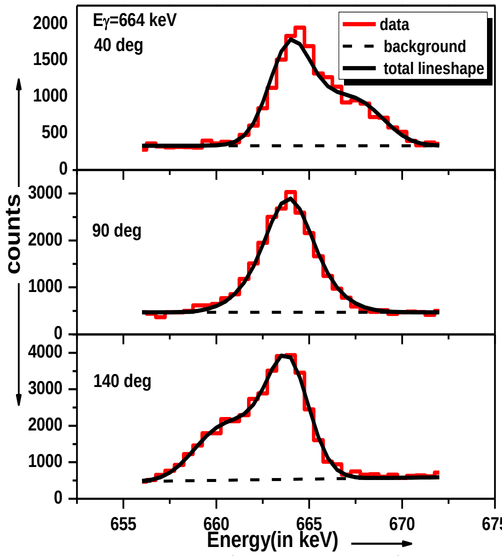

Figure 2: Expt. and fitted lineshape for 664 keV

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