Spectroscopy of N = 90 ^{160}Yb

A. Saha[1], T. Bhattacharjee[1,*] D. Banerjee[2], S. R. Banerjee[1], S. Rajbanshi[3], A. Bisoi[3], Soumik Bhattacharya[1], T. Roy[1], S. Das Gupta[1], A. Chakraborty[4], S. Bhattacharyya[1], D. Mondal[1], B. Dey[1], D. Pandit[1], R. Palit[5], R. P. Singh[6], S. K. Das[3], M. Saha Sarkar[2], A. Goswami[2], S. K. Basu[1], S. Saha[5], S. Biswas[5], J. Sethi[5], D. Curien[7], J. Dudek[7], G. Duchene[7] and G. d. Angelis[8]

[1]*Physics Group, Variable Energy Cyclotron Centre, 1/AF Salt Lake, Kolkata – 700 064, INDIA*
[2]*RCD (BARC), Variable Energy Cyclotron Centre, 1/AF Salt Lake, Kolkata – 700 064, INDIA*
[3]*Saha Institute of Nuclear Physics, 1/AF Salt Lake, Kolkata – 700 064, INDIA*
[4]*Department of Physics, Krishnanath College, West Bengal, INDIA*
[5]*Tata Institute of Fundamental Research, Mumbai, INDIA*
[6]*Inter University Accelerator Centre, New Delhi – 700 064, INDIA*
[7]*IPHC/DRS Université de Strasbourg, Strasbourg, France*
[8]*LNL-INFN, Legnaro, Italy*
* *email: btumpa@vecc.gov.in*

Introduction

The N = 90 Yb nucleus has drawn immense interest in recent years in low, moderate and high spin spectroscopy. Reduced quadrupole collectivity has been observed at high spin [1], consistent with shape coexistence and band termination phenomena [2, 3]. A strongly deformed triaxial band has been observed in the nucleus, extending up to or beyond spin 50ђ [4]. The lifetime measurements have been carried out for several states of the yrast band using both Recoil Distance and Doppler Shift Attenuation techniques [5,1]. Present understanding of the structure of yrast band demands the lifetime measurement of several low and moderate spin states of this band.

The low lying spectroscopy of this nucleus has attracted a renewed interest due to the existence of tetrahedral deformation with magic gaps of Z = 70 and N = 90 which is being greatly discussed recently [6, 7]. Bark et al nullified the possibility of existence of tetrahedral deformation in this nucleus from the band mixing calculation on several positive and negative parity bands [8]. However, intensities and coincidence relationships of the transitions decaying out of these bands [8, 9] are not known with much detail. Most importantly, for a clear understanding of the underlying structure of these parity doublet bands, the experimental measurement of transition probability is required.

In the present work, the spectroscopy of ^{160}Yb has been performed in order to study the low and moderate spin structure of this nucleus by using gamma ray spectroscopic techniques using Indian National Gamma Array (INGA). Lifetime measurement has been attempted using Doppler Shift Attenuation technique.

Experiment

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. A PCI-PXI based digital data acquisition system [10] was used for the collection of two and higher fold data in trigger less mode.

Data Analysis and Results

The time stamped data were collected with the individual Pixie cards used for different sets of Clovers. These data were merged to generate a single data stream, as per the time stamp and event number. The obtained data has then been sorted using the MARCOS sorting program [10] to construct the RADWARE compatible γ–γ matrix and γ–γ–γ cube with which a very preliminary analysis has been carried out. In total, 6.1 × 10^9 prompt γ–γ events were gathered in the experiment. Figure 1, 2 and 3 show the gated spectra obtained from the prompt background subtracted γ–γ matrix for identifying different bands in the nucleus. The transitions occurring within the levels of a band have been marked with black. The transitions belonging to other bands and the connecting transitions have been marked with red. The transitions marked with * are not yet identified. Almost all the positive and negative parity bands, reported by Bark et. al.[8], have been observed in the present work. In Figure 1, the γ transitions belonging to the yrast band have been identified and from the present analysis the band is visible up to 30^+, 9125 keV level. Figure 2 shows the spectrum of added gate corresponding to two strong transitions of band 5, the predicted band carrying the signature of tetrahedral deformation. The spectrum shows a large number of transitions for which the placements are not known. From the present analysis, the presence of 210, 929 and 1115 keV transitions observed by Bark et. al.[8] could not be confirmed. The decay of band 4, which is known to be interacting with band 5 according to earlier data, has been shown in Figure 3. It is expected that the obtained data will provide meaningful information on the level scheme, the lifetime of the levels and the transition probabilities of different transitions, therefore, giving useful insight on the low and moderate spin structure of the nucleus.

Acknowledgement:

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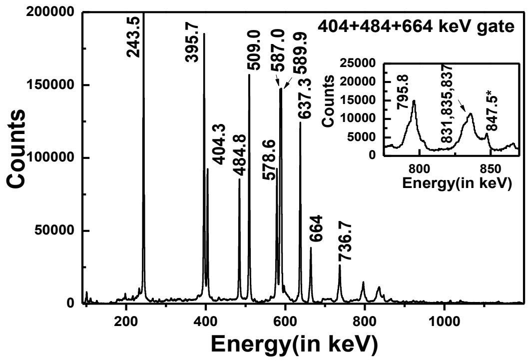

Figure 1: Gate showing the γ lines from B7.

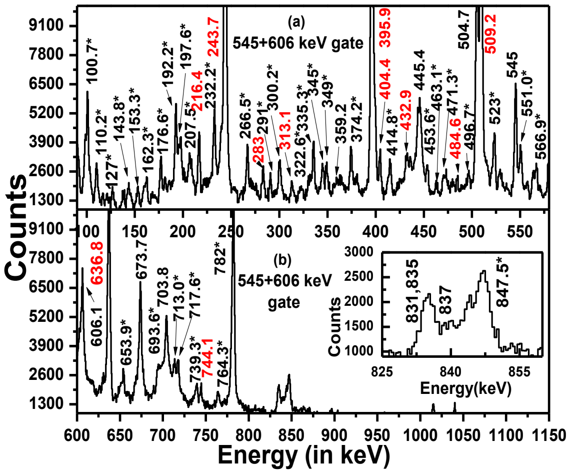

Figure 2: Added gate showing the γ lines from band B5 and the transitions connected to B5.

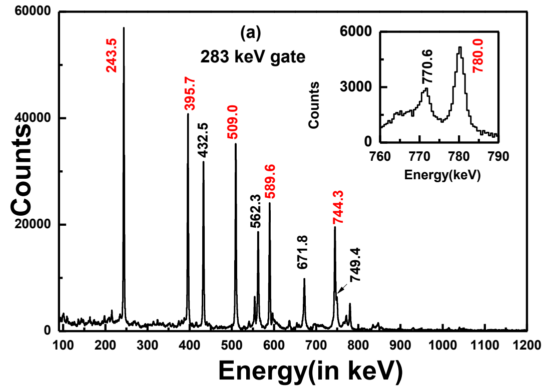

Figure 3: Added gate showing the γ lines from band B4 and the transitions connected to B4.

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