Correlating states across isomers in ^{152}Ho isotope

Dibyadyuti Pramanik[1], A. Bisoi[2], S. Ray[2], A.Chakraborty[3], G. Dey[1], Krishichayan[4], R. Kshetri[2], I. Ray[2], S. Ganguly[5], M. K. Pradhan[2], M. Ray Basu[6], R. Raut[7], G. Ganguly[6], S.S. Ghugre[7], A.K. Sinha[7], S.K. Basu[8], A. Goswami[2], P. Banerjee[2], A. Mukherjee[2], S. Bhattacharya[2], M. Saha Sarkar[2], S. Sarkar[1*]

[1] *Bengal Engineering and Science University, Howrah - 711103, INDIA*
[2] *Saha Institute of Nuclear Physics, Kolkata - 700064, INDIA*
[3] *University of Kentucky, Kentucky 40506-0055, USA*
[4] *Texas A&M University, TX 77843-3366, USA*
[5] *Chandernagore College, Hooghly-712136, INDIA*
[6] *University of Calcutta, Kolkata - 700009, INDIA*
[7] *UGC-DAE Consortium for Scientific Research, Kolkata- 700098, INDIA and*
[8] *Variable Energy Cyclotron Centre, Kolkata - 700064, INDIA*

Introduction

The odd-odd ^{152}Ho (N=85) is a very interesting candidate for investigation of interplay of single - particle oblate states and prolate collective states, because it is situated between the N=82 shell closure and the strongly collective N>87 region. It has been shown [1] that there is a possibility of shape coexistence even at lower spins in ^{153}Ho. The structural evolution of Ho isotopes from A=151 to 154 has also been studied [1]. The features observed have been interpreted theoretically using shell model as well as Total Routhian surface calculations. Results have been combined with that for ^{153}Ho to study the evolution of structural features in these Ho isotopes with increasing neutron numbers and increasing spin.

One of the distinguishing features of this mass region is the existence of an island of high spin isomers which are excited in heavy ion reactions. These isomers indicate a sharp change of structural configurations within the same nucleus. We have studied a few isomers in the mass $\simeq$ 150 region using RF - gamma coincidence data [1]. ^{152}Ho isotope also possesses at least three isomers in its excitation spectrum. This nucleus has been studied by several groups in the last decade [2]. In the level scheme (Fig.1), three groups of transitions have been identified. The first one (A in Fig.1) is the group of long-lived delayed transitions all in coincidence with the 734 keV line below a 8.4 μs isomer, the group of transitions (B) in between the 47 ns and 8.4 μs isomers, and a third group (C) of prompt transitions above both these isomers. There have been tentative assignments of a few weak transitions which seem to connect the different groups. But none of the earlier studies [2] have found correlations between these three groups. In the present work, experimental data on ^{152}Ho have been analysed to connect the three groups of transitions and confirm the possibility of a fourth isomer in the excitation spectrum.

Experimental details and Results

High-spin states in ^{152}Ho are populated by $^{139}_{57}La(^{20}Ne, 5n)$ reaction at a projectile energy of 139 MeV. The gamma-gamma coincidence measurements have been done using the multi-detector array of eight Compton suppressed Clover detectors (Indian National Gamma Array, INGA setup) at Variable Energy Cyclotron Centre (VECC), Kolkata, India. The relevant details of the experiment have been discussed in Ref.[1]. Delayed and prompt gamma-gamma correlation matrices have been generated by putting gates at different parts of RF-gamma time difference spec-

*Electronic address: ss@physics.becs.ac.in

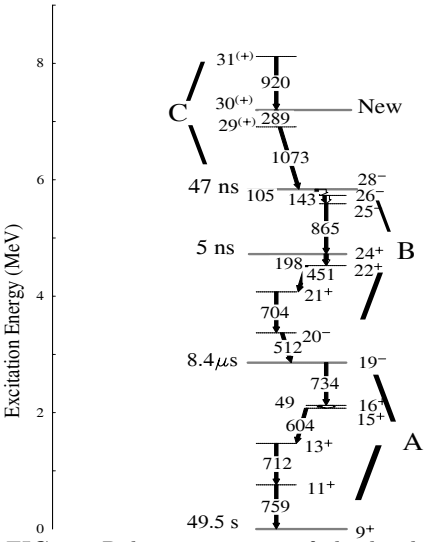

FIG. 1: Relevant portion of the level scheme in ^{152}Ho.

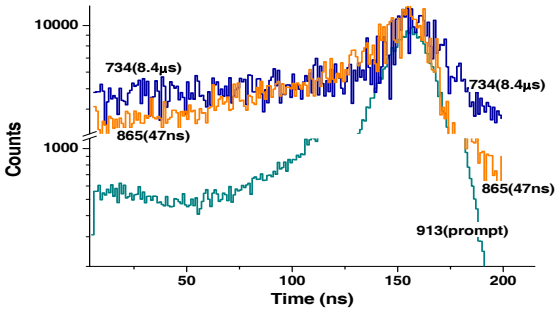

FIG. 2: RF-gamma TAC spectra generated by putting gates on the energy axis for 913 keV (a prompt gamma), 865 keV (gamma decaying from 47 ns isomer) and 734 keV (gamma decaying from 8.4 μs isomer.)

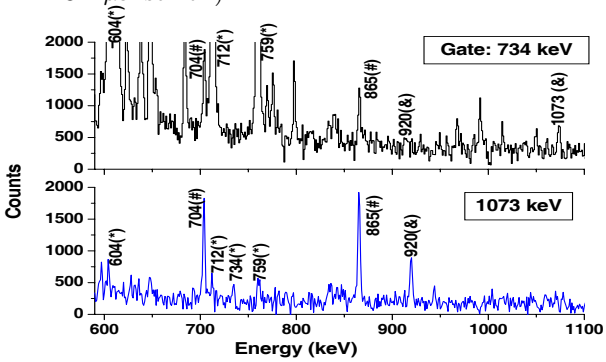

FIG. 3: Spectra generated with gates on 734 keV gamma below 8.4 μs isomer and 1073 keV gamma above the 47 ns isomer. *, # and & indicate gammas belonging to groups A, B and C, respectively.

tra (range 200 ns) as well as on the gamma-gamma time difference spectra (range 800 ns), to correlate the states above and below the isomers. The variation in the prompt centroid of the time difference spectra (RF-γ as well as $\gamma - \gamma$) as function of gamma energy has been determined to facilitate quantitative estimation of level lifetimes using centroid shift method. The lifetime of the long-lived 47 ns isomer has been remeasured (Fig.2). The result argees well with earlier measurements. The RF-gamma TAC for 734 keV is also projected in Fig.2. TAC spectra gated by a prompt gamma from ^{153}Ho has been drawn for comparison.

Discussions

In earlier work [2], two branches of very weak transitions ($\simeq$ 1% of the 734 keV intensity) were found which bypass the long-lived micro-second isomer. They indicated that this weak branch was parallel to the 734 keV gamma. But from our present data (Fig. 3), both 734 keV and 1073 keV gated spectra clearly indicate presence of gammas from all three branches. A systematic search has been done to establish alternate routes of connection.

In Ref. [2], existence of a fourth yrast isomer of short half-life (2 to 3 ns) at an excitation energy of 7.2 MeV (marked as New in Fig.1) was indicated. The plot for estimating prompt centroid variations with energy also indicated this. A preliminary estimate of the half-life of this isomer has been obtained ($\simeq 2 - 6$ ns) using centroid shift method.

References

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