Observation of high-spin states in ^{153}Er

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INTRODUCTION

The ^{153}Er nucleus belongs to the so called transitional nuclei in the rare earth region. Presence of relatively large number of valance particles ($\Delta Z = 4$ and $\Delta N = 3$ above the $Z = 64$ and $N = 82$ closed shells) resulted in special structural features which are manifested in complex decay spectrum in this nucleus. In the neighboring ^{152}Er isotope yrast structure can be understood by the coupling of six valance nucleons outside the ^{146}Gd core [1]. On the other hand ^{154}Er, the decay scheme evolves from a weakly collective rotational structure at the lower spins to a typical non – collective one including a few charecteristics multiplet sequences [2]. In order to have a better understanding of the structure of these isotopes in the high spin region, the level structure of ^{153}Er nucleus required to be reinvestigated. Because the study by Foin et al [3] on ^{153}Er nucleus does not have any intensity measurements and no definite spin-parity was assigned for the states above excitation energy 5.25 MeV. The present work started with the motivation to determine the spin-parity and intensity of the high spin part of the reported level scheme and extend the level scheme to the high excitation energy and also to search, if there is any, band like structure present in the higher excitation energy.

EXPERIMENTAL DETAILS

The experiment were performed using ^{40}Ar beam of energy E_{lab} = 280 MeV provided by the VECC cyclotron. The target was 4.5 mg/cm^2 enriched ^{121}Sb on 2 mg/cm^2 aluminium backing. Indian National Gamma Array (INGA) stationed at VECC, Kolkata was used to detect the gamma rays produced in this experiment. The detection system consist with eight Compton suppressed clover detectors, four of which were placed at 90^0. Other four detectors were placed in the median plane, two each at 125^0 and other two each at 40^0 with respect to the beam direction. Out of 4 detectors at 90^0, 2 detectors were placed at 36^0 out of plane. About 5×10^8 events, two and higher fold gamma-gamma coincidence list mode data were recorded during this experiment. The highest angular momentum transferred to the compound nucleus at 280 MeV for the given target – projectile combination is $l_{max} = 128\hbar$ [4]. The recoil velocity of the compound nucleus is almost 3% of c. Kinetic energy of compound nucleus (^{161}Tm) is 69 MeV. Energy loss of ^{161}Tm in target and backing are 20keV/(mg/cm^2) [5] and 40keV/(mg/cm^2) respectively. So compound nuclei produced even at the last layer of target will be stopped inside the Al backing.

RESULTS

^{153}Er was previously studied by Foin et al. [3, 6] using (^{14}N, pxn) reaction and extend the level scheme up to 8.4 MeV and assigned spin parity below 5.2 MeV state but no spin-parity and intensity was assigned for the states above 5.25 MeV state.

The proposed level scheme of ^{153}Er, shown in Fig. 1 has been established using the coincidence relationship, relative intensities and R_{DCO} ratios measurements (Table I). The energy levels above 5.25 MeV state has been reconstructed and extended up to excitation energy 10 MeV. Typical background subtracted gated spectra are shown in Fig. 2. From the intensity measurement it was observed that 211 keV transition should be

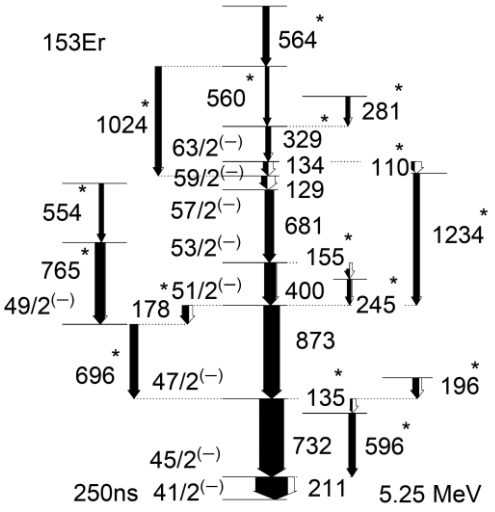

FIG.1. Level scheme of ^{153}Er above the 5.25 MeV, 41/2$^-$ state. Widths of arrows indicate the intensity of transitions. Transitions marked with an asterisk are observed from the present data.

placed just above the 5.25 MeV, $41/2^{(-)}$ state. Also the position of 680.8keV and 129.5 keV transitions were reversed from the present intensity measurements.

For spin measurements we take 732 keV transition as pure dipole transition which is tentatively assigned in the previous work of Foin et. al [7] and confirmed it from the present angular distribution data. We have also determined the spin of other two known transitions 177.6 keV and 696.1 keV as dipole transitions and the corresponding cross over 873 keV transition as a quadrupole transition which justifies their placement.

We have placed thirteen new transitions in the proposed level scheme, a sequence of 329, 560, 564 keV observed in the main cascade. A 1024 keV cross over transition justifies that 560 keV transition must be placed just above the 329 keV transition.

We also observed several other transitions (272, 259, 604, 422, 485, 1396, 417 keV) which belong to this nucleus but their placements are yet to be confirmed from the coincident measurements. In order to determine the parity of the states above 5.25 MeV, calculation of PDCO values are in progress.

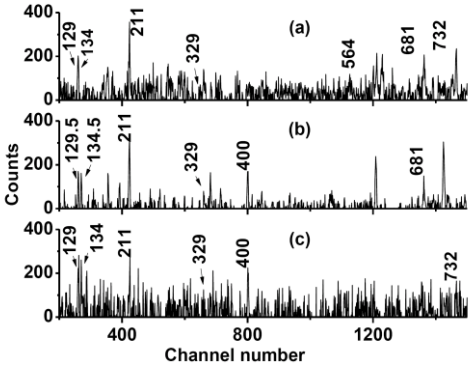

FIG.2. Representative gamma- gamma coincidence spectrum with gate on (a) 400 keV (b) 732 keV and (c) 681 keV transitions for ^{153}Er nucleus.

Table I. The measured DCO ratios of the states in ^{153}Er above 5.25 MeV.

E_γ(keV)	R_{DCO} ratio	Multipolarity of transition
211.2	1.54(0.14)	ΔI=2
873.0	1.58(0.16)	ΔI=2
696.1	1.09(0.08)	ΔI=1
177.6	1.07(0.15)	ΔI=1
400.0	1.05(0.09)	ΔI=1
680.8	1.49(0.11)	ΔI=2
129.5	0.90(0.11)	ΔI=1
134.5	1.42(0.14)	ΔI=2

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