Gamma-vibrational states and other high-spin band structures in the deformed ^{162}Er nucleus

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Introduction

Collective excitations in nuclei have been the focus of comprehensive investigation due to their important roles in nuclear structure studies. Among all the collective excitation modes, γ vibration, and in particular, multi-phonon γ vibration in nuclei have been quite fascinating. The γ-vibration with $K = 2$ corresponds to oscillations in γ, and it represents a dynamic time-dependent excursion from axial symmetry in nucleus. Among the deformed, neutron-deficient, even-even Er isotopes, the data on vibrational modes of excitations (γ, β, octupole etc.) in ^{162}Er are rather sparse. The 2^+, 3^+, 4^+ states of the γ band were reported earlier by de Boer *et. al* [1]. Following that, the band was extended up to 8^+ state by West *et. al.* employing ^{160}Dy(α, 2n) reaction [2]. Subsequently, the aforesaid band was further extended up to $I^\pi = 11^+$ by Janssens *et. al* with another measurement that utilised the ^{165}Ho(p, $4n$) reaction [3]. The present work primarily aims to further extend as well as characterize this γ band, and explore the possibility of 2-γ phonon state(s) in this nucleus.

Experimental details

The experiment was carried out at the Room Temperature Cyclotron (RTC) facility at VECC, Kolkata. Higher-spin states in the ^{162}Er nucleus were populated using the ^{161}Dy(α, 3n) reaction at a beam energy of 43 MeV. The ^{161}Dy target was prepared by depositing enriched Dy_2O_3 powder(I.E.$\sim$92.1%) on mylar foil (thickness 25 μm) employing the centrifugal precipitation technique. Two such targets, each having an average thickness of $\sim$5 mg/cm^2, were stacked together during the measurement, with the backing-mylar of one facing the beam, and the other one facing the beam-dump. Deexciting γ-rays were detected using the Indian National Gamma Array (INGA) spectrometer, which consisted of 11 Compton-suppressed clover HPGe detectors and 1 LEPS detector during the time of the present measurement. Out of the total 11 clovers, six were placed at 90^0, three at 125^0 and two at 40^0 with respect to the beam direction. The only LEPS that was mounted in the array was at 40^0 w.r.t. the beam direction. The events were recorded using the PIXIE-16 digitizers-based data acquisition system [4]. Data sorting was carried out

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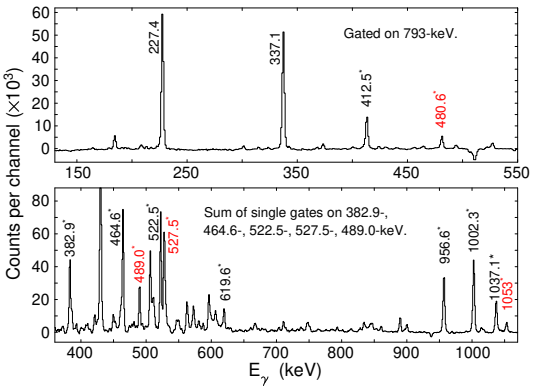

FIG. 1: Representative gated spectrum showing the transitions deexciting the states in the γ band. Some of the newly observed transitions have been marked in red colour (also in Fig. 2).

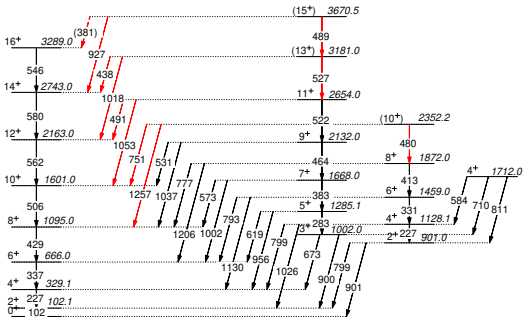

FIG. 2: Partial decay scheme of ^{162}Er showing the γ band and the K^{π}=4^{+} state.

using the BINDAS software package [5]. The crucial in-beam auto calibration feature in this software was used to correct for instrumental drift in the data, if any. Finally, $\gamma-\gamma$ coincidence matrices (both symmetric and asymmetric) as well as $\gamma-\gamma-\gamma$ coincidence cube were generated for further analysis employing the RADWARE suite of programs [6].

Results & discussion

The ground-state rotational band has been observed beyond the $i_{13/2}$ neutron alignment, up to spin, I^{π}=26^{+}, in the present data. The γ band has been extended up to the $I^{\pi}=15^{+}$ (E_x = 3.7 MeV) level based on the newly observed 480 keV ((10^{+}) $\rightarrow$ 8^{+}), 527 keV ((13^{+}) $\rightarrow$ 11^{+}) and 489 keV ((15^{+}) $\rightarrow$ (13^{+})) in-band γ transitions (Figs. 1, 2). New inter-band M1 and E2 transitions, connecting these newly observed states to the ground-band have also been observed. DCO and polarization measurements will be undertaken to unambiguously assign spins and parities to these levels. This γ band will be further interpreted by comparing the experimental branching ratios of the inter-band transitions to those obtained from the Alaga intensity rules.

The 4^{+} level (K=4) with E_x= 1712 keV, which was observed earlier in the β-decay of ^{162m}Tm [1], and decays exclusively to the γ band, has also been observed in the present data. This level was suggested earlier as originating from two quasiparticle excitations. However, further investigation is required to find the real character of this state and other members, if any, based on this K^{π}=4^{+} bandhead state.

Apart from these, from the preliminary analysis of the data, a new strongly-coupled band structure has been observed. The information on the previously reported β-band and negative-parity octupole bands in this nucleus is limited in literature. Such states will also be investigated in detail in the ongoing analysis.

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