Spectroscopy of ^{136}Ce

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1. Introduction

The A~135 mass region is the forefront of nuclear structure research because of different variety of interesting phenomena such as the occurrence of chiral partner bands [1-3] and wobbling bands [4-5]. Previously the excited states of Ce in this mass region were investigated and several bands were reported [1,6-12].

In this mass region, the proton orbitals, $1g_{7/2}$, $2d_{5/2}$, and $1h_{11/2}$, and neutron holes orbitals, $1h_{11/2}$, and $1h_{11/2}$, $1g_{7/2}$, $2d_{3/2}$, and $3s_{1/2}$ are lying near the Fermi surface of the nucleus and playing important role in the bands structures and shape evolution. Due to the availability of $h_{11/2}$ shape driving negative-parity orbital for both proton and neutron (with low-Ω and high-Ω) many interesting structural phenomena are expected [1, and 6-10].

The collectivity in ^{136}Ce (Z=58, N=78) nucleus was reported on the basis of B(E2) value ~ 8 w.u. for 762.2 keV transition of the ground state band. However, the presence of 6^+ ,8^+ and 10^+ irregular doublets states indicate the non-collective nature of these states, competing with collectivity. Spin and parity of low lying states were not confirmed, hence investigation of these states is important in order to obtain the structural evolution in these nuclei.

The study of evolution of nuclear shapes, changing role of pairing and Coriolis forces, etc. with increasing rotational frequency has enriched our knowledge about the interplay of collective and non-collective modes of excitations in producing richness in nuclear spectra. In this work, we report an experimental investigation of low lying exited states of ^{136}Ce nucleus.

2. Experimental Details

The ^{124}Sn (^{16}O, 4n) ^{136}Ce fusion evaporation reaction was used to populate the excited states of ^{136}Ce at 90 MeV beam energy. The experiment was carried out using the 15 UD pelletron accelerator facility at Inter-University Accelerator Centre (IUAC), New Delhi.

An isotopically enriched target of 1 mg-cm^{-2} was used in the experiment and Indian National Gamma Array (INGA) was used to detect the γ-rays from the excited nucleus. In this experiment, sixteen clover detectors were used at different angles, with respect to the beam direction. About 10^9 two-fold coincidence γ-events were recorded by CAMAC-based data acquisition system [13]. Offline data analysis was carried out using the INGASORT [14] and RADWARE [15,16] computer programmes.

3. Results and Discussion

The γ-γ coincidence gates were used for the coincidence relationship between γ-rays

transitions within the bands. A new γ-ray transition of 657.9 keV is found in coincidence with the 328.5 keV at $I^{\pi} = 7^-$ (Fig.2). For the determination of the multipolarities of γ−ray transitions, two-dimensional angle dependent asymmetric matrices were used. The ratio of intensities (R_{DCO}) of γ−transitions from

directionally oriented states were determined by the given relation

$$R_{DCO} = \frac{I\gamma_1(\text{measuresdat}\theta 1, \text{gatedat}\theta 2)}{I\gamma_1(\text{measuresdat}\theta 2, \text{gatedat}\theta 1)} \quad (1)$$

In the present work the experimental value of R_{DCO} for 657.9 keV γ−transition is found to be 0.84 (0.14), 1.05 (0.16) and 1.03 (0.13) in 552, 762.2 and 328.5 keV energy gates respectively. The data of R_{DCO} suggesting the quadrupole nature of the newly placed 657.9 keV transition in the present work. Hence, a new state above the 2308 keV is established (Fig.1) with energy 2966 keV. This may be a new band which need more information from the present experiment and from the systematic. Further analysis is in progress and the result will be presented during the conference.

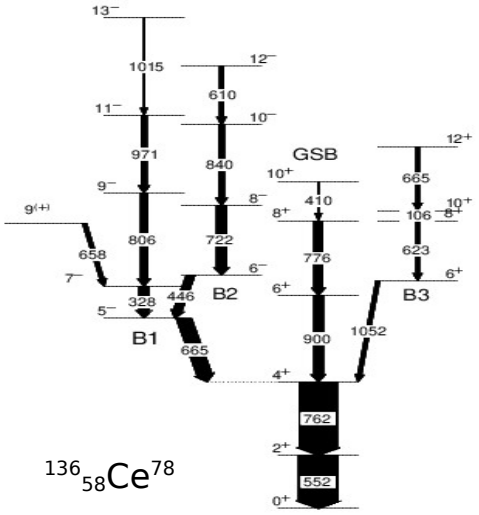

Fig.1: Proposed partial level scheme of ^{136}Ce relevant to present work interest.

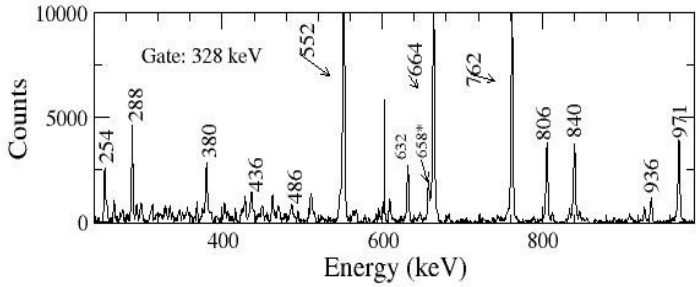

Fig.2: The coincidence energy gate on 328.5keV, showing the decaying transitions of 657.9 keV and ground state band. Several other transition also observed belonging to other bands in ^{136}Ce.

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