Coulomb excitation measurement of ^{132}Ba at IUAC, New Delhi

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In recent years, several experimental and theoretical studies have been focused on nuclear shell structure far from the line of stability [1]. Nuclei in the vicinity of doubly-magic ^{100,132}Sn are of key importance for the understanding of the nuclear shell structure [2]. In ^{100}Sn, protons and neutrons occupy the same orbit, but have very different binding energies. As a consequence its structure may be influenced by proton-neutron pairing and by the coupling of the weakly bound protons to the continuum. Many experimental data are available for the neutron-rich tin isotopes [3, 4] and now the focus is on the nearby isotopic chains with valence protons and neutrons. In the mass region A $\approx$ 130 the xenon and barium nuclei develop a transitional path from spherical shapes to strong deformations. The aim of the present measurement was to probe the nuclear structure of stable ^{132}Ba nuclei, more precisely to investigate the collectivity of the above mentioned nuclei by extracting B(E2 $\uparrow$) values with higher experimental accuracy. Earlier, ^{132}Ba was measured in 1958 and 1985 [5, 6], also there is no measurement available for 4_1^+ state.

The present experiment was performed with Gamma Detector Array (GDA) set-up at Inter University Accelerator Centre (IUAC), New Delhi. The $\approx$ 500 μg/cm^2 thick target of ^{132}Ba, with 40% isotopic enrichment, used in this experiment was prepared on $\approx$ 20 μg/cm^2 carbon backing at HIL, Warsaw. ^{58}Ni beam at 175 MeV from the 15 UD tandem accelerator was bombarded on the target to Coulomb excite the Ba-nuclei. The scattered beam particles and the recoils were detected in an annular gas-filled parallel plate avalanche counter (PPAC), position sensitive for both the azimuthal (ϕ) and the polar (θ) angles. The PPAC was placed in the forward direction from the target position, covering an angular range of $15^\circ \leq \theta_{lab} \leq 45^\circ$ in the laboratory frame.

The azimuthal (ϕ) angle was obtained from the anode foil which was divided into 16 radial sections of 22.5° each. The polar (θ) angle was determined from the cathode which

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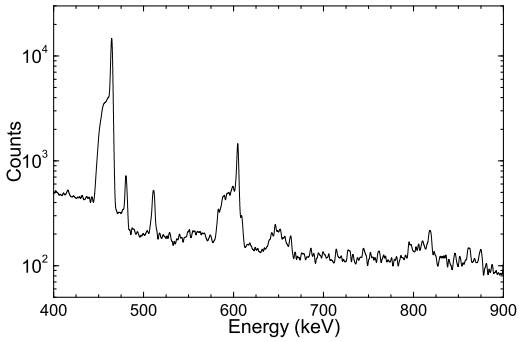

FIG. 1: Energy calibrated raw γ-ray spectrum for single crystal of Clover detector.

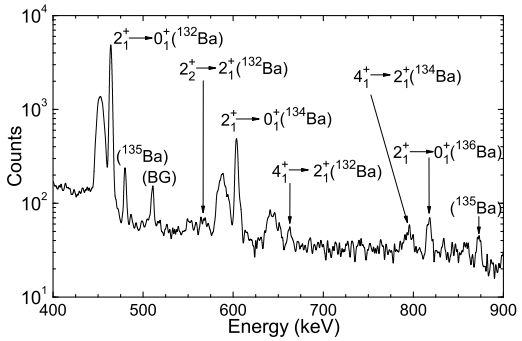

FIG. 2: Doppler-shift corrected γ-ray spectrum for single crystal of Clover detector in coincidence with scattered projectiles measured in PPAC.

was patterned in concentric conductor rings of constant tan θ, each 1 mm wide, with an insulating gap of 0.5 mm between them.
The de-exciting γ-rays were detected in the four clover detectors, having an energy resolution of about 2.5 keV, mounted at angle $\approx 135^\circ$ relative to the beam direction. The ϕ_γ angles for the clover detectors were $\pm 50^\circ$ and $\pm 130^\circ$ relative to the vertical direction. Individual energies and timing from the 16 crystals were recorded in-coincidence with the PPAC cathode (16 signals) event by event.

The data were analyzed by using the GSI On-line Off-line Object Oriented (GO4) software package. Individual timing gates were applied for each crystal of Clover detectors and phi segments of PPAC to reduce the background radiation. Energy calibrated raw gamma-ray spectrum for a single crystal of Clover detector is shown in Fig-1. The scattered particles and the recoils were detected in the parallel plate avalanche counter (PPAC). The information of azimuthal angle (ϕ) was obtained by detecting the hit pattern in the azimuthal sector of the PPAC. However, the scattering angle θ_p was obtained from the time difference between the inner and outer conact of the delay lines.

Doppler shift correction of the measured γ-ray energies was performed event by event by using the information of scattering angles and Clover detectors position. A γ-ray resolution of about 3.5 keV was obtained after a Doppler shift correction for the target excitation. Detailed description of the analysis procedure is given elsewhere [7]. The Doppler-shift corrected γ-ray spectrum for a single crystal of Clover detector is shown in Fig-2. Higher excited states 4_1^+, 2_2^+ and 0_2^+ of ^{132}Ba were also populated along-with other stable Ba-isotopes (^{134}Ba, ^{135}Ba, ^{136}Ba, and ^{138}Ba present as an isotopic contamination in the target) and are shown in Fig-2. Futher analysis of the data is in progress, and the results will be presented.

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