Small Axially Symmetric Deformation for the Dipole Band in ^{112}In

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Introduction

Various nuclear excitation modes are predicted depending upon the symmetry of nuclear mean field and relative orientation of the total angular momentum of nuclei with respect to principal axes. In particular, the investigation of generation of high angular momentum states in nuclei based on symmetry consideration and geometrical models has been extremely successful in case of novel excitation modes like magnetic, anti-magnetic and chiral rotations. Recently, ^{112}In has attracted considerable experimental attention due to predicted favorable γ deformation required for chirality [1]. In the present work, polarization and lifetime measurement have been performed for establishing the parity of different bands required for detailed understanding of their configurations. The results from these measurements along with Tilted Axis Cranking (TAC) calculations have been used to obtain the shape parameters and quasi-particle configurations for different bands in ^{112}In.

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Experimental Details

High spin states in ^{112}In were populated using ^{100}Mo(^{16}O, p3n) reaction. The 80-MeV ^{16}O beam was obtained from 15-UD Pelletron accelerator at IUAC, New Delhi. The target consisted of 2.7 mg/cm^2 of ^{100}Mo on $\sim$ 12 mg/cm^2 thick Pb backing. Indian National Gamma Array (INGA)[2] which consist of eighteen Compton suppressed clover detectors was used to detect gamma-rays emitted in the reaction. The data were acquired when at least three clover detectors fired simultaneously. The coincidence data was stored in the gamma-gamma matrix and $E_\gamma \times E_\gamma \times E_\gamma$ cube. We have confirm the previously known level scheme [3] by putting double gates on different transitions.

Results and Discussion

The Directional Correlation of Oriented states (DCO) and the integrated polarization direction correlation (IPDCO) analysis were carried out to determine the spin and parity of different states. Polarization and DCO values obtained for 261 keV transition establishes the positive parity of the band A. The polarization asymmetry for 273, 393 and 554 keV transi-

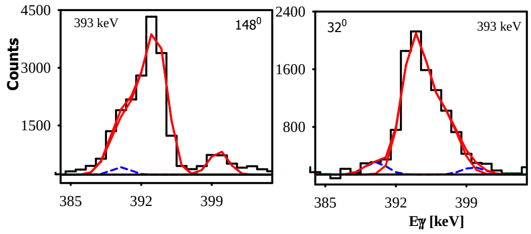

FIG. 1: Representative spectra for the line shape of 393 keV transition in positive-parity band of ^{112}In.

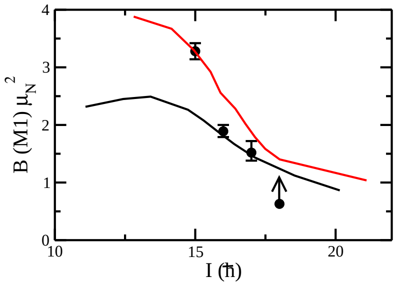

FIG. 2: The results of TAC calculations and its comparison with the experimental data for positive parity band of ^{112}In.

tions are found to be negative suggesting their magnetic character. Lifetimes of the higher-lying states of dipole bands of ^{112}In have been measured using the Doppler-shift attenuation method (DSAM). For the DSAM analysis line shapes were obtained from the background-subtracted spectra projected from two matrices consisting of events in the 148° or 32° detectors along one axis and all other detectors along the second axis, respectively. LINE-SHAPE program by J.C Wells was used to fit the line shapes of different transition. The fitting of the theoretical line shape with the experimental data for 393-keV transitions is shown in Fig 1.

In the discussion that follows, the experimental data of the dipole bands are compared with the predictions of TAC model calculations. The values of the proton paring gap parameter $\Delta_\pi = 0.99$ and the neutron pairing gap parameter $\Delta_\nu = 0.85$ were used in the TAC calculations. The values of deformation parameter ϵ_2 and γ were obtained by Nilsson Strutinskys minimization procedure. The nature of band, which is a $\Delta I = 1$ positive-parity M1 band, was investigated. A quasi-particle configuration $\pi g_{9/2} \otimes \nu((h_{11/2})^2(d_{5/2}/g_{7/2})$ is used in the tilted axis cranking (TAC) calculation for the dipole band. A minimum is found at deformation of $\epsilon_2 = 0.12$ and $\gamma = 6°$. The calculated $B(M1)$ *vs.* I plots based on this global minima given in Fig 2. qualitatively explains the measured data. However, a static deformation with $\epsilon_2 = 0.08$ and $\gamma = 5°$ based TAC calculations provides better agreement for the B(M1) values at higher spin for this band. The low deformation of these states indicates that the contribution from the core in angular momentum generation is negligible and the whole of the angular momentum generation along the band can be attributed to the shears mechanism. Moreover, the fair agreement between the TAC calculations with the measured excitation energy and B(M1) values, firmly establishes magnetic rotation for the positive parity band.

In summary, the polarization and lifetime measurements for the excited states of ^{112}In have been carried out. The extracted B(M1) values from the measured lifetime of positive parity band has a decreasing trend with increasing spin. The TAC calculations based on $\pi g_{9/2} \otimes \nu g_{7/2}(h_{11/2})^2$ configuration reproduces the measured trend of B(M1) with increasing spin. The fair agreement of TAC calculations with the measurement suggests weak prolate deformation for the dipole bands of ^{112}In.

Acknowledgments

The authors would like to thanks the Pelletron staff of IUAC, New Delhi and INGA collaboration.

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