First experimental signature of twin-shears mechanism in odd-odd ^{112}In

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Introduction

The phenomenon of Antimagnetic rotation(AMR) was first suggested by Frauendorf [1]. In this mechanism, two shears like systems are formed by the neutron particle(s) spin aligned along the symmetry axis with two proton holes aligned perpendicular to the symmetry axis and aligned anti-parallel *w.r.t.* each other. The high spin states of the antimagnetic rotational bands are generated by the simultaneous step-by-step closing of the two shears.

Nuclei in the A $\sim$ 110 region, near the Z = 50 shell closure, with the $h_{11/2}$ neutron particles and the $g_{9/2}$ proton holes, are suitable candidates to exhibit the twin shears mechanism. AMR bands have been observed in a few isotopes of Cd and Pd in this mass 110 region. A new band structure in ^{112}In was reported and based on the microscopic calculation, it was predicted to be a candidate AMR band [2]. In our work, we performed the DCO ratio, polarization and lifetime measurements to confirm the nature of the band.

Experimental Details

Excited states of the doubly odd ^{112}In nucleus were populated using ^{100}Mo(^{16}O, p3nγ) reaction at a beam energy of 80 MeV, provided by 15-UD Pelletron accelerator at IUAC, New Delhi. The target consisted of 2.7 mg/cm^2 thick ^{100}Mo backed with 12 mg/cm^2 thick ^{208}Pb. The emitted γ-rays from the excited states of the populated nuclei were detected using the Indian National Gamma Array (INGA) consisting of 18 Compton suppressed clover detectors [3]. Three and higher fold clover coincidence events were recorded and further sorted to generate $E_\gamma - E_\gamma$ matrices and $E_\gamma - E_\gamma - E_\gamma$ cube.

Results and Discussion

Based on the $E_\gamma - E_\gamma$ matrix and $E_\gamma - E_\gamma - E_\gamma$ cube analysis, the full level scheme of the ^{112}In nucleus is in conformity with that of the previous reported works [2, 4, 5]. However, the parity of the states was left unassigned in the refs. [2, 5]. The double gated spectrum shown in Fig.1, shows the transitions belonging to the predicted AMR band. In addition, spins and parities of the levels have

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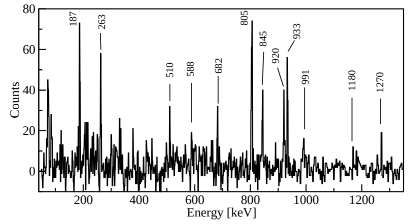

FIG. 1: Double gated spectrum from the triple coincident data showing the transitions of the proposed AMR band in ^{112}In.

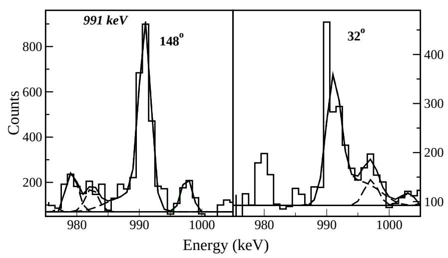

FIG. 2: Lineshape fits of 991 keV transition at 148° (Top) and at 32° (Bottom) *w.r.t* beam axis, gated on 582 keV transition.

been assigned by using the directional correlation of oriented nuclei (DCO) ratio analysis followed by the linear polarization measurements. From our multipolarity assignments, the in-band transitions of the predicted AMR band have been confirmed to be of electric quadrupole nature. Lifetimes of the high spin states of this band are determined using the Doppler Shift Attenuation Method (DSAM). Doppler broadened lineshapes were obtained from the background subtracted spectra projected from the angle dependent matrices with events in detectors at 148°, 90° or 32° on one axis and coincident events in rest of the detectors on the other axis. LINESHAPE program by J.C. Wells was used to fit the lineshapes of various transitions. The level lifetimes for 4 transitions 845-, 920-, 991-, and 1181-keV, have been measured. The preliminary fitting of the lineshape of 991 keV transition, with a gate on 582 keV, at 148° and 32° angles is shown in Fig.2.

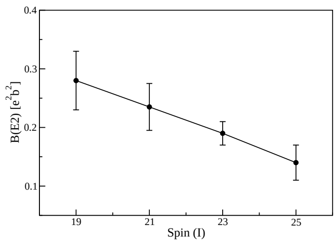

FIG. 3: The experimental data for reduced B(E2) strengths *vs.* Spin

The experimentally obtained electric quadrupole transition strengths have been deduced from the measured level lifetimes. The B(E2) values decrease systematically with increasing spin, which is an experimental signature of anti-magnetic rotation [Fig. 3].

In conclusion, the level scheme of ^{112}In has been established. Spins and parities of the levels have been assigned. The lifetime measurements for the proposed AMR band have been carried out. The results for the experimentally obtained B(E2) values from the measured lifetimes of the levels have been compared to microscopic calculations of Ref. [2]. The decreasing trend of B(E2) values with increasing spin suggests the presence of the double shears mechanism in ^{112}In.

Acknowledgments

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