Observation of non-yrast states in ^{116}Sn and measurement of polarisation asymmetry

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Introduction

The structural aspects of nuclei have been deduced, conventionally, by investigating high-spin phenomena observed by incorporating the so-called yrast bands. The yrast bands connect those states which lie in lowest energies for a particular spin value(I). Attempts can, however, be made to study the non-yrast states in order to unravel nuclear structure at relatively lower spin values. Different excitation energy levels at lower angular momentum of the non-yrast bands can be made by bombarding targets with lighter projectiles. Many questions, such as γ-softness, can be answered with more data available in such low energy regime [1].

Sn (Z=50) isotope, being a spherical nucleus, has a rich low-lying collective structure originating from proton 2p-2h excitation across the proton Z=50 shell closure. Even though this nucleus was very extensively studied, little or no information is available for the non-yrast states.

Hence, the in-beam γ-ray spectroscopy is used to extract information regarding the electromagnetic transition among the various low-lying states of ^{116}Sn.

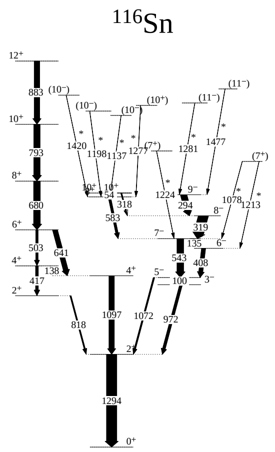

FIG. 1: Relevent partial level scheme of ^{116}Sn taken from [4]. For newly observed transitions(marked with asterisks), tentative spin-parities are put within braces.

Experimental Details

The low-lying excited states of ^{116}Sn was populated using fusion-evaporation reaction ^{114}Cd(α,2n)^{116}Sn. Self supportig ^{114}Cd foil of thickness of 6.22 mg/cm^2 was used for the experiment. The α beam of 34-MeV, supplied from K-130 cyclotron at VECC(kolkata), was used and the de-excited γ-rays were detected using INGA set-up comprising of seven compton suppressed HPGe clover detectors at angles 40°, 90°and 125°, respectively. The ac-

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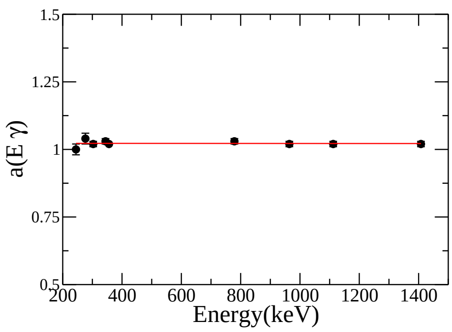

FIG. 2: Geometrical asymmetry plotted as a function of energy.

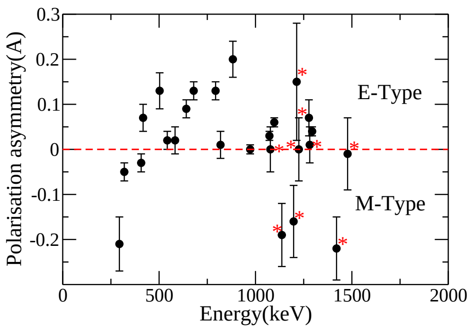

FIG. 3: Polarisation asymmetry plotted as a function of energy. Asterisk(*) marked transitions are for the newly observed γ-transitions.

quired listmode data was processed using the IUCPIX [2] package, developed at UGC-DAE CSR, Kolkata Centre.

Data Analysis and Results

The lower spin structure of ^{116}Sn has been investigated (Fig. 1) and several new transitions have been observed using γ-γ matrix and γ-γ-γ cube incorporating RADWARE and INGANEW software packages. Polarisation asymmetry measurement was carried out giving information regarding the electric or magnetic type of relevent γ-transitions. For this purpose, two asymmertic matrices were created. One matrix contained events in which one of the gamma rays was scattered in the direction perpendicular to the emission plane inside a 90° detector, while a coincident gamma ray was registered in any clover placed at the other angles. For the other matrix, gamma rays were scattered in the direction parallel to the emission plane. Experimentally, polarisation asymetry(A) is defined as:

$$A(\theta) = \frac{a\,(E_\gamma)\,N_\perp - N_\parallel}{a\,(E_\gamma)\,N_\perp + N_\parallel}. \qquad (1)$$

where, "a"is called geometrical asymmetry and is evaluated from unpolarised radioactive sources ^{152}Eu and ^{133}Ba using the follwoing relation:

$$a(E_\gamma) = \frac{N_\parallel}{N_\perp}, \qquad (2)$$

For this present experimental set-up, "a" is plotted with energy (Fig. 2) and is found to be 1.02. The polarisation asymmetry as calculated using eq. (1), is positive for electric-type of transition, negative for magnetic-type and nearly zero for mixed type of transition [3]. The polarisation asymmetry thus calculated for existing γ-transitions are found to be compatible with the level scheme [4]. Fig. 3 shows the experimental asymmetries of both the known and few newly observed γ-transitions plotted with energies (E_γ). Detailed analysis regarding the spin-parity assignment is in progress and will be presented.

Acknowledgments

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