In-beam gamma ray spectroscopy of ^{107}Sn

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Introduction

The study of nuclei near the N=Z=50 shell closures offers a fascinating avenue to deepen our knowledge of nuclear shell structures near the proton drip line. The presence of a limited number of valance nucleons compared to the ^{100}Sn core serve as an ideal testing ground for exploring various structural phenomena. These include magnetic and anti-magnetic rotation, band termination, and the assessment of how the nucleus changes from collective to non-collective structures, or vice versa. These investigations offer a more profound understanding of how residual interactions influence the behavior of particles as they move through different energy levels within the nucleus.

The systematic examination of level structures in odd-A Sn isotopes, including ^{105}Sn, ^{109}Sn, and ^{111}Sn [1–3], offers valuable insights into the progression from single-particle configurations at low spins to collective structures at high spins. Notably, ^{109}Sn transitions from a spherical shape at low spin states (J up to 27/2) to a deformed shape at higher spin states, eventually evolving into non-collective terminating states. In contrast, in the lighter ^{105}Sn nucleus, a magnetic dipole band has been reported above $J\pi = 27/2^+$. The low-lying band structures in these isotopes are a result of excitations involving valence neutrons in the $\nu d_{5/2}$ and $\nu g_{7/2}$ orbitals, while the emergence of collective structures can be attributed to the promotion of neutrons into the $h_{11/2}$ orbital or particle-hole excitations across the $Z = 50$ proton shell gap.

The odd-A ^{107}Sn nucleus, situated between ^{105}Sn and ^{109}Sn, was previously characterised up to low-spin states [4], including the identification of positive parity states up to $J\pi = 25/2^+$ and negative parity states up to $J\pi = 31/2^-$, has been revisited in this current work. The level structure of ^{107}Sn further elucidated through the in-beam gamma-ray spectroscopy.

Experimental Details

In the current experiment, in-beam gamma ray spectroscopy of ^{107}Sn was carried out through the ^{94}Mo(^{16}O, 3n) ^{107}Sn reaction. An isotopically enriched ^{94}Mo target with a thickness of 0.9 mg/cm^2, supported by a ^{197}Au backing of 6.5 mg/cm^2 thickness, was em-

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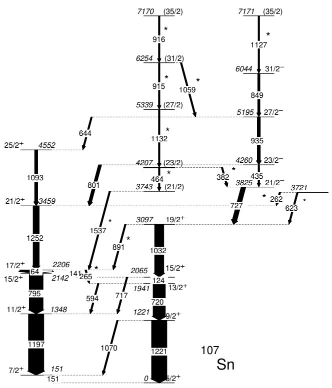

FIG. 1: Proposed partial level scheme of ^{107}Sn.

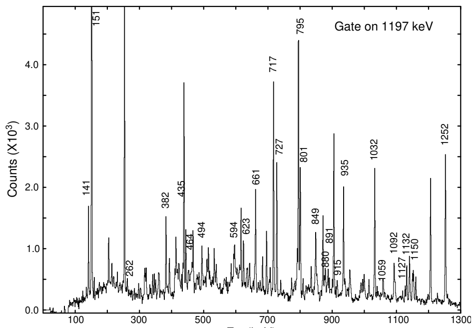

FIG. 2: A γ-γ coincidence spectrum gated on 1197 keV of ^{107}Sn.

ployed. The reaction was carried out at a beam energy of 70 MeV, which was delivered by the 15UD Pelletron Accelerator situated at the Inter University Accelerator Centre (IUAC) in New Delhi. The emitted γ-rays from this reaction were detected using the Indian National Gamma Array (INGA)[5]. At the time of the experiment, INGA comprised seventeen Compton-suppressed Ge clover detectors positioned at various angles relative to the beam axis.

Data Analysis and Results

Data collection was conducted in list mode format using a CAMAC-based multicrate synchronization mode on a Linux platform. The data collection process was initiated in the γ-γ mode. A total of one billion γ-γ events were recorded during the experiment. The measured coincidence events were sorted in to γ-γ symmetric matrix using the INGASORT program and further analyzed offline for the construction of the level scheme using the RADWARE gamma ray spectroscopy analysis software.

In this study, we have revisited and validated the level structure of ^{107}Sn, aligning our findings with prior research. The known band structures have been reconfigured and expanded to encompass higher spin states by introducing over twenty new γ-ray transitions. Fig. 1 presents the partial level scheme of ^{107}Sn showing both the positive and negative band structures along with the some of the newly added transitions. These transitions are placed in the level scheme based on the γ-γ coincidence relationships, intensity of the γ -ray transitions and information from previous level schemes. Fig. 2 illustrates a representative γ-γ coincidence spectrum, featuring gamma rays associated with observed band structures and the newly recognized γ-ray transitions. Further analysis of DCO and polarization information is in progress to confirm the spins and parities of the observed gamma transitions,and complete level scheme information will be presented during the symposium.

Acknowledgments

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