Study of nuclear structure in ^{125}I

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Introduction

The odd mass Iodine nuclei (Z=53) shows transitional behavior as they lie between the spherical (Z = 50) and the well deformed (Z = 57) nuclei. In the low lying single particle excitation region, a competition between oblate and prolate shapes for the $\pi d_{5/2}$ and $\pi g_{7/2}$ configurations was predicted for some of the iodine isotopes [1,2]. The coexistence of oblate and prolate shapes has also been proposed in ^{125}I along with the observation of single quasiparticle and three quasi-particle rotational bands [3].

Single quasi-particle band based on core excitation from $g_{9/2}$ orbital has also been proposed in the above work, as observed in several other odd-A I nuclei in this mass region [4,5]. However, the $g_{9/2}$ band was not reported in the later experiments on ^{125}I with heavy ion beam [6].

In the Iodine nuclei with A < 121, rotational structures built on $\pi h_{11/2}$ states have been seen [7] though in the heavier odd-mass I nuclei with A > 121 a vibrational structure built on $\nu h_{11/2}$ orbital have been observed [8]. The favoured signature partner of this unique parity band was observed in both light ion and heavy ion work on ^{125}I [3,6]. However, the unfavoured partner is partly observed in the light ion work. A similar structure is also known to exist in the neighboring ^{127}I [9].

In the neighboring odd-A nuclei the interactions among the above single quasi-particle and multi-quasi-particle band structures are also observed. However, such interconnecting decays between the bands observed in ^{125}I seem to be incomplete when compared to the structures of ^{123}I and ^{127}I[4,9].

So it is important to explore the ^{125}I nucleus for the complete understanding of the single and multi-quasiparticle structures, their shapes and the associated shape coexistence. In the present work, the ^{125}I nucleus has been populated with alpha induced reaction with K-130 cyclotron at VECC, Kolkata in order to study the low to moderate spin structure by γ-spectroscopic measurements with Indian National Gamma Array (INGA).

Experiments and Analysis

Excited states of ^{125}I have been populated by using alpha induced fusion evaporation reaction ^{123}Sb $(\alpha,2n\gamma)^{125}$I with 30 MeV beam energy from K-130 cyclotron at VECC, Kolkata. This gives a unique opportunity to study the low lying levels in this nucleus without the influence of feeding through high spin yrast levels. Mylar backed enriched ^{123}Sb metal target of 7mg/cm^2 thickness, produced with centrifuge technique, was used in the experiment. The beam

Fig. 1: Indian National Gamma Array setup at VECC, Kolkata

energy was estimated by using PACE4 calculation in order to maximize the cross

section for 2n evaporation channel. For the detection of the gamma rays, coming from the excited levels, using INGA set up at VECC, Kolkata, as shown in Fig. 1 has been used. In this array, total 6 Compton suppressed CLOVER HPGe detectors were used, among which four were placed at 90^O and the rest two were at 55^O in the backward direction. One LEPS detector was also placed in the forward direction for the detection of X-ray and low energy γ ray. The distance of the detectors was at 25cm from the target. The data were collected with PIXIE-16 digitizer based data acquisition system and the data were sorted by using the IUCPIX sorting programs [10]. Standard ^{152}Eu and ^{133}Ba source was used for the energy and efficiency calibration. The INGASORT and RADWARE packages were used for the analysis of data.

Data Analysis and Results

The symmetric and asymmetric γ–γ matrices have been generated from the two fold list mode data. The γ–γ coincidence analysis for the development of level scheme has been performed from the background subtracted symmetrized γ–γ matrix. Fig. 2 and Fig. 3 show the representative γ–γ coincidence spectra in which the added gates of few selected γ energies from the existing bands. All the known γ decays of these bands have been observed clearly and the presence of new γ transitions are indicated

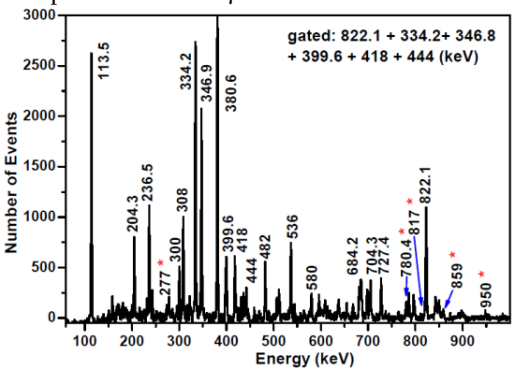

*Fig. 2: Added gates corresponding to the decay of Band-7 of Ref. [3] having $g_{9/2}$ band head. New transitions are marked with *.*

with red *s which could be placed in the respective bands according to the present γ–γ analysis. Fig. 2 corresponds to Band-7 of Ref. [3] based on core excitation from $g_{9/2}$ orbital and present analysis indicates the existence and addition of new transitions to this band structure. Similarly, Fig. 3 is for the Band-5 of Ref. [6] which is developed on $\pi h_{11/2}$ quasiparticle structure. The existence of the unfavoured partner for this structure as well as the placement of new gamma rays are indicated in these two partner bands.

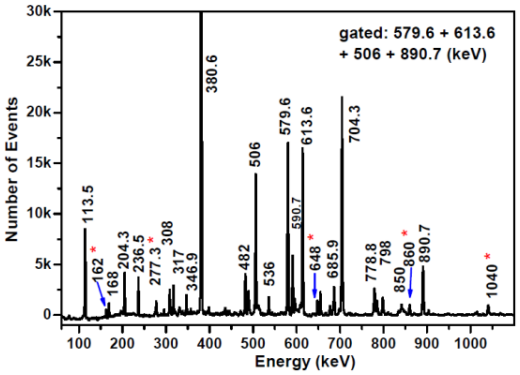

*Fig. 3: Added gate corresponding to the decay of Band-5 of Ref. [6] having $\pi h_{11/2}$ band-head. The new γ-rays are marked as * .*

Acknowledgment

Authors would like to acknowledge K-130 cyclotron staffs at VECC for providing good quality alpha beam. Dr. G. Mukherjee, INGA LEC; the DAQ team from UGC-DAE-CSR and the INGA working group members at VECC are sincerely acknowledged for their help and support in carrying out the experiment.

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