Band Structures and Single particle excitations in ^{117}Sb

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Introduction

Nuclei near Z=50 are known to exhibit collective structures due to the rotation of valence particle about the core. Sb nuclei (Z=51) are thus helpful in understanding the competition between single particle degrees of freedom with collective nature. The structures of odd mass Sb isotopes are mainly obtained from the coupling of the odd valence proton occupying the available valence orbitals to the corresponding core. Rotational bands based on a $9/2^+$ state have been observed in odd-A (A=113-119) Sb isotopes [1,2]. Decoupled bands ($\Delta I=2$) arise from the coupling of $g_{7/2}$, $d_{5/2}$ and $h_{11/2}$ valence proton orbitals with the 2p2h deformed core and strongly coupled bands ($\Delta I=1$) result from the coupling of 2p1h core with the $g_{9/2}$ proton hole [3,4]. Shape coexistence at a high spin due to the $g_{9/2}^{-1}$ proton hole excitation has also been indicated from the observation of high spin isomer in ^{117}Sb [4].

Experiment

The excited states of ^{117}Sb has been populated by using the reaction ^{115}In (α,2n)^{117}Sb at a beam energy of 28 MeV delivered from K-130 Cyclotron at VECC (Kolkata). The VENUS array [5] consisting of six Compton suppressed Clover detectors was used for recording the data. The detectors were placed at angles $\pm30^0$ (one each), 90^0 (two detectors) and one at 45^0 and another 55^0 with respect to the beam axis. The γ–γ coincidence data along with singles data were collected using PIXIE-16 (XIA LLC) digitizer based pulse processing and data acquisition system [7].

Data Sorting and Analysis

The time stamped listmode data was sorted using a set of programs, IUCPIX [7] to form an Eγ-Eγ symmetric matrix and Eγ-Eγ-Eγ cube which were used to check and verify various coincidence relationships between the γ-rays. A conventional DCO matrix having 90^0 detectors in one axis and another axis containing 30^0 detectors was also made to find the multi-polarities of the γ-rays. Angular distributions for various γ-rays had also been done to reconfirm the dipole/quadrupole nature of the transitions. The two 90^0 detectors are used to find the IPDCO parameters which helps to determine the electric/magnetic nature of the γ-ray.

Results

Present work can establish the population of the previously reported bands in ^{117}Sb[4] upto a maximum of spin 35/2ħ along with few new band structures and single particle excitations. A total of 28 new γ-transitions are observed in present work to extend the level structure. Two new band structures above the 2356 and 2876 keV level respectively have been observed. A number of new transitions were placed in the level scheme, which are dominantly coming from the single particle excitations, which is more expected in fusion-evaporation reaction using α beam.

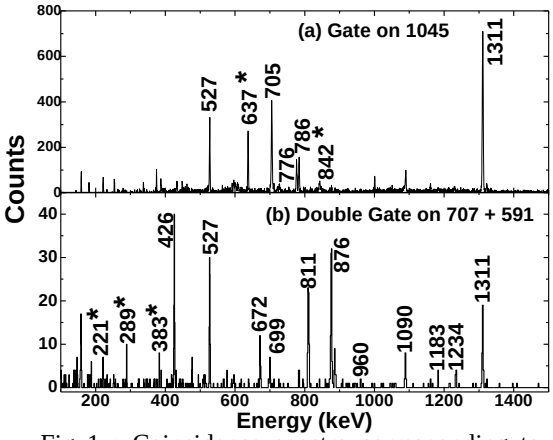

Fig 1 : Coincidence spectra corresponding to (a) 1045 keV gate from γ–γ matrix and (b) 707-591 keV gate from γ–γ–γ cube. New transitions are marked with '*'.

Coincidence of 1045 keV gate and 707-591 keV double gate are shown in fig.(1) with the marking of newly observed transitions.

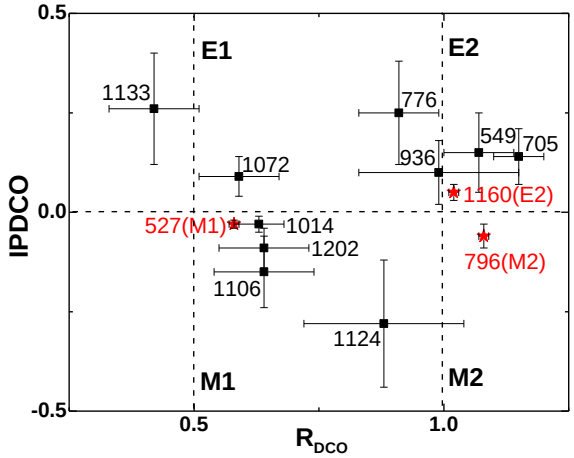

Fig 2 : DCO ratio vs polarization asymmetry (IPDCO) of various transitions in ^{117}Sb obtained with different quadrupole gates. Red points are representative of previously known γ-transition and others are newly observed.

Spin-Parities of the levels are determined with the assignment of multi-polarities to the γ-rays on the basis of DCO and IPDCO measurements. For a pure stretched quadrupole or dipole transition, the R_{DCO} comes near to unity when gated by a transition of same multipolarity. For the gating transition of different multipolarity, the R_{DCO} value depends on the nature of the gating transition. On the other hand, the positive and negative values of Δ_{IPDCO} correspond to the electric and magnetic transitions, respectively. Fig.(2) shows the measured R_{DCO} and IPDCO values for various new transitions obtained in quadrupole gate observed in the present work. Angular distributions of various transitions have also been done to deduce the multipolarity of the γ-ray. Spin-parity assignments for other γ-rays are in progress.

TRS calculations

TRS calculation with a $\pi(g_{7/2}d_{5/2})^2(g_{9/2})^{-1}$ configuration to the strongly coupled positive parity band has been done and shown in fig.(3). Minimum at the prolate side ($\gamma = 60^0$) can be seen from the Routhian energycontours.

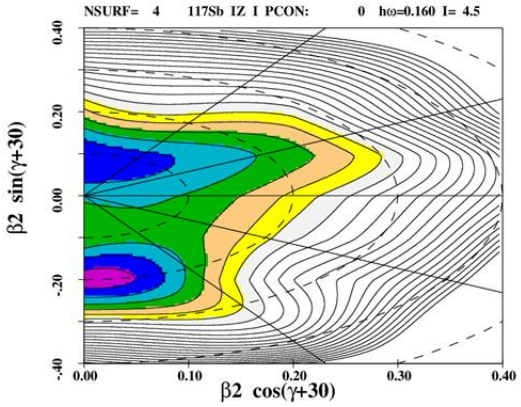

Fig 3 : TRS plot corresponding to ħω = 0.16

Detail TRS calculations along with other theoretical analysis are in progress.

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