Deformed structure based on $\nu i_{13/2}$ orbital in ^{199}Hg

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Introduction

As a bridge between the strongly deformed (prolate) rare-earth region and the spherical lead region the Hg nuclei are interestingly showing slight oblate deformation. The positive parity $\Delta I=2$ band structure for odd mass Hg nuclei (Z=80) near A~199-200 are mainly observed to be built on $13/2^+$ band head and interpreted as a $(\nu i_{13/2}^{-1})$ decoupled band [1-2]. The nearby even mass Hg isotopes ^{190}Hg to ^{196}Hg show decoupled band structure based on rotation-aligned $(\pi h_{9/2}^{-2})$ states and $(\nu i_{13/2}^{-2})$ states from ^{198}Hg onwards [3]. Other negative parity bands in both odd mass and even mass Hg nuclei with band heads of $21/2^-$ and 5^- spins respectively are observed. These bands are interpreted as the semi-decoupled bands with one neutron hole completely decoupled and the other strongly coupled to the core [4]. Both the positive parity and negative parity states of ^{199}Hg are known only upto $25/2^+$ and $31/2^-$ from the previous work [5], in which a few Ge(Li) detectors were used to detect the gamma rays. Whereas, for adjacent ^{197}Hg, $(\nu i_{13/2}^{-1})$ band has been extended upto $41/2^+$ with an indication of a structural change in-between. In the current study the yrast as well as near yrast structures of ^{199}Hg have been explored using the α beam from the K-130 cyclotron at VECC, Kolkata.

Experiment and Analysis:

The levels above the isomer of ^{199}Hg have been populated using the fusion evaporation reaction ^{198}Pt(α,2n)^{199}Hg at a beam energy of 36 MeV. At this particular beam energy, the neighboring ^{200}Hg and ^{198}Hg have negligibly small contamination. The decaying γ rays from the excited states were detected using **VE**CC array for **NU**clear **S**pectroscopy (VENUS) [6] at VECC, consisting of six Compton suppressed Clover HPGe detectors. The detectors were placed at 26 cm from the target position with suitable orientation for (Directional Correlation from Oriented states) DCO ratio, IPDCO and Angular Distribution measurements. The signals from the Clover detectors were processed with 16 channel Mesytec amplifiers. Standard NIM analog electronics were used to process the BGO-ACS signals and for other singles and doubles (γ–γ coincidence) trigger logics. The data were collected with high resolution VME ADCs and VME based data acquisition system using LAMPS. TAC spectra were used to select the prompt transitions. Data were sorted using LAMPS, INGASORT and Radware software packages. Standard ^{152}Eu and ^{133}Ba source were used for calibration of the detectors and a γ–γ matrix has been formed with the addback to obtain the coincidence relations of the γ rays. An asymmetric matrix was also formed for DCO analysis using the data from two detectors at backward 30° and other two detectors at 90° for various transitions. The 90° detectors are used for the measurements of Integrated Polarization from Directional Correlation of Oriented states (IPDCO) for assigning the parity of the states.

Results:

The total projection from the γ–γ coincidence matrix shows clear spectra dominated only by the known lines from ^{199}Hg. Few connecting M1 transitions (i.e. 142 keV and 302 keV) between

two signature partner of negative parity band can be found from the current work and placed in the level scheme and marked * in Fig 1. A few new transitions are also shown in Fig 1. and yet to be placed in the level scheme.

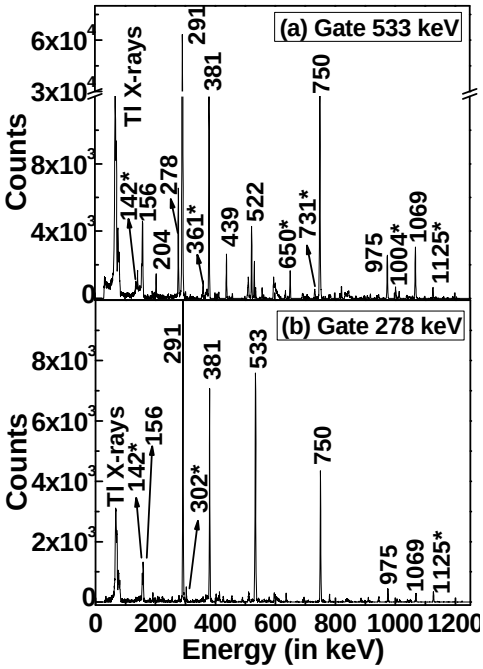

Fig. 1 Coincidence spectrum of **(a)** known 533 keV gate of positive parity band and (b) known 278 keV gate of negative parity side band. New transitions are marked as '*'.

The preliminary analysis indicates that the main yrast band based on $\nu i_{13/2}$ orbital can be extended up to higher spins compared to the previous work [5] with the placement of new transitions. The DCO ratio is defined by

$$R_{DCO}=\frac{I_{\gamma 1}\ at\ \theta_1(150°),\ \ gated\ by\ \gamma_2\ at\ \theta_2(90°)}{I_{\gamma 1}\ at\ \theta_2(90°),\ \ gated\ by\ \gamma_2\ at\ \theta_1(150°)}$$

The overlap of the spectra according to the DCO ratio definition clearly indicates the multipolarities of some of the known and new transitions, as shown in Fig. 2, in a known quadrupole (E2) gate of 533 keV which is a part of *ΔI=2* transition of rotational-aligned band.

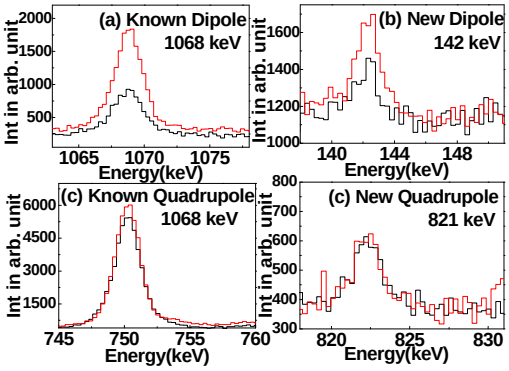

Fig. 2: (Colour online) Projected spectra of DCO matrix for (a) Known dipole (b) New dipole (c) Known quadrupole (d) New quadrupole transitions in ^{199}Hg. Black (Red) spectrum is the projection at 30˚(90˚) detectors of different transitions when gated by known quadrupole transition of 533 keV at 90˚(30˚) detectors.

Summary:

Preliminary analysis shows new transitions which can be assigned to ^{199}Hg from the present data. A few new transitions parallel to the main decoupled band on $13/2^+$ have been observed. Another negative parity band based on $(\nu i_{13/2}^{-3})$ can be extended with new transitions. The multipolarities of the transitions are found from the DCO ratio measurements. Detail study of the coincidence data to search for more near yrast structure (expected in α-beam population) is in progress. The analysis of polarization data to find the nature of transitions and the angular distribution data for assignment of mixing ratios and ΔJ of the transitions are in progress.

References

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