Yrast and non-yrast Spectroscopy of N=117, ^{197}Hg nucleus

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Introduction

All the odd mass Hg isotopes around mass A~190 have a positive parity band built on an isomeric $13/2^+$ level, and been interpreted as a $(\nu i^{-1}_{13/2})$ decoupled band [1,2] . This band is extended up to $49/2^+$ for ^{197}Hg in the latest work [3]. Another $\Delta I=2$ sequence of negative parity band is also observed with a $21/2^-$ bandhead [4] and extended up to $45/2^-$ in ^{197}Hg [3] , which are described as members of a semi decoupled band. The levels of the $13/2^+$ band have a similar feature with their even core isotopes. But in the case of ^{197}Hg this trend does not uphold as the levels of $13/2^+$ band are at much higher energy than their cores, which can be explained as a result of the blocking effect if the configuration of ground band of the ^{198}Hg core is $(\nu i^{-2}_{13/2})$ [4]. Focus of the present work is to enrich the spectroscopic data and to understand the involvement of the intruder orbital in generating the yrast and non-yrast states in ^{197}Hg .

Experimental setup & Data analysis

A fusion evaporation reaction with 32 MeV alpha beam from K-130 Cyclotron at VECC Kolkata on the 97% enriched, 13.6 mg/cm^2 thick ^{198}Pt target was used to populate the excited states in ^{197}Hg. The gamma rays, emitted from the excited states of ^{197}Hg were detected using INGA facility at VECC which consisted of 8 Compton-suppressed Clover HPGe detectors and two LEPS detectors [5]. Five of the Clover detectors and one LEPS were placed at 90^0 to the beam direction whereas two Clovers were placed at 125^0 and one was placed at 40^0 angles. Time stamped data were taken using digital DAQ. Gain matching and addback for each clover detector were done using the sorting package called IUCPIX [6] developed by UGC-DAE-CSR, Kolkata Centre. γ–γ matrix, γ–γ–γ cube and asymmetric matrices were constructed for establishing the coincidence relationship and calculation of the DCO ratio [7] and the polarization asymmetry (Δ_{PDCO}) [8] values. RADWARE package was used for analysis [7].

Results

The coincidence analysis leads to the identification of many new transitions and bands in ^{197}Hg. Use of alpha beam in this experiment leads to the population of several non-yrast side bands. We also have observed the 884 keV gamma (M1+E2) which is in parallel with the 621 keV of the yrast positive parity band and connects to the $19/2^+$ level at 1537 keV . In the neighboring lower odd mass isotopes this $19/2^+$ level was observed but not extended to higher spins. Several new gamma rays have been observed in three parallel branches, having

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energies 732 keV, 762 keV and 648 keV, 1094 keV and 566 keV, respectively, above the $19/2^+$, 1537 keV level. These new gamma rays are shown in the coincidence gate of 884 keV transition [Fig 1].

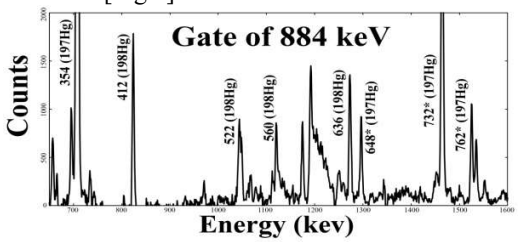

Fig 1 : New gamma rays are indicated with a '*' in the gate of 884 keV

New sequence of transitions (691 & 968 keV) are found in coincidence with the 466 keV γ-ray. In our analysis 466 keV is found to be an E2 transition. DCO ratio of 691 keV and 968 keV indicated their quadrupole nature but due to lack of statistics Δ_{PDCO} cannot be determined, but we assumed them to be as electric quadrupole type from systematics. For spin assignment, the asymmetric DCO matrix was utilized. From the known gammas it has been established that a DCO ratio of unity indicates quadrupole nature and 0.57 dipole nature obtained in a gate of pure quadrupole. For a mixed transition, DCO ratio has an intermediate value depending on the degree of mixing [Fig 2].

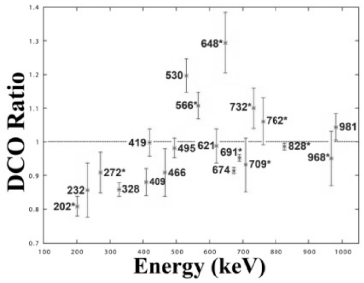

Fig 2 : DCO ratio of the newly observed & few previously known transitions with a gate on a known stretched quadrupole transition.

Parity assignment of the levels were done from the Δ_{PDCO}. The negative and positive values of Δ_{PDCO} are considered as magnetic and electric type transitions, respectively [Fig 3].

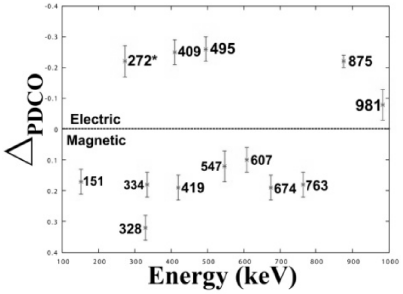

Fig 3 : Δ_{PDCO} values vs Energy

Discussions

The $vi^{-1}_{13/2}$ configuration of the decoupled band built on the isomeric $13/2^+$ level and the 3qp configuration of the semi-decoupled band built on the $21/2^-$ level are confirmed from our work also. Linear nature of the Energy vs I(I+1) plot confirms the rotational nature of the newly observed semi-decoupled band built on the $29/2^-$ (2364 keV) level. Its configuration is supposed to be of three quasi-particle in nature, with one neutron from the $p_{3/2}$ or $f_{5/2}$ and two $i_{13/2}$ neutrons. A known 530 keV and a newly observed 202 keV transitions connect the band head of the newly observed semi-decoupled band with the $25/2^-$ and $29/2^-$ levels of the previously established semi-decoupled band.

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