Calculation of theoretical Polarizations for N = 117, ^{197}Hg isotope.

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Introduction

A positive parity band based on an isomeric $13/2^+$ level exists in all of the odd mass Hg isotopes at mass A~190, and it has been described as a ($\nu i^{-1}_{3/2}$) decoupling band. [1],[2] which, in the most recent studies, is increased to $49/2^+$ for ^{197}Hg. [3]. Another ΔI=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 semi decoupled band. The levels of the $13/2^+$ band have a similar feature with their even core isotopes. In this report we will be discussing about the polarization measurements of ^{197}Hg which was computed and compared between experimental and theoretical results.

Experimental setup & Data analysis

A fusion evaporation reaction with 52 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 consist of 8 Compton-suppressed Clover HPGe detectors and two LEPs detectors [5]. Five of the Clover detectors and one LEPs were placed perpendicular to the beam direction whereas two Clovers were placed at 125^0 and one of them was placed at 40^0 angles. Gain matching and Addback spectra for each clover detector were done using the sorting package called PIXSORT [6] developed by UGC-DAE-CSR (Kolkata). An asymmetric γ–γ matrix was constructed for establishing the Δ_{PDCO} values [8]. By using the asymmetric matrix and accounting for the parallel and perpendicular components for the Δ_{PDCO} ratios, the experimental polarization was calculated. For many known and unknown gamma transitions, we have estimated the experimental polarization, and for a selected handful of them, the theoretical polarization. The following section provides brief information about the results and its explanations along with the methods and expressions used for the calculation of theoretical Polarization. For data analysis and interpretation RADWARE package was used [7].

Results

The calculation of Δ_{PDCO} was done based on the following methods,

$$\Delta_{PDCO} = \frac{a(E_\gamma)N_\perp - N_\parallel}{a(E_\gamma)N_\perp + N_\parallel} \quad (1)$$

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The asymmetry correction factor $a(E_\gamma)$ in eq.1 which describes the geometrical asymmetry of the detection system and has been determined as a function of energy (Eγ) from the relation ($a(E_\gamma) = N_{||}/N_\perp$), using γ-transitions from the unpolarized radioactive sources (^{152}Eu & ^{133}Ba) [8]. Fig.1 shows the Energy vs Geometrical asymmetry plot along with the fitted line and fitting parameters.

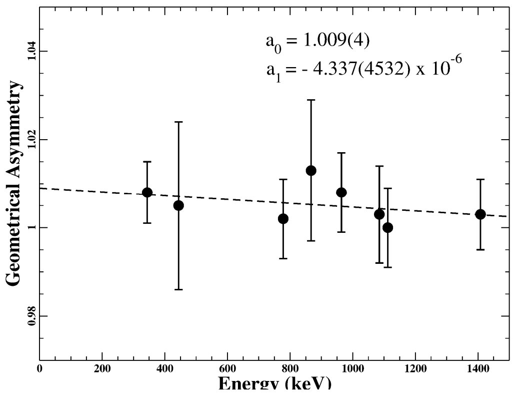

Fig. 1: Plot of geometrical asymmetry vs γ–ray energies (E_γ) for all four 90^0 detectors along with the fit to the data points using $a_0 + a_1(E_\gamma)$

We have done a successful measurement of Δ_{PDCO} values for many new transitions. We have also calculated the Polarization values for a few pure transitions. The calculation of theoretical polarization was done using the equations from [8] which are as follows,

$$P(\theta) = \frac{\Delta}{Q} \quad (2)$$

Where,

$$Q(E\gamma) = (CE_\gamma + D)Q_0(E_\gamma) \quad (3)$$

With,

$$Q_0(E_\gamma) = \frac{\alpha + 1}{\alpha^2 + \alpha + 1} \quad (4)$$

Where, $\alpha = E_\gamma / m_e c^2$. We used C = -0.0001 keV^{-1} and D = 0.446 in eq. 3 which were adapted from [8]. First, we verified that our Δ_{PDCO} ratios for intense and preset transitions which were matching well with the theoretical ones. Our data allowed us to determine the spin and parity of the levels, and those results were in good agreement with earlier research [1][2][3] and NNDC adopted level schemes .

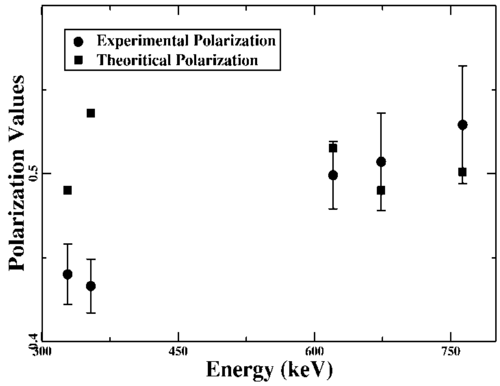

Fig.2: Theoretical Polarization vs experimentally calculated polarization for few pure transitions of ^{197}Hg.

In Fig.2 theoretical polarization and experimental polarization are included for the same transitions whose multipolarity and mixing ratios were previously known and calculated using the expressions of [8]. Because there were insufficient statistical data to calculate the Δ_{PDCO} values, the experimental and theoretical polarization did not overlap for the lower values of gamma transitions. The polarization values discovered in the current research are supported by the good overlap between the theoretical and experimental Polarization values for these conditions.

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