

# Experimental study on $^{192}\text{Tl}$

Snigdha Pal<sup>1,2,\*</sup>, G. Mukherjee<sup>1,2</sup>, S. S. Nayak<sup>1,2</sup>, S. Basu<sup>1,2</sup>, S. Panwar<sup>1,2</sup>,  
Suchorita Paul<sup>1,2</sup>, Sneha Das<sup>1,2</sup>, S. Chakraborty<sup>1</sup>, Soumik Bhattacharya<sup>1</sup>,  
S. Bhattacharyya<sup>1,2</sup>, A. Karmakar<sup>2,3</sup>, S. Basak<sup>1,2</sup>, A. Pal<sup>1,2</sup>, D. Kumar<sup>1,2</sup>,  
Saumanti Sadhukhan<sup>1,2</sup>, S. Roy<sup>1,2</sup>, R. Banik<sup>4</sup>, S. Das Gupta<sup>5</sup>,  
S. Rajbangshi<sup>6</sup>, R. Shil<sup>7</sup>, P. Pant<sup>1,2</sup>, S. Manna<sup>1,2</sup>, K. Banerjee<sup>1,2</sup>,  
Pankaj K. Giri<sup>8</sup>, S. Kundu<sup>8</sup>, A. Sharma<sup>8</sup>, R. Raut<sup>8</sup>, and S. S. Ghugre<sup>8</sup>

<sup>1</sup>Variable Energy Cyclotron Center, 1/AF Bidhannagar, Kolkata 700064, India

<sup>2</sup>Homi Bhabha National Institute, Anushaktinagar, Mumbai-400094, India

<sup>3</sup>Saha Institute of Nuclear Physics, 1/AF Bidhannagar, Kolkata 700064, India

<sup>4</sup>Institute of Engineering and Management, Saltlake, Kolkata-700091, India

<sup>5</sup>Victoria Institution (College), Kolkata, India

<sup>6</sup>Department of Physics, Presidency University, Kolkata 700043, India

<sup>7</sup>Department of Physics, Visva-Bharati, Santiniketan-731235, India and

<sup>8</sup>UGC-DAE CSR, Kolkata Centre, Kolkata 700098, India

## Introduction

The high-spin structures of the odd-odd Tl nuclei are governed by the high-j  $h_{9/2}$  and  $i_{13/2}$  orbitals [1–3]. In addition to a rotational band built on  $\pi h_{9/2} \otimes \nu i_{13/2}$  configuration, chiral doublet bands in  $^{194}\text{Tl}$  [3] and magnetic rotational (MR) bands in  $^{190}\text{Tl}$  [4] are also reported in odd-odd Tl nuclei in  $A \sim 190$  region. However, there is lack of data for the neutron deficient isotopes of odd-odd Tl nuclei. In  $^{192}\text{Tl}$ , several band structures are known but without proper spin-parity ( $J^\pi$ ) assignments [5]; also no detailed information of the level structures was reported. In the present work, the  $J^\pi$  of the levels are firmly established and the configuration of the bands are assigned.

## Experimental Details

The excited states of  $^{192}\text{Tl}$  were populated by  $^{181}\text{Ta}(^{16}\text{O}, 5n)^{192}\text{Tl}$  reaction with 142 MeV  $^{16}\text{O}$  beam, delivered from K-130 cyclotron at VECC, and a thick (25 mg/cm<sup>2</sup>) Ta foil as target. The INGA array with 11 clovers HPGe and 1 LEPS detectors was used to detect the prompt  $\gamma$  rays. The time-stamped  $\gamma - \gamma$  coincidence data were collected using PIXIE-16 based digital data acquisition system [6].

## Results and Discussion

The data sorting and analysis were performed using BiNDAS [7] and Radware [8] packages.  $\gamma - \gamma$  symmetric (for coincidence relation) and asymmetric (for DCO ratio and polarization asymmetry measurement) matrices were created. A partial level scheme, obtained from the present work, is shown in Fig. 1. The reported bands [5] are confirmed in this work. Representative gated spectra are shown in Fig. 2. The  $J^\pi$  of several states and thereby, the bands, have been unambiguously assigned, based on  $R_{\text{DCO}}$  and  $\Delta_{\text{asym}}$  measurements. The configuration of the bands could be determined, for the first time, following these assignments. The  $R_{\text{DCO}}$  and  $\Delta_{\text{asym}}$  values of a few crucial  $\gamma$ -transitions are given in table I. The bands B1 and B2a were reported with tentative band heads  $8^-$  and  $7^+$  [5], respectively. In the present work, the nature of the 135 keV  $\gamma$  comes out to be  $\Delta J = 1$  dipole type, making the spin of the 1302 keV level as  $11$ , instead of  $10^+$ , tentatively assigned earlier. Also, the comparison of the measured and calculated polarization (P) and  $R_{\text{DCO}}$  values (Fig.3(b)) gives E1 nature for the 870 keV  $\gamma$ . These results make the band head of B1 as  $9^-$  instead of earlier assignment of  $8^-$ . The  $9^-$  assignment fits nicely the energy-spin systematics of the first 3 states of B1 with the other odd-odd Tl isotopes (Fig.3(a)). Similarly, the

\*Electronic address: snigdha.pal@vecc.gov.in

