High spin structure of ^{200,201}Tl isotopes

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Introduction

The heavy Tl isotopes in mass 190-200 region with one proton hole and a few neutron holes in Z=82 and N=126 shells are expected to show various structural changes as a function of angular momentum due to the strong interplay of single particle and collective degrees of freedom. Thus, the high spin states of Tl isotopes are fertile testing ground for different nuclear models and the underlying angular momentum coupling schemes. There is also a prediction of Chiral partner bands in mass 190 region. In even mass Tl isotopes, a two-quasiparticle rotational band structure, interpreted as $\pi h_{9/2} \otimes \nu i_{13/2}$, has been reported [1-2]. For the neighbouring odd-A isotopes of Tl, a rotational band built on $9/2^-$ isomeric level exists in $^{191-201}$Tl isotopes [3-4]. Very little data on high spin states are available for heavier Tl isotopes. The spectroscopy of ^{200}Tl was studied earlier [5] with two Ge(Li) detectors, in which the main yrast band was observed, but with an ambiguity in bandhead energy, mainly due to an unobserved low energy transition. In the next odd-A Tl isotope, i.e., ^{201}Tl, a few members of a rotational band built on $9/2^-$ isomeric state was observed earlier from deuteron induced fusion reaction [6]. The aim of the present experiment was to extend the known yrast band structures to higher spin states and search for other non-yrast side bands to carry out complete spectroscopy of ^{200,201}Tl.

Experimental details and Analysis

The excited states in ^{200,201}Tl have been populated via the fusion evaporation reaction ^{198}Pt(^{7}Li,xn) at the beam energy of 45 MeV obtained from Pelletron LINAC Facility, Mumbai, India. The gamma transitions from the excited states of above nuclei have been detected using 15 Clover detectors of Indian National Gamma Array, presently setup at TIFR, Mumbai. The target was a 1.3 mg/cm^2 enriched ^{198}Pt self supporting foil. The clover detectors were arranged in six angles with two clovers each at ±40° and ±65° while four clovers were at 90° and three were at -23°. A digital data acquisition system having digitization rate of 100 MHz, implemented for the first time with INGA, was used. The time stamped, trigger-less data was obtained with the condition of γ-γ coincidence, ensured at Clover level. From the raw data, γ-γ matrices and γ-γ-γ cubes, with various conditions of time window, were made. For the DCO analysis a γ-γ matrix with -23^o detectors and 90^o detectors has been generated. IPDCO values analysis to assign the type of transition is in progress.

Results

From the coincidence analysis of the γ-γ matrix and γ-γ-γ cube, a number of new transitions in ^{200,201}Tl could be observed, which indicates a significant extension of the main two-quasiparticle $\pi h_{11/2} \otimes \nu i_{13/2}$ yrast band in ^{200}Tl and the band built on $9/2^-$ isomeric level in ^{201}Tl. Fig.1(a) shows a coincidence spectrum corresponding to a gate on a known transition (229-keV) of the yrast band in ^{200}Tl. Double gated spectrum of the known 229-keV transition and two new transitions, viz., 192-keV and 1076-keV, obtained from the γ-γ-γ cube are shown in Fig.1(b) and 1(c). This shows the clear identification of the transitions in ^{200}Tl. The DCO ratio analysis also identified some of the crossover E2 transitions of the band with M1 cascade transitions. Fig.2(a) and 2(b) shows double gates on lowest transition of the band developed on $9/2^-$ state and other two higher members of the band, of which the 785 keV was only tentatively placed in earlier work. The different transitions in two gates clearly indicate the extension of two branches at higher spins.

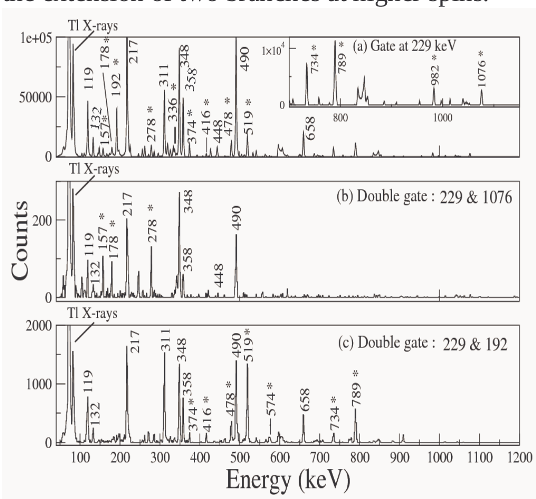

Fig. 1 (a) Spectrum corresponding to a gate on a 229-keV of the negative parity band in ^{200}Tl. The new transitions are marked as "*". The expanded higher energy part is shown in the inset. Double gated spectrum of 229-keV & new transitions (b) 1076- and (c) 192-keV, respectively.

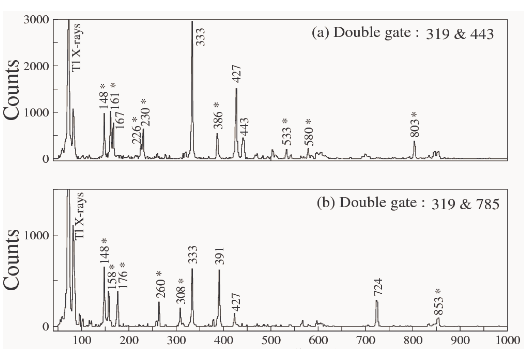

Fig. 2 Coincidence spectra corresponding to the double gate of 319- & 443-keV and 319- & 785-keV transitions in ^{201}Tl. The new transitions are marked as "*".

Discussion

The main yrast band of ^{200}Tl is based on the $\pi h_{9/2}\otimes\nu i^{-1}_{13/2}$ configuration. Total Routhian Surface (TRS) calculations have been performed for this band with Woods-Saxon potential and pairing interaction using the Strutinsky shell correction method. The results of the calculations are given in Fig. 3. Two minima occur, one at near oblate shape (γ = -64^o) and the other at triaxial shape (γ = 48^o), with similar deformation of β_2 = 0.12. This suggests an oblate deformation for the yrast band, similar ti lighter isotopes. The other minimum with sizable γ-deformation indicates a possibility to observe Chiral partner bands, similar to ^{198}Tl [2]. For odd-A Tl isotopes, the symmetric rotor-plus-particle model has been shown to successfully describe the lower members of the band built on $9/2^-$ state. Such calculations have been initiated including the higher spin states.

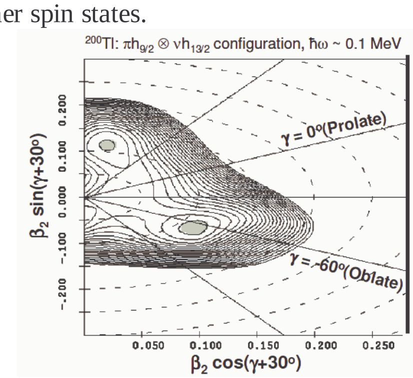

Fig. 3 TRS plot for the $\pi h_{9/2}\otimes\nu i_{13/2}$ configuration of ^{200}Tl. The contours are 150 keV apart.

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