Spectroscopy of ^{201}Tl isotope

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Introduction

Variation of the nuclear deformation as a function of angular momentum for chain of Tl isotopes makes them interesting candidates to test the predictions of different theoretical models involving the coupling of core and single particle degrees of freedom. Tl isotopes with one proton hole in Z=82 shell and a few neutron hole in N=126 shell are expected to have spherical structure at lower excitation while the deformation sets in for higher spin states. For odd A Tl isotopes ground state spin is ½, and the $\pi h_{9/2}$ orbital above the Z=82 shell closure is accessible by the odd proton for oblate deformation. A rotational band build on $9/2^-$ isomeric level have been reported for $^{195\text{-}199}$Tl isotopes [1, 2] . In case of ^{201}Tl, a few members of the $9/2^-$ rotational band have been observed from deuteron induced fusion reaction [3]. Rotational band based on the intruder $\pi i_{13/2}$ orbital have been observed in some of the lighter odd-mass Tl nuclei and recently in ^{197}Tl [4]. The aim of the present work is to extend the band structures of ^{201}Tl to higher spin states.

Experimental details and Analysis

The high spin states in ^{201}Tl were excited by the fusion-evaporation reaction ^{198}Pt(^{7}Li,4n) using 45 MeV beam from Pelletron LINAC facility, Mumbai, India. The INGA array was used to detect the γ–rays. The experimental details are given in Ref. [5]. γ-γ matrices and γ-γ-γ cubes, with various conditions of time window, were generated from the time stamped data collected using digital data acquisition system [6]. For the DCO analysis a γ-γ matrix, with X-axis containing the data from the -23° detectors and Y-axis containing the data from the 90° detectors has been generated. The IPDCO asymmetry parameter was deduced from the parallel and perpendicular scattering components in 90° clover detectors. The correction due to geometrical asymmetry of the array was obtained as 1.066 using the standard sources.

Results

From the coincidence analysis of the γ-γ matrix and γ-γ-γ cube, 29 new transitions in ^{201}Tl have been observed and most of them are placed in the level scheme unambiguously. Spin and parity of the new levels are assigned from the DCO and IPDCO analysis.

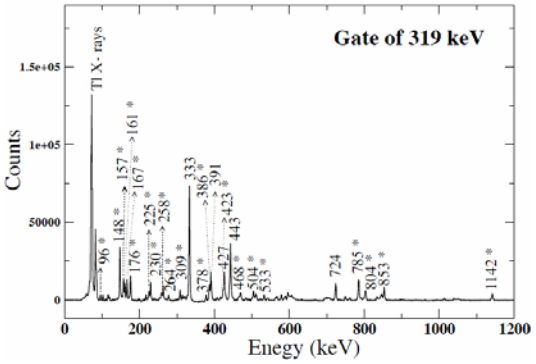

Fig.1 : Coincidence spectrum of 319 keV gate. The new transitions are marked as '*'.

A representative coincidence spectrum corresponding to a gate at 319 keV, obtained from γ-γ matrix, is shown in Fig.1. Tentative transitions of 167, 427, 468, 749 and 785 - keV, assigned in previous work [3] have been

confirmed from the present work. The deduced DCO and IPDCO ratios are plotted in Fig.2, from which two groups of transitions, either electric or magnetic type and of dipole or quadrupole character could be identified. Fig.3 represents the proposed level scheme of ^{201}Tl which indicates a significant extension of the main band built on $9/2^-$ isomeric level as well as development of other band structures.

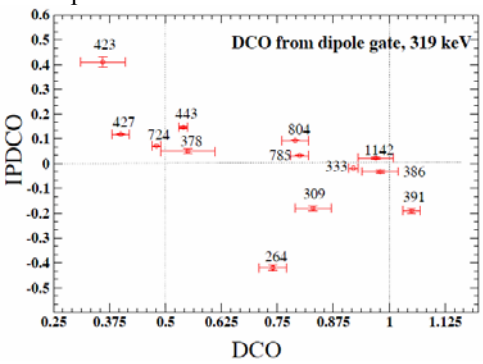

Fig.2 : The DCO ratio of some of the new transitions in 319 keV (dipole) gate and their corresponding IPDCO values are plotted.

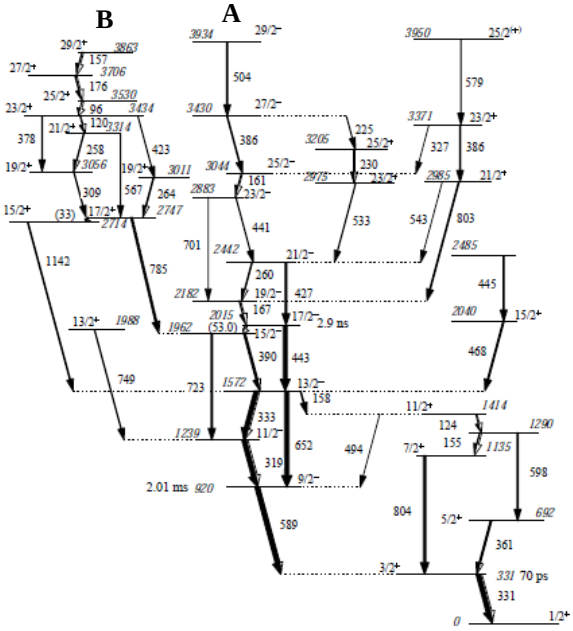

Fig.3 : Proposed level scheme of ^{201}Tl

Discussion

The band A based on $\pi h_{9/2}$ state has been interpreted earlier [3] as an oblate band up to $15/2^-$ state. In the present work this sequence is extended to higher spin members. The alignment as a function of rotational frequency is plotted in Fig.4 for the bands A and B. Two band crossings at ~ 0.27 and ~0.33 MeV are seen in band A. The observed gain in alignment shows that the $\pi h_{9/2}$ band is crossed by a three quasiparticle ($\pi h_{9/2}^{-1} \otimes \nu f_{5/2}^{-2}$) and subsequently by a five quasiparticle ($\pi h_{9/2}^{-1} \otimes \nu f_{5/2}^{-2} p_{3/2}^{-2}$) configurations. Two band crossings are also seen for band B in Fig.4. A $13/2^+$ state at 1988 keV, decays to band A by an E1 transition, corresponding to $\pi i_{13/2}$ orbital has been observed for the first time in ^{201}Tl. Another important feature in the level scheme of ^{201}Tl is the presence of several E1 transitions connected to other positive parity sequences indicating excitation of neutrons in $i_{13/2}$ and either in $f_{5/2}$ or in $p_{3/2}$ orbital, as has been observed in case of ^{200}Hg core nucleus [7]. A detailed discussion on several bands observed in ^{201}Tl will be presented in the symposium.

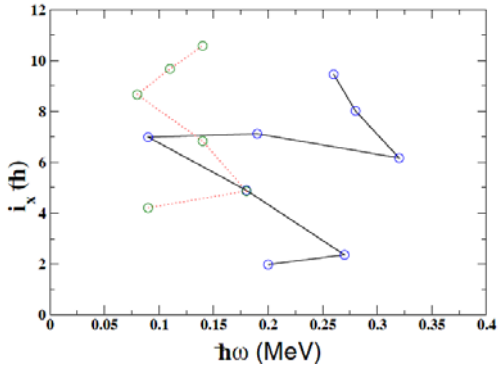

Fig.4 : Alignment plot for band A (solid curve) and band B (dotted curve)

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