High spin gamma ray spectroscopy of ^{196}Tl

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Introduction

For the odd-odd Thalium nuclei (Z = 81), the proton Fermi level lies near $2s_{1/2}$ orbital below the Z = 82 spherical shell closure and for small deformation, $\pi h_{9/2}$ Nilsson orbital intrudes near the proton Fermi level. In A$\sim$190 region, the neutron Fermi level lies near the top of $\nu i_{13/2}$ orbital. Rotational bands based on $\pi h_{9/2} \otimes \nu i_{13/2}$ configuration has been observed in the neutron deficient odd-odd Tl isotopes in A = 190 region. Recently, some works on ^{194}Tl and ^{196}Tl have been reported [1–3] in which MR band as well as doubly degenerate bands due to chirality based on this configuration have been claimed. However, the high spin states in ^{196}Tl were not well studied until now.

Experiment and Data Analysis

In our study, the high spin excited states in ^{196}Tl has been populated through the ^{185,187}Re(^{13}C, xn)^{196}Tl fusion evaporation reaction at a beam energy of 75 MeV from BARC-TIFR Pelletron, Mumbai. INGA with 15 Compton suppressed HPGe clover detectors was used to detect the γ-rays. The details of the experimental set up are given in Ref. [1].

A digital data acquisition (DDAQ) system [4] was used for the in-beam coincidence data collection in this experiment. The γ-γ matrix and γ-γ-γ cube have been formed and analyzed by RADWARE and MARCOS codes. Coincidence relation and intensity balance have been used for constructing the level scheme of ^{196}Tl. For spin and parity assignment of the nuclear states, Directional Correlation from Oriented states (DCO) and Integrated Polarisation Directional Correlation from Oriented states (IPDCO) methods have been used. DCO matrix was formed using 90^o and -23^o detectors. The four 90^o detectors were used for IPDCO matrix.

Results and Discussion

The old level scheme of ^{196}Tl [5] has been extended with the observation and placement of 48 new γ-transitions and the earlier reported tentative γ-transitions have also been confirmed. The ground state band, based on $\pi h_{9/2} \otimes \nu i_{13/2}$ configuration, has been extended beyond band crossing up to $\sim$5.2 MeV of excitation energy and $(23^-)\hbar$ spin. The previously observed two side bands have also been extended. The DCO ratios and IPDCO values for some of the transitions in ^{196}Tl along with those of three transitions in ^{194}Tl, for which type and multipolarity were known, are shown in Fig.1. The DCO ratios have been obtained by gating on stretched E2 transitions

The systematic study of alignment and signature splitting of ^{196}Tl for different bands have been compared with its neighbouring odd-odd Tl isotopes. All of them show

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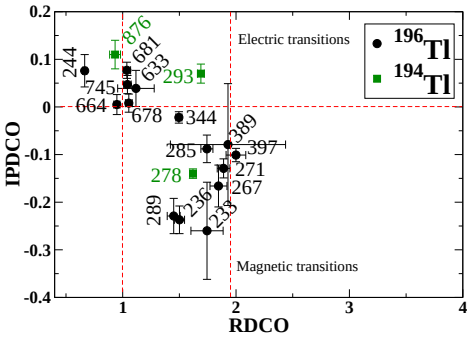

FIG. 1: R_{DCO} and IPDCO values for different γ-transitions in ^{196}Tl (solid circle) and three known γ-transitions in ^{194}Tl (solid sqaure). R_{DCO} values have been obtained by gating on stretched E2 transition.

signature inversion around 11 $\hbar$ and similar band crossing frequencies for the ground state bands. The comparison of experimental B(M1)/B(E2) ratios as a function of spin of the ground state rotational band of ^{196}Tl, along with the neighbouring odd-odd Tl isotopes (A = 190 - 200), has been shown in Fig.2. The systematic trend of the experimental B(M1)/B(E2) ratios for all the odd-odd Tl isotopes before backbending are similar. The calculated B(M1)/B(E2) ratios (solid line in Fig.2) from semiclassical Donau-Frauendorf model [6], considering the ground state band configuration for ^{196}Tl, match well with the experimental B(M1)/B(E2) ratios.

Conclusion

The high spin excited states in ^{196}Tl have been studied by ^{185,187}Re(^{13}C, xn)^{196}Tl fusion evaporation reaction using INGA facility. An extended and modified level scheme with 48 new γ-transitions have been proposed in the present work. DCO ratios and IPDCO values for spin and parity assignment of nuclear states have been obtained for the γ-transitions. The systematic study of alignment, signature splitting and experimental B(M1)/B(E2) ratios of ^{196}Tl along with neighbouring odd-odd Tl isotopes has been performed. The experimental B(M1)/B(E2) ra-

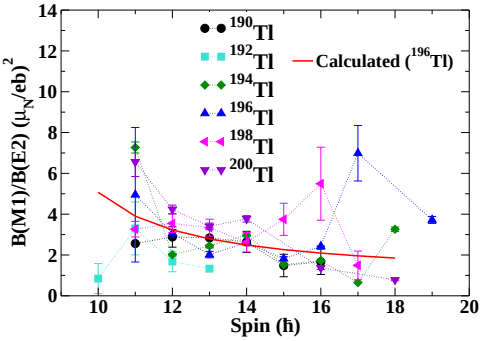

FIG. 2: Experimental B(M1)/B(E2) values as a function of spin of $\pi h_{9/2} \otimes \nu i_{13/2}$ rotational bands in odd-odd Tl isotopes. The solid line is the calculated B(M1)/B(E2) from semiclassical Donau-Frauendorf model for ^{196}Tl for the same configuration.

tios match well with Donau-Frauendorf model calculation. However, we have not observed any indication of chirality in ^{196}Tl in the present work.

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