Study of positive parity band in ^{190}Tl

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Introduction

Study of nuclei near proton shell closure Z=82 is important as interplay between different shapes has been observed in this region. Many experimental investigations have been carried out on odd-odd thalium nuclei in recent times [1-3]. For odd-odd Tl($Z = 81$) nuclei, proton Fermi level lies near $2s_{1/2}$, but intuder $h_{9/2}$ and $i_{13/2}$ Nilsson orbitals come down in energy at moderate deformation and neutron Fermi level lies above N=100, semi magic shell closure. Different negative and positive parity bands, based on the intruder configurations have been observed in odd-odd Tl nuclei [1-3] in this region.

Negative parity rotational bands based on $\pi h_{9/2} \otimes \nu i_{13/2}$ configuration are reported in ^{190,192}Tl. However, there are several other positive and negative parity band structures in ^{192}Tl, which are not known in ^{190}Tl [4]. In our previous work in ^{190}Tl [5] we have observed a non-yrast negative parity band at lower excitation than in ^{192}Tl and established the spin parity of the states, but the positive parity structure remain illusive in this N = 109 isotope. We present here the first observation of a positive parity band structure in ^{190}Tl, which is found to be much different compared to ^{192}Tl.

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Experimental Details

The high spin states of ^{190}Tl was populated using the fusion-evaporation reaction ^{165}Ho(^{30}Si, 5n). The 157 MeV, ^{30}Si beam was obtained from the BARC-TIFR Pelletron LINAC facility in Mumbai, India and INGA was used to detect the prompt γ-rays. Other experimental details can be found in Ref.[5].

Analysis and Result

Details of data analysis can be found in Ref.[5]. A partial scheme of ^{190}Tl is shown in Fig. [1], which shows a newly identified band (B2). It decays to the ground state band B1 by three transitions, 1095, 942 and 749 keV. The gated spectra in Fig.[2] shows the new γ transitions. The DCO (Directional Correlation from Oriented states) ratio and integrated polarization asymmetry (IPDCO) ratio of the 1095 keV and 942 keV γ-rays confirm the positive parity of the band B2.

The dipole nature of these transitions are apparent from the DCO ratio measurement of 1095 keV ($R_{DCO} = 0.95(7)$) and 942 keV ($R_{DCO} = 1.01(9)$) connecting γ-rays gated by 272 keV (M1+E2) transition with measured mixing ratio of $\delta = 0.076$ [5]. With polarisation assymetry $\Delta_{IPDCO} > 0$, these connecting transitions are confirmed to be of electric type (E1), this in turns establishes the spin parity of the band B2 with 12^+ as bandhead.

It is suggested to be a MR band. In MR band, level energy (E) and spin (I) follow the pattern (E-E_0) $\propto A(I - I_0)^2$, where E_0 and I_0

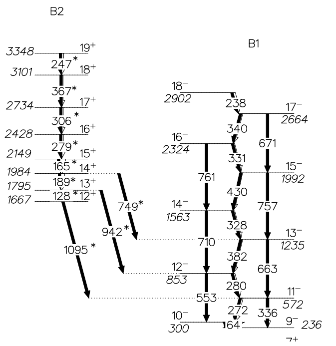

FIG. 1: Partial level scheme of ^{190}Tl.The new γ rays are indicated by asterisks.

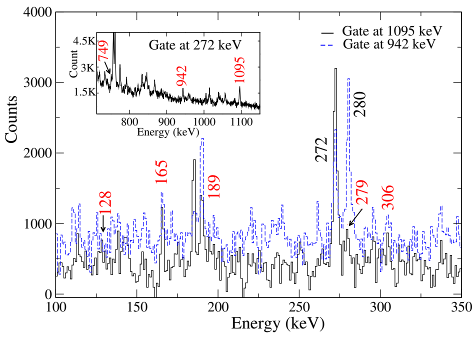

FIG. 2: Coincidence γ-ray spectra gated by 1095 keV, 942 keV and 272 keV(inset).

are bandhead energy and spin, respectively. In Fig. [3], the plot of (E-E_0) vs. $(I-I_0)^2$ for B2 band is shown and the fitted curve is in good agreement with the experimental points. Also, the last two points lie on a different straight line, indicating a different configuration for these states. In alignment (i_x) vs rotational frequency ($\hbar\omega$) plot (inset in fig.3) a back-bending phenomenon is observed which suggests that particle alignment takes place at about the rotational frequency of $\hbar\omega \sim 0.26$ MeV. This is in sharp contrast to the rotational band observed for the positive parity band in ^{192}Tl [1], indicating smaller deformation for the positive parity band in ^{190}Tl.

Summary

Excited states of ^{190}Tl has ben studied using heavy ion fusion evaporation reaction. A new positive parity band is observed for the first time in this nucleus. Further analysis is going on and final results will be presented at the sympossium.

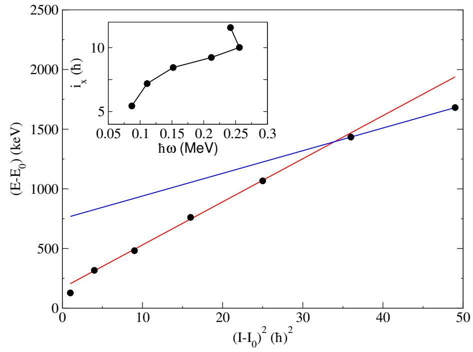

FIG. 3: Relative energy (E) vs square of spin (I) curve for band B2 built on the 12^+ bandhead. E_0 and I_0 are the bandhead energy and spin, respectively. Experimental alignment (i_x) as a function of rotational frequency ($\hbar\omega$) for band B2 is shown (in inset) (Harris parameters are chosen to be $J_0 = 8\hbar^2$ MeV^{-1} and $J_1 = 40\hbar^4$ MeV^{-3}).

Acknowledgments

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