HIGH SPIN STATES IN ^{194}Tl: STRUCTURAL CHANGE IN $\pi h_{9/2} \otimes \nu i_{13/2}$ CONFIGURATION IN Tl ISOTOPES ?

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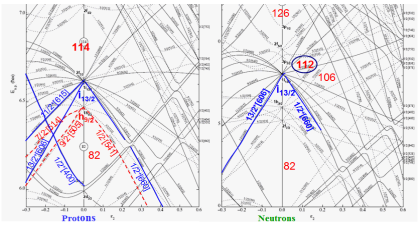
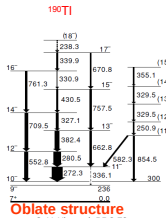
Structure of nuclei around Z ~ 82 ➔ A ~ 190



- Single particle structure
- Intruder strongly coupled and decoupled rotational bands
- Magnetic rotational bands
- Chiral doublet bands

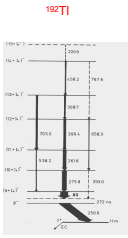
Rotational bands based on $\pi h_{9/2} \otimes \nu i_{13/2}$ configuration in the odd-odd Tl isotopes



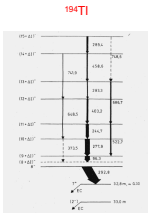
Oblate structure

C. Y. Xie et al, PRC **72**, 044302(2005)

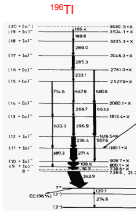
β_2 ~ 0.17, γ = -60° from TRS calculations



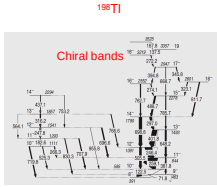
A.J. Kreiner et al, PRC **21**, 2205 (1980).



A.J. Kreiner et al, PRC **20**, 2205 (1979).



A.J. Kreiner et al, NPA **308**, 147 (1978).



E.A.Lawrie et al, PRC **78**, (R) 021305 (2008)

in order to understand the possible transition from oblate to triaxial shape induced by the change in the neutron Fermi surface of Tl nuclei, it is important to characterize the $\pi h_{9/2} \otimes \nu i_{13/2}$ band systematically in an isotopic chain.

γ = 44° from particle rotor calculations. Triaxial structure.

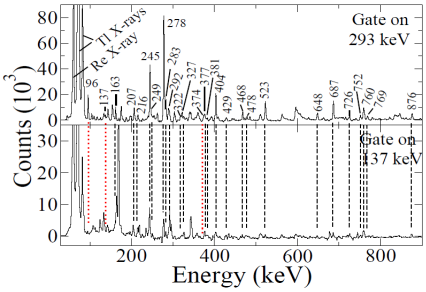
Experiment

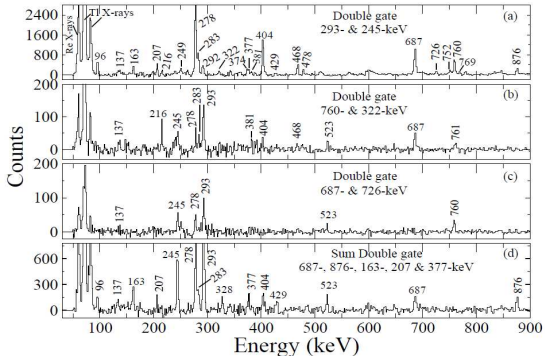
Indian National Gamma Array (INGA) at TIFR

^{13}C + ^{185,187}Re ➔ ^{194}Tl + xn at 75 MeV (from 14-UD Pelletron)

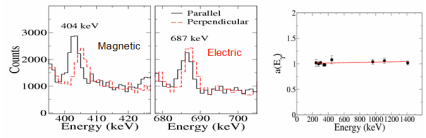
Detectors: 15 Compton Suppressed Clover Ge Detectors.

$\gamma\gamma$coincidence matrix, DCO, Polarization.





Polarization measurements



Clover

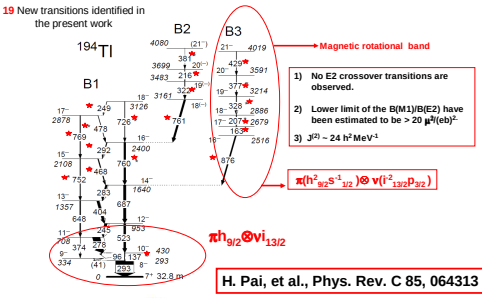
$$A(E_\gamma) = \frac{a(E_\gamma)N_\perp - N_\parallel}{a(E_\gamma)N_\perp + N_\parallel}$$

$A(E_\gamma)$ = Positive ➔ Electric type
= Negative ➔ Magnetic type

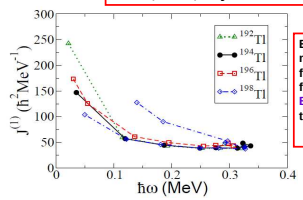
$$a(E_\gamma) = \frac{N_\parallel(\text{Source})}{N_\perp(\text{Source})} = \text{Correction factor} = 1.004(1)$$

$N_\perp$ and $N_\parallel$ are perpendicular and parallel counts (scattering), respectively.

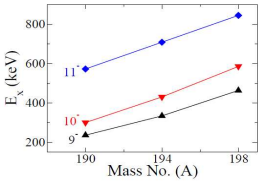
Level structure of ^{194}Tl: from the present work



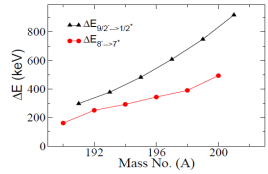
H. Pai, et al., Phys. Rev. C 85, 064313 (2012).



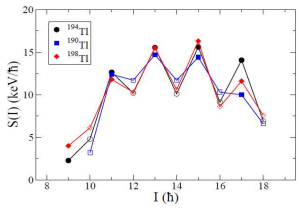
Experimental values of the moment of inertia $J^{(1)}$ as a function of the rotational frequency ($\hbar\omega$) for the band B1 in ^{194}Tl are compared with the similar bands in ^{192,196,198}Tl.



Excitation energies of the 9⁻, 10⁻ and 11⁻ states in odd-odd isotopes of Tl as a function of mass No. A.



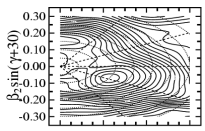
Systematic of the energy difference between the 1/2⁺ & the 9/2⁻ states ($\Delta E_{9/2^- \to 1/2^+}$) in odd-A Tl and between the 8⁻ & the 7⁺ states ($\Delta E_{8^- \to 7^+}$) in odd-odd Tl nuclei as a function of mass no. A.



The staggering, S(I) = [E(I) - E(I-1)]/2I, plots as a function of spin (I) for the negative parity yrast bands in ^{194}Tl along with those in ^{190,198}Tl.

Total Routhian Surface (TRS) Calculations for $\pi h_{9/2} \otimes \nu i_{13/2}$ configuration

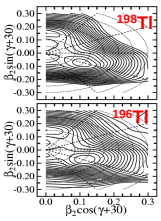
^{194}Tl



β_2 ~ 0.15, γ = -57° for ^{194}Tl

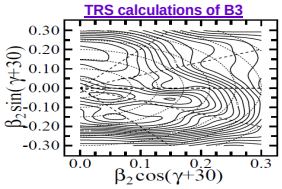
β_2 ~ 0.15, γ = -57° for ^{196}Tl

β_2 ~ 0.15, γ = -58° for ^{198}Tl



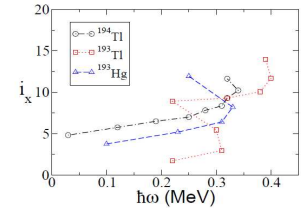
- Configuration dependent Hartee-Fock-Bogoliubov code [1].
- Deformed Wood-Saxon potential, BCS Pairing.
- Total energies calculated in the β_2 - γ plane (minimized in β_4).

TRS calculations of B3



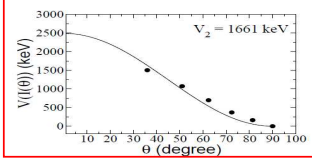
Band B3: $\pi(h^2_{9/2}s^{-1}_{1/2}) \otimes \nu(i^{-2}_{13/2}p_{3/2})$

β_2 ~ 0.06, γ = -80°



i_x (alignments) vs. $\hbar\omega$ (rotational frequency) plot for the band B1 in ^{194}Tl, $\pi h_{9/2}$ band in ^{193}Tl and $\nu i_{13/2}$ band in ^{193}Hg.

Semiclassical calculation of B3



$J\pi$ = 8.5 and j_ν = 13.5

$V(I(\theta)) = E_I - E_b = (3/2)V_2 \cos^2\theta_I$ [2, 3, 4]

E_I = energy of the level with angular momentum I.

E_b = Band head energy.

θ_I = corresponding Shears angle.

V_2 = the strength of interaction between the blades of the shear.

V_2 = 332-keV per particle-hole pair

Summary

- An improved level scheme of ^{194}Tl (Z = 81) up to 4.1 MeV excitation has been established with 19 new γ-ray transitions. J^π assignments have been done.
- The uncertainties in the excitation energies and the spins in this band have been removed.
- Two new side bands (B2 and B3) have been observed in the present work.
- Band (B1) has been extended just beyond the band crossing.
- Band (B3) has been interpreted as an MR band.
- TRS calculations have been performed for $\pi h_{9/2} \otimes \nu i_{13/2}$ configuration and band B3.
- In the present work no indication of chiral doublet band structure in ^{194}Tl, unlike the one reported for ^{198}Tl, was observed.

Acknowledgements

- The help of all the collaborators of the above works, are gratefully acknowledged.
- The efforts of the operators and support staff at BARC-TIFR Pelletron and all the participating group in the CLOVER Array Collaboration are acknowledged.

References

[1] W. Nazarewicz et al., Nucl. Phys. **A 512** 61 (1990).

[2] A. O. Macchiavelli et al., Phys. Rev. **C 57 R**1073 (1998).

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[4] H. Hubel, Prog. Part. Nucl. Phys. **54** 1 (2005).