



Influence of the vi_{13/2} orbital on the structure of ¹⁹⁷Tl & ¹⁸⁷Os nuclei

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Outline

Introduction

Active single particle orbitals in mass A~180-200 region
Motivation behind the study of ¹⁹⁷Tl, ¹⁸⁷Os
Different modes of excitation in ¹⁹⁷Tl &¹⁸⁷Os based on vi_{13/2} orbital

Summary

Introduction

- The neutron rich nuclei with proton and/or neutron numbers close to the shell closures are of paramount interest to understand the r-process nuclear synthesis.
- Observed r-process abundance peak at around A~ 195 originates from the waiting point nuclei at N=126 neutron magic number and the nuclear structure properties are important to understand nuclear synthesis.
- On the above context, neutron rich Os, and Ir isotopes are important to study.
- Structure of near shell closure nuclei is important to understand the r –process nuclear synthesis.





The Nucleus





Neutron (N)

Motivations

- The isotopes, near the stability line of heavier nuclei near Z=82, mostly produced as end products of the β decay of the rprocess elements and the slow neutron capture.
- The active high j single particle orbitals like $\pi h_{11/2}$, $\pi h_{9/2}$, $\nu h_{9/2}$, $\nu i_{13/2}$ etc. control the nuclear structural properties in A ~ 190 region.
- Different novel excitations like chiral band, gamma band, wobbling band are expected in these nuclei due to the interplay of single particle and collective degrees of freedom.
- Recently we have studied the excited states in ¹⁹⁷Tl, an odd proton system and ¹⁸⁷Os, an odd neutron system.
- These odd A systems are ideal laboratory to understand the effects of the single particle orbitals on the structure of nuclei.

Nilsson Diagrams



197**T**

- In the isotopic chain of Tl, ¹⁹⁷Tl nucleus lie in between moderately deformed lighter Tl isotopes and very less deformed (A>199) Tl isotopes.
- Therefore, the structural information of ¹⁹⁷Tl is very important to understand the shape evolution of Tl with neutron number.
- Neutron deficient isotopes show shape co-existence near ground state e.g. in ^{187,189}Tl.
- Recently, doubly degenerate chiral bands have been observed in ^{194,195}Tl.





- Os nuclei are the transitional nuclei lie between prolate deformed Hf and spherical Pb.
- Os nuclei are known to be γ -soft, e.g-^{185,186}Os.
- γ -band observed in ¹⁸⁶Os.
- In ¹⁸⁷Os (N==111), the neutron Fermi level lies in the mid upper region of $vi_{13/2}$ orbital.
- Coupling of odd-neutron in $vi_{13/2}$ with the γ -band ?



Experimental details

197**T**

VENUS at VECC:

150

000

Reaction: ¹⁹⁷Au(⁴He,4n)¹⁹⁷Tl at 50 MeV from K=130 cyclotron at VECC Kolkata.

300

- Detector: <u>VECC Nuclear Spectroscopy</u> (VENUS) array with six Clover HPGe.
- Target: Au target of thickness 5mg/cm²
- Data Acquisition: VME based data acquisition system was used.



- Reaction: ¹⁸⁶W(⁴He,3n)¹⁸⁷Os at 36 MeV from K-130 cyclotron at VECC Kolkata.
- Detector: Indian National Gamma Array (INGA) Seven CLOVER and one LEPS
- Target: A stack of three ¹⁸⁶W foils each 300µg/cm² thick on a 20µg/cm² ¹²C backing.
- Data Acquisition: 2 fold coincidence data were recorded using PIXIE -16 digitizer based system of UGC-DAE-CSR, Kolkata.

New level scheme of ¹⁹⁷Tl

28 new γ transitions



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Geometrical representation of different band structures



Discussions on 3 & 5 –qp magnetic rotational band



MR BAND (3-qp & 5-qp)

• Input parameters used for SPAC





Band D

Anomalous signature splitting in high Ω orbital (Band D)



- * The band D, based on high-Ω v11/2⁺[615] configuration, has been extended up to particle alignment and shows large signature splitting similar to ¹⁸⁵Os.
- * γ-softness may be responsible for the anomalous signature splitting of band D.







1 & 2 γ phonon bands



Summary

- 3- and 5-qp bands in ¹⁹⁷Tl are MR in nature in contrast to chiral doublet bands in ¹⁹⁵Tl. This implies that as neutron number moves away from $i_{13/2}$ orbital in ¹⁹⁷Tl (N = 116), the particle-hole coupling with the core attains a planar, tilted-axis geometry.
- A new level scheme of ¹⁸⁷Os, much improved compared to the known one, has been proposed which reveals many interesting features of the bands built on different single-particle configurations (including band crossings).
- Bands corresponding to the coupling of $vi_{13/2}$ with the 1-phonon and 2-phonon quanta of the γ -band in ¹⁸⁶Os have been identified.
- Detailed analysis of ¹⁸⁷Os is in progress.

Collaborating institutes

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- UGC, DAE, CSR, Kolkata
- Presidency College, Kolkata
- GANIL, France

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