Oblate deformed band structures in ^{199}Tl

Manu Thulaseedharan, S.G. Wahid, Saket Suman, and S.K. Tandel*
UM-DAE Centre for Excellence in Basic Sciences,
University of Mumbai, Mumbai - 400098

Introduction

Thallium ($Z = 81$) isotopes, having one proton hole with respect to lead ($Z = 82$), exhibit a variety of phenomena. These range from well-deformed rotational bands in proton-rich isotopes to superdeformation at high spin and possible chiral bands. In the region of isotopes with $A \approx 200$, collective and intrinsic modes of generating angular momentum compete leading to excited states with varying contributions from both mechanisms. The nucleus ^{199}Tl lies in this region of transition with excited states having been established only up to 33/2 $\hbar$ from two recent experiments [1, 2]. It is of interest to explore this competition between intrinsic and collective modes at high spin and also the shape evolution.

Experiment

Previous work on ^{199}Tl led to the identification of a metastable state with a half-life of 28.4 ms [3, 4]. Further measurements with ^{7}Li and alpha beams [1, 2] resulted in the establishment of levels up to a moderate spin of 33/2 $\hbar$. Due to the inaccessibility of ^{199}Tl for population in fusion-evaporation reactions with considerably heavy-ion beams, the high spin structure remains unexplored. In the present work, excited states at quite high spin were populated through multi-nucleon transfer using a 1450-MeV ^{209}Bi beam from the ATLAS accelerator at Argonne National Laboratory incident on a ^{197}Au target. The Gammasphere detector array, comprising 100 HPGe detectors, was used to record three- or higher-fold γ-ray coincidence data. The data were sorted into a number of different histograms as described in our earlier work [5]. Most of the data analysis was performed using the Radware suite of programs [6].

Results and Discussion

The yrast, negative-parity sequence in ^{199}Tl has been considerably extended beyond spin 25 $\hbar$ with the inclusion of many new transitions with both $\Delta I = 1$ and $\Delta I = 2$ character (Fig. 1). The intensity of the former is found to be pronounced in comparison to the latter. Discontinuities in the regularity of the band structure are evident at two locations which are a possible indication of rotation-induced nucleon alignments, most likely from the decoupling of neutrons occupying the $i_{13/2}$ subshell. The branching ratios of $\Delta I = 1$ and $\Delta I = 2$ transitions decaying from a given level have been determined across the band and these yield important insights into the mechanism of angular momentum generation.

One of the sidebands has also been significantly extended and transitions in this sequence are found to be coincident with the higher-lying γ rays in the yrast, negative-parity band. Overall, the level scheme has been considerably extended in comparison to the previous measurements using relatively light ions [1, 2].

Various observables like moment of inertia, aligned angular momentum etc. have been extracted from the experimental data. Calculations, within the framework of the cranking model, using a modified oscillator potential, have been performed using the Ultimate Cranker code [7]. The decay scheme and the above results will be presented at the symposium.

Acknowledgments

We would like to thank P. Chowdhury, R. V. F. Janssens, M. P. Carpenter, F. G. Kondev, T. Lauritsen, C. J. Lister, D.Seweryniak

*Electronic address: `sktandel@gmail.com`

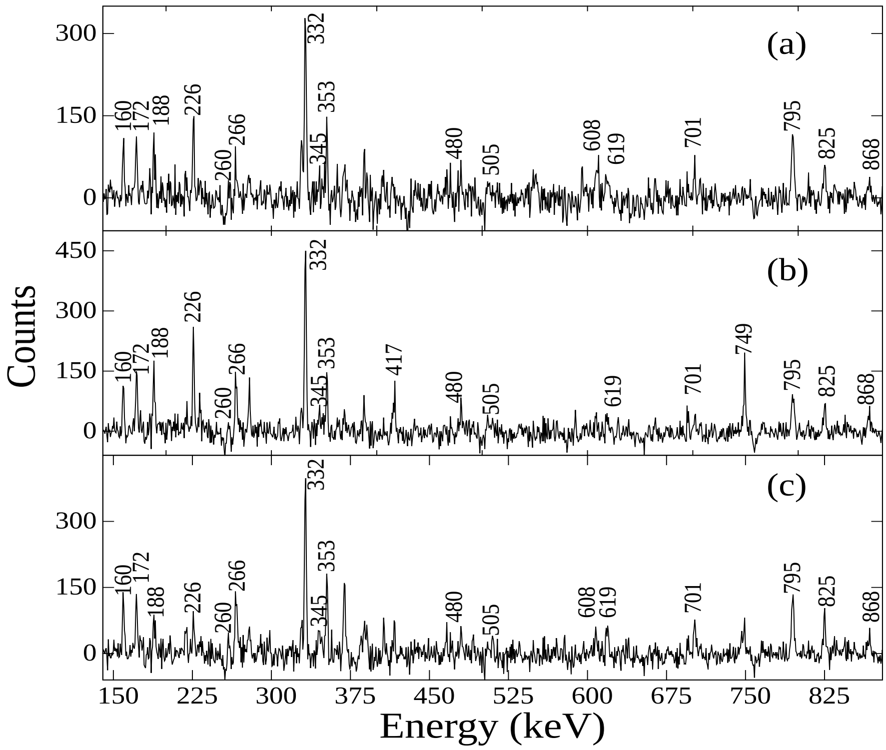

FIG. 1: Gated spectra from a three-dimensional symmetric histogram displaying transitions in ^{199}Tl.

and S. Zhu for their contributions during the experiment. Manu would like to thank the Department of Science and Technology, India, for support under the INSPIRE program. SGW acknowledges support under the DST-INSPIRE PhD Fellowship program (IF150098). Saket acknowledges support under the DST-INSPIRE PhD Fellowship program (IF170965). SKT would like to acknowledge support from the University Grants Commission, India, under the Faculty Recharge Programme.

References

[1] C.B. Li *et al.*, Phys. Rev. C 97, 034331 (2018).

[2] Soumik Bhattacharya *et al.*, Phys. Rev. C 98, 044311 (2018).

[3] R. M. Diamond and F. S. Stephens, Nucl. Phys. A **45**, 632 (1963).

[4] G. Andersson, E. Arbman, and B. Jung, Ark. Fys. **11**, 297 (1957).

[5] S. K. Tandel *et. al.*, Phys. Lett. B 750 (2015) 225.

[6] D.C. Radford, Nucl. Instr. Meth. A 361 (1995) 297.

[7] T. Bengtsson, Nucl. Phys. A 496 (1989) 56.