High-spin structure in odd-A Hg isotopes

D. Negi[1],* S. K. Tandel[1], A. Kumawat[1], and P. Chauhan[1]
[1] UM-DAE Centre for Excellence in Basic Sciences, Mumbai 400098, India

Introduction

The study of high-spin states in the mass region A = 190-200 is interesting due to the presence of varied structural features [1, 2]. In Hg isotopes, due to their oblate shape near the ground state, the Fermi level moves towards low-Ω $i_{13/2}$ neutron orbitals with increase in mass number. In lower mass odd-A isotopes, the positive-parity yrast states built on the $13/2^+$ spin isomer have been observed beyond the first backbending. Information on the nature of backbending is yet not available in ^{199}Hg, where the levels are known only up to the $I^\pi = 25/2^+$ level.

The nucleus ^{199}Hg may be considered to have a hole coupled to ^{200}Hg and is therefore expected to show similar properties in its excitation spectrum. In ^{200}Hg, there is a report [3] on the influence of $N = 120$ subshell gap on the excitation of rotation-aligned $i_{13/2}$ neutron quasiparticles, which results in a significant gap between the 10^+ and 8^+ levels in comparison to that observed in lower-mass isotopes. This effect also shows up in terms of a higher crossing frequency in this band. It is therefore important to have new information on high-spin states in ^{199}Hg.

Experimental details and data analysis

High spin states in mercury isotopes were populated via multinucleon transfer reactions between ^{197}Au and ^{209}Bi. The target was a gold foil of thickness 50 mg/cm^2 and the beam was ^{209}Bi with an energy of 1450 MeV. The experiment was performed using the Gammasphere facility at the Argonne National Laboratory, USA. Further details about the experiment and data analysis may be found in Ref.[4, 5].

Results and Discussion

The previously reported level schemes of ^{197}Hg and ^{199}Hg [6] have been verified and extended. Preliminary findings of this work have been reported earlier [7]. A search was performed for isomers in the nanosecond to sub-microsecond time range however no such states were evident.

A three $i_{13/2}$ neutron quasiparticle (qp) band in ^{199}Hg has been observed for the first time. Spin-parity assignment has been possible up to the $41/2^+$ level. A similar 3-qp band in ^{197}Hg has been extended up to the $49/2^+$ level. As mentioned earlier, based on the expectation of similar properties of excitations in ^{199}Hg and ^{200}Hg, a large gap in the excitation energy is observed between the $33/2^+$ and $25/2^+$ levels in ^{199}Hg. This is due to the effect of the $N = 120$ subshell gap.

A more detailed understanding of the yrast positive-parity bands in Hg isotopes in this mass region can be obtained from the systematic behavior of aligned angular momentum as a function of rotational frequency (Fig. 1). It is evident that the band crossing frequency on an average is higher for the odd-A isotopes ($\hbar\omega$ = 0.22 MeV) than the even-A isotopes ($\hbar\omega$ = 0.16 MeV). Within the cranking model, this observation can be explained by the blocking of the AB $i_{13/2}$ neutron crossing in odd-A isotopes. The crossing frequency in both ^{199}Hg and ^{200}Hg is higher than observed for the lower mass isotopes, also a consequence of the $N = 120$ subshell gap.

Cranking calculations have been performed for these nuclei using the Ultimate Cranker code. These calculations provide a satisfactory description of the experimental value of alignment frequency for the BC crossing and angular momentum gain of 10 $\hbar$. These cal-

*Electronic address: dinesh.negi@cbs.ac.in

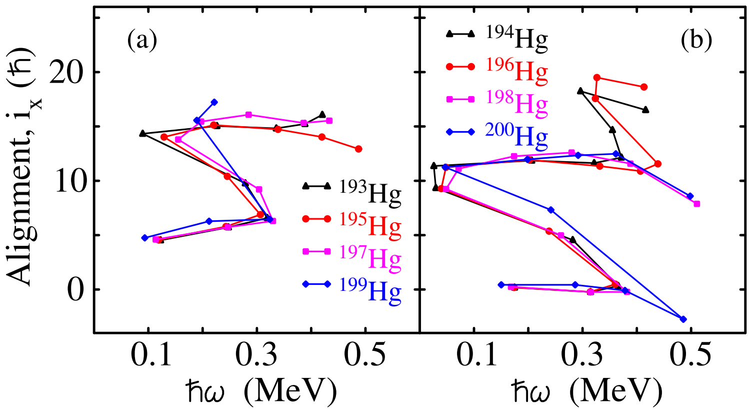

FIG. 1: Aligned angular momentum for the positive-parity bands in (a) ^{196,198,200}Hg and (b) ^{195,197,199}Hg.

culations also suggest a considerably higher $h_{11/2}$ proton crossing frequency.

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, and S. Zhu for their contributions during the experiment. SKT would like to acknowledge support from the University Grants Commission, India and the Board of Research in Nuclear Sciences, India. This work is also supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics.

References

[1] D. Proetal *et. al*, Nucl. Phys. **A226**, 237 (1974).

[2] D. Proetal *et. al*, Nucl. Phys. **A231**, 301 (1974).

[3] A. Görgen *et al.*, Eur. Phys. J. A **6**, 141 (1999).

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

[5] S. G. Wahid *et. al*, Phys. Rev. C **92**, 054323 (2015).

[6] D. Mertin *et. al*, Nucl. Phys. **A301**, 365 (1978).

[7] D. Negi *et. al*, Proc. of the DAE Symp. on Nucl. Phys. **62**, 266 (2017).