Oblate rotation in Hg isotopes along the line of stability

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Introduction

Mercury isotopes with $A \approx$ 190-200 lie in a transitional region. A variety of band structures, such as decoupled or semi-decoupled, rotation-aligned etc., are observed in their level schemes [1]. Such richness of phenomena is possible because of the presence of different coupling mechanisms by which the high-j $i_{13/2}$ neutron quasiparticle couples with the core. For example, weak oblate deformation in Hg nuclei readily accounts for the presence of a decoupled band built on the $13/2^+$ spin isomer in odd-A isotopes. On the other hand, the band built on the 7^- state in even-A isotopes is explained as resulting from a semi-decoupled configuration, where the decoupled $i_{13/2}$ neutron quasiparticle combines with an effective-core which contains neutron quasiparticles in low-j orbits strongly coupled to the core. In the present work, we report extensive new experimental information obtained in ^{197}Hg, ^{199}Hg, and ^{200}Hg isotopes.

Experimental details and data analysis

Excited states in Hg isotopes were populated via multinucleon transfer reactions followed by neutron evaporation in two separate experiments. The target for both these experiments was a 50 mg/cm^2 thick ^{197}Au foil while the projectiles were 1450 MeV ^{209}Bi and 1430 MeV ^{207}Pb ions. The experiments were performed using the Gammasphere facility at the Argonne National Laboratory, USA. Further details of the experiments can be found in Ref. [2, 3].

Three- and four-fold γ-ray coincidence analysis, using the RADWARE package, was perfomed to establish the placement of γ transitions in the level schemes of the nuclei. For the spin assignment of levels, wherever possible, the multipolarity of the decaying γ transition was determined using the Directional angular Correlation from Oriented nuclei (DCO) analysis.

Results and Discussion

In odd-A isotopes ^{197}Hg and ^{199}Hg, the level schemes [4] were reported up to intermediate values of spin. The placement of transitions is verified and the level schemes are considerably extended. Overall, 22 transitions and 20 levels in ^{197}Hg and 21 transitions and 18 levels in ^{199}Hg are newly observed. Lifetime measurements are also performed for the 7^- state of the semi-decoupled band and the 12^+ state of the decoupled band in ^{200}Hg, using the delayed-coincidence method.

One of the main results of this work is the observation of a three-quasiparticle (3-qp) band in ^{199}Hg built on the $33/2^+$ state. This band is built on the coupling of an $i_{13/2}$ neutron quasiparticle with rotation-aligned two $i_{13/2}$ neutron quasiparticles, and is observed up to quite high spin (beyond 25 $\hbar$). A similar 3-qp band in ^{197}Hg has been extended upto 49/2 $\hbar$ with the addition of two new levels. Further, a new sequence has been observed to decay to the 3-qp band in ^{199}Hg.

The semidecoupled band, built on $21/2^-$ level, is also extended upto $45/2^-$ $\hbar$ in ^{197}Hg and upto $37/2^-$ $\hbar$ in ^{199}Hg. The signature partner of the semi-decoupled band has been observed for the first time in ^{197}Hg, while in ^{199}Hg it is extended upto $39/2^-$ $\hbar$.

While the level schemes for the 1-qp bands built on the $13/2^+$ isomer in ^{197}Hg and ^{199}Hg exhibit similarities with the lighter isotopes (see Fig. 1), the observed variation suggests a gradual change in their properties. For the 3-qp band, on the other hand, this similar-

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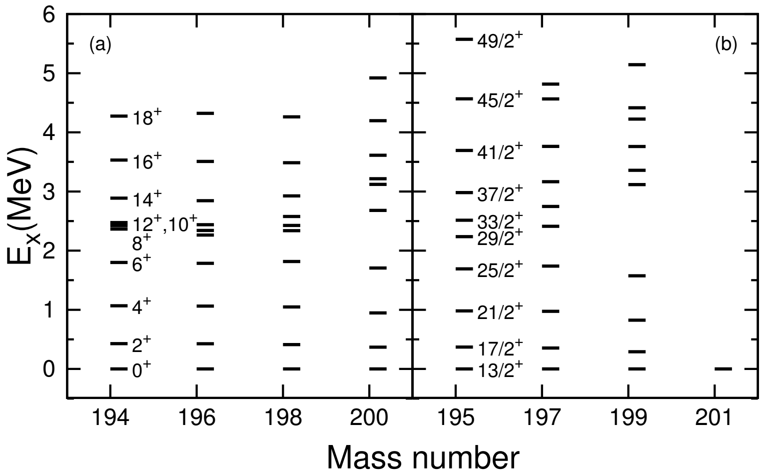

FIG. 1: Systematics of levels in the positive parity bands built on the ground states in ^{194,196,198,200}Hg in (a) and on the $13/2^+$, 1-qp states in ^{195,197,199,201}Hg in (b).

ity is less evident in ^{199}Hg, where the excitation energy of the $29/2^+$ state is observed to be significantly higher. This is ascribed to the effect of the energy gap at $N = 120$ in the single-particle spectrum. Cranking calculations have been performed for these nuclei using the ULTIMATE CRANKER code with standard Nilsson parameters, and also using a Wood-Saxon potential with universal parameterization. These calculations agree with the experimental value of alignment frequency of $\hbar\omega \approx 0.22$ MeV and angular momentum gain of $\approx 10\ \hbar$ which is due to the neutron BC crossing. The alignment process involving the $h_{11/2}$ protons is significantly delayed in these nuclei. Potential energy surface calcuations for ^{197,199}Hg suggest that, along the yrast line, there is a significant reduction in collectivity. At a spin of $21/2^+\ \hbar$, the shape is oblate with moderate deformation, while at $33/2^+\ \hbar$ it changes towards a weakly deformed triaxial one with the triaxiality parameter (γ) approaching -90^o. $B(E2)$ strengths obtained from the lifetime measuements along with the systematics for the 2-qp band in even-A isotopes and for the semi-decoupled band in odd-A isotopes have been analyzed. Detailed results will be presented during the symposium.

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