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High spin study of even Hg isotopes

The study of Hg isotopes (Z=80), close to doubly magic ^{208}Pb (Z=82), provides an opportunity to study the interplay between collective and intrinsic excitation mechanisms. High-spin data in neutron-rich Hg nuclei are not as well established as in the proton-rich region. The neutron-rich region can be reached through projectile fragmentation and multi-nucleon transfer reactions. Previous work includes the study of excited states populated in (α, xn) reactions for ^{196,198,200}Hg and (n, γ) and (d, pn) reactions for ^{202,204}Hg. In this work, multi-nucleon transfer products ^{198,200,202}Hg are studied upto high spin.

Data have been obtained for even Hg isotopes from two experiments performed at the Argonne National Laboratory using the ATLAS superconducting linear accelerator and Gammasphere detector array. Excited states in Hg isotopes were populated through multi-nucleon transfer between ^{209}Bi and ^{197}Au followed by neutron evaporation, with a 1450-MeV ^{209}Bi beam incident on a thick (50 mg/cm^2) Au target. Further, using a 1430-MeV ^{207}Pb beam incident on another ^{197}Au target, similar reaction channels also produced a number of Hg isotopes. High-fold coincidence data with different timing conditions were analyzed. The data have also been explored for the presence of high-spin isomers with lifetimes in the ns or higher range. $\gamma - \gamma$ directional correlation measurements were done for spin assignments.

The level scheme for ^{198}Hg has been expanded with the inclusion of 11 new transitions at high spin upto $E_x \approx 6$ MeV. Two high spin coupled rotational sequences built on a four-quasiparticle configuration have been identified. These are observed to decay to positive- and negative-parity bands with two-quasiparticle character. The excitation energy and moment of inertia of the newly observed band structure support the four-quasiparticle assignment. The lifetimes of isomeric states in ^{198}Hg have also been determined and are in agreement with previously reported values. The decay scheme for ^{202}Hg has been expanded with the inclusion of 15 new transitions placed above the 5^- state. The time difference analysis leads to a halflife of $10.4(18)$ ns for the 7^- state and $1.2(10)$ ns for the 9^- state. Similar analysis suggested half-life of 1.2(5) ns for the 12^+ state in ^{200}Hg.

Hg isotopes are characterized by moderate oblate deformation near their ground states. A pronounced alignment similar to Pt isotopes has also been observed in the yrast positive parity sequences in ^{196,198,200}Hg at $\hbar\omega \approx 0.2$ MeV in all three isotopes. It is attributed to the decoupling of an $i_{13/2}$ neutron pair occupying low-Ω orbitals. The close lying 5^-, 7^- and 9^- negative-parity states are built from a configuration of aligned $i_{13/2}$ and $p_{3/2}/f_{5/2}$ neutrons. Effective g-factor measurements for the 12^+ state in ^{198}Hg suggest a rotation-aligned $(\nu i^{-2}_{\frac{13}{2}})$ configuration. Cranked shell model calculations also indicate rotation alignment of $i_{13/2}$ neutrons around $\hbar\omega \approx 0.2$ MeV and suggest moderate oblate deformation for the observed bands. A systematic study of the excitation energy of the positive and negative parity sequences in Hg isotopes is done to illustrate that with the increase in neutron number towards N=126, reduction in collectivity is evident along with an abrupt increase in the excitation energy of the 12^+ state due to N=120 sub-shell gap.

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