

Configurations and decay hindrances of high-K states in $^{180}\text{Hf}^*$

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Deformed, mid-shell nuclei in the $A \approx 180$ region are characterized by the presence of both proton and neutron high- Ω orbitals near the Fermi surface. A natural consequence is the realization of intrinsic high-K states which can favorably compete with collective excitations. The observation of intrinsic states, especially K-isomers, and the associated rotational bands can provide an insight into the relative positions of the underlying single-particle orbitals about which there is limited information in neutron-rich territory. Isotopes of Hf are particularly suited for such studies since they are some of the best examples of rigid, axially symmetric, prolate rotors and therefore K is a conserved quantum number in these nuclei. This work focuses on the structure of intrinsic two- and four-quasiparticle states in ^{180}Hf , the heaviest stable Hf isotope.

Excited states in ^{180}Hf were studied using deep-inelastic reactions, with a 1.4 GeV ^{207}Pb beam from the ATLAS accelerator at Argonne National Laboratory, incident on an isotopically enriched, 250 mg/cm² ^{180}Hf target. The Gammasphere array was used to record coincidence events in two time regimes viz. *prompt* and *pulsed*, where all and 1 in 10 beam pulses respectively, with the natural 82.5 ns pulsing from ATLAS, were made incident on the target. This data complements earlier out-of-beam studies focused on μs isomers [1,2] and the prompt spectroscopy of ^{180}Hf [3,4] using Gammasphere in conjunction with the auxiliary heavy ion counter CHICO.

The data reveal the presence of a rotational band built upon the previously determined two-quasiparticle, $K^\pi=10^+$ state in ^{180}Hf which helped in establishing the nucleonic configuration from the deduced g-factors. A rotational band built upon a four-quasiparticle state reported in the previous work [1] has also been identified. The lifetimes determined for the $K^\pi=10^+$ and 12^+ states are found to be substantially different from those reported in the previous work [1], where the experimental parameters had been optimized for isomers with $t_{1/2} \gg 1 \mu\text{s}$. A new four-quasiparticle state and the associated rotational band have been identified. The lifetime of the $K^\pi=6^+$ state has been measured using the centroid-shift technique and is found to be $t_{1/2}=2.8(3)$ ns. The decay hindrances for the various isomers have been analyzed in detail. Multi-quasiparticle calculations to determine the excitation energies of high-K states have been performed and compared with experiment.

[1] R. D'Alarcao *et al.*, Phys. Rev. C **59**, R1227 (1999).

[2] I. Shestakova *et al.*, Phys. Rev. C **64**, 054307 (2001).

[3] E. Ngijoi-Yogo, Ph.D. Thesis, University of Massachusetts Lowell, 2004, and E. Ngijoi-Yogo *et al.* (to be published).

[4] U.S. Tandel *et al.* (to be published).

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