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Configurations and decay hindrances of high-K states in 180Hf

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Nuclei in the A=180 region are characterized by quite favorable conditions for the realization of K isomers. These include rigid, axially symmetric deformed shapes, and the presence of both proton and neutron orbitals near the Fermi surface with large projections of the intrinsic angular momentum along the symmetry axis. K isomers constitute a very effective spectroscopic means of investigating both intrinsic and collective excitation modes. While K-isomeric decays offer insight into the degree of conservation of the K quantum number, high-K rotational bands yield information about the properties of the underlying core.
Multi-quasiparticle high-K states are observed in 180Hf through excitation with a 1.4 GeV 207Pb beam obtained from the ATLAS accelerator at Argonne National Laboratory, incident on an enriched, 250 mg/cm2 180Hf target. Both prompt and delayed gamma rays were detected using the Gammasphere array, and several new high-K structures identified, in addition to the K isomers already established from previous work [1]. Lifetimes of isomeric states in the nanosecond-microsecond range are measured using centroid-shift and decay measurements within the microsecond coincidence time window. Configurations for the high-K states involve two, four and six quasiparticles, with states up to K=22 established. High-K states are found to be progressively more favored with increasing excitation energy. The K quantum number is quite robust up to the highest observed spins as evidenced by large values of reduced hindrance for isomeric decays. Rotational bands built on several high-K states are identified, and the measured branching ratios in these structures have allowed assignment of underlying configurations. Multi-quasiparticle calculations using the Lipkin-Nogami approach for pairing, with blocking included, reproduce the observed high-K energies quite well.

References

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

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