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Search for multi-quasiparticle isomers in ^{254}Rf*

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Deformed, axially-symmetric nuclei in the trans-fermium region are known to exhibit high-K isomerism [1], owing to the presence of high-K orbitals near both the proton and neutron Fermi surfaces. The properties of such isomers provide important information on the single-particle structures in the region, as well as on the role played by the pairing and residual nucleon-nucleon interactions.

We have carried out a search for isomeric states in ^{254}Rf using the ^{206}Pb(^{50}Ti,2n) reaction and the Argonne Fragment Mass Analyzer (FMA). A 242.5-MeV beam of ^{50}Ti with an intensity of $\sim$200 pnA was provided by the ATLAS accelerator. The recoiling reaction products were identified at the FMA focal plane by their mass to charge-state ratio and implanted into a DSSD. Both implant and decay events were measured and correlated temporally, and spatially. For the first time, a digital data acquisition system was deployed, which allowed comprehensive pulse-shape analysis of the recoil-decay pile-up events to be performed and identification of implant and decay events separated by decay times as short as hundreds of nanoseconds. Furthermore, this novel approach resulted in a much lower $\sim$50-keV threshold for conversion-electron events, associated with decays of isomeric states within the first 6 μs following implantation, independent from the energy threshold set in the digitizer firmware.

Fission events associated with the known ^{254}Rf ground-state decay were unambiguously identified. In addition, fast ($\sim$2 μs) electron events correlated with an implanted A=254 recoil and followed by a ^{254}Rf ground-state fission events were observed and associated with the decay of a new isomeric state. Evidence was also found for the existence of a second, longer-lived isomer. The data from this experiment will be presented and the results will be discussed in comparison with predictions from multi-quasiparticle blocking calculations that include empirical estimates for the residual configuration-dependent, nucleon-nucleon interactions.

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