

Multi-quasiparticle states in ^{254}No : K-conservation, single particle energies and pairing strengths*

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Spectroscopic studies of the heaviest nuclei are challenging due to their sub-microbarn cross-sections and overwhelming fission competition. The investigation of K-isomers in these nuclei reveal the extent of robustness of axial symmetry for nuclear shapes in a regime characterized by a delicate balance between nuclear attraction and Coulomb repulsion. Experimental information regarding energies and nucleonic configurations of multi-quasiparticle states provide an insight into single particle energies and in even-even nuclei, also the pairing strength. These are important new inputs for model predictions of superheavy nuclei and can also provide discriminating tests of the models and, indirectly, of their predictions of magic gaps for superheavy nuclei.

Two experiments were performed to identify the γ rays and conversion electrons emitted in the decay of isomers in ^{254}No , which was formed with the $^{208}\text{Pb}(^{48}\text{Ca},2n)$ reaction, using a 217 MeV (at mid-target) beam of ^{48}Ca from the ATLAS accelerator at Argonne. Evaporation residues of ^{254}No were transported and identified by their mass/charge ratio with the Fragment Mass Analyzer (FMA), then implanted into a 140 μm thick double-sided Si strip detector (DSSD) with 40x40 pixels, each with 1 mm^2 area. An isomeric decay in ^{254}No was identified by time and spatial correlations, namely an electron signal within 1 s of an evaporation residue in the same pixel as the implanted nucleus. The γ rays from the decay of an isomer were also detected, in prompt coincidence with an isomeric electron signal, in three large clover Ge detectors.

Two isomers, built on two and four-quasiparticle excitations, with $K^\pi = 8^-$ and (14^+) and half-lives of 266(10) ms and 171(9) μs have been identified in ^{254}No [1]. The 266 ms isomer had been found earlier, but its quantum numbers had not been determined [2]. In addition, a low-energy two-quasiparticle $K^\pi = 3^+$ state has also been established. The observed large decay hindrances provide a quantitative indication that K is a good quantum number and therefore the nucleus has an axially symmetric shape. Calculations of two-quasiparticle energies in ^{254}No have been performed with single particle energies given by the universal parameters of the Woods-Saxon potential and a Lipkin-Nogami formalism for pairing, which accounts for reduced pairing due to orbit blocking. These calculations show better agreement (within 150 keV) with experiment than those obtained from self-consistent mean-field Skyrme-Hartree-Fock-Bogolyubov and Relativistic Mean Field models. This extends the validity of Woods-Saxon single-particle energies for nuclei with Z up to at least 102. These results suggest a need for improved interactions for self-consistent mean-field models, which can more accurately describe single-particle energies.

[1] S.K. Tandel *et al*, submitted to Physical Review Letters

[2] A. Ghiorso, K. Eskola, P. Eskola, and M. Nurmi, Phys. Rev. C **7**, 2032 (1973).

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