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The onset of triaxiality in neutron-rich rhenium isotopes

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Experiments that observe nuclear isomers provide insight into the composition of nuclei and enable tests of nuclear structure predictions. In general, isomers in heavy neutron-rich isotopes, at or beyond the line of stability, cannot be produced by conventional fusion-fission or fusion-evaporation reactions. Our approach has been to access these nuclei via multinucleon transfer or deep inelastic reactions. To maximise production cross-sections, neutron-rich targets and beams were chosen. Neutron-rich rhenium isotopes were populated using a pulsed or chopped ^{136}Xe beam produced by the ATLAS accelerator at Argonne National Laboratory, incident on gold-backed ^{187}Re and ^{192}Os targets. Gamma-ray emission from excited reaction products was measured using the Gammasphere detector array.

The region close to ^{190}W has been predicted to exhibit changes in nuclear deformation [1,2], transitioning from prolate, through triaxial, to oblate shapes as more neutrons are added. Recent experiments on heavy neutron-rich isotopes in the region (^{188,190}W and ^{191,193}Ir) [3,4] show signatures of a transition to triaxial shapes. Specifically, in ^{188}W and ^{190}W there is a decreasing trend of the reduced hindrances for the isomer decays in more neutron-rich nuclei. Whilst the significant signature splitting of the $h_{11/2}$ band in ^{191}Ir and ^{193}Ir points to these nuclei having non-prolate shapes, theoretical calculations predict significant changes in triaxiality for different 3-quasiparticle configurations [4]. Measurements of quasiparticle configurations in ^{189}Re and ^{191}Re will further the understanding of this transition into a triaxial regime in heavy neutron-rich nuclei.

The present focus is on the neutron-rich isotopes ^{187}Re, ^{189}Re and ^{191}Re. Previous experiments in this region identifed delayed γ-rays from isomeric states in ^{187}Re [5] and ^{191}Re [6], although a full level scheme is only known ^{187}Re. In addition to γ-ray spectroscopic studies, ^{187}Re,^{189}Re and ^{191}Re have also been the subject of particle transfer experiments (polarised t,α) on stable osmium targets, where low-spin excited states were examined [7]. In the current experiment, the $9/2^-[514]$ proton state and its associated rotational band were observed in the decay of 3-quasiparticle isomers in all three isotopes. The trends in the isomeric transition reduced hindrances and the aligned angular momenta of the $9/2^-[514]$ bands are related to shape changes across the isotopic chain, and can be used to test the inference of increasing triaxiality in the more neutron-rich isotopes.

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