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High-spin structure and shape evolution in neutron-rich Re isotope

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Abstract

Neutron-rich nuclei below ^{208}Pb, also known as so called "blank spot" in the nuclear chart, remain poorly explored because of the difficulty in producing them with sufficient yield and clean identification. In this region, Re isotopes with $Z = 75$ are of particular interest because they are expected to evolve from well-deformed prolate shapes toward non-axial and oblate configurations with increasing neutron number [1, 2]. The nucleus ^{192}Re, with $N = 117$, lies close to the predicted prolate-oblate transitional region [3], but prior to the present study, no spectroscopic information was available on its high-spin structure and the known data were mainly restricted to the low-spin isomeric state [4]. Recent developments in multi-nucleon transfer reactions with heavy-ion beams have opened new possibilities for accessing neutron-rich nuclei around A$\sim$190, which are difficult to populate by conventional fusion-evaporation, fission, or fragmentation techniques [5]. In the present work, excited states in ^{192}Re were populated using a multi-nucleon transfer reaction induced by a ^{136}Xe beam at 7 MeV/nucleon on a ^{198}Pt target at GANIL. Prompt and delayed γ rays were measured with the AGATA tracking array and the CATLIFE-EXOGAM setup [6], while projectile-like fragments were identified event-by-event using the VAMOS++ spectrometer. The ^{192}Re channel was selected through fragment identification, kinematic correlations, total kinetic energy loss gates, and the known isomer decay. Using prompt-delayed and prompt-prompt γ-γ coincidence analyses, excited states above the known isomeric structure of ^{192}Re were established for the first time, making it the most neutron-rich rhenium nucleus with measured excited states above an isomer. The observed level sequence provides the first information on the high-spin excitation pattern of this nucleus and indicates the development of collective structures above the isomer. Comparisons with lighter odd-odd Re isotopes suggest changes in the underlying quasiparticle configuration with increasing neutron number. The experimental results are interpreted using cranked relativistic DFT calculations with the PC-PK1 functional and a shell-model-like approach. These findings extend the spectroscopy of ^{192}Re into the high-spin regime and provide new constraints on shape evolution in neutron-rich Re isotopes below ^{208}Pb.

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