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Structure of low-lying states in 140Sm studied by Coulomb excitation

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The open-shell nuclei with Z>50 and N<82 are known to have some of the largest ground-state deformations in the nuclear chart. The shapes of the nuclei in this region are expected to be prolate, except for a small island of nuclei with Z>62 and N≈78, which are predicted to be oblate. Nuclei near 140Sm are therefore expected to be located in a transitional region between deformed and spherical shapes (as a function of N) and between prolate and oblate shapes (as a function of Z). The measurement of spectroscopic quadrupole moments and transition strengths for low-lying states represents a sensitive test for theoretical predictions in this region. Lifetimes of low-lying states in 140Sm were unknown due to the occurrence of two isomeric 10+ states . A Coulomb excitation experiment with radioactive 140Sm beam was performed at the ISOLDE facility at CERN, using the MINIBALL spectrometer coupled to a DSSSD array. The laser-ionized beam of 140Sm was quasi-pure with an average intensity of 2·10^5 particles per second. At least three excited states in 140Sm were populated during the experiment: the 2+ and 4+ states of the ground-state band and the tentatively assigned 0+ state at 990 keV excitation energy. The statistics collected during the experiment allows the analysis of differential Coulomb excitation cross sections as a function of scattering angle. In addition to the Coulomb excitation experiment a RDDS lifetime measurement was preformed at HIL, Warsaw, to determine B(E2) values in a complementary way. Using experimental lifetimes as independent spectroscopic data in the Coulomb excitation analysis enhances the sensitivity to the reorientation effect. Furthermore, the spin assignment of the state at 990 keV was revised based on angular correlations measured in a third experiment in Warsaw following the beta decay of 140Eu. The experimental B(E2) values and quadrupole moments are compared with theoretical calculations using beyond mean-field models, the shell model, and algebraic models. The results show that the triaxial degree of freedom is important for the transition from spherical shape for the N=82 isotope 144Sm to axial symmetric prolate shape for the most neutron-deficient Sm isotopes.

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