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Nuclear structure studies of the neutron-rich rubidium isotopes using Coulomb excitation

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We report on the first study of properties of excited states of odd-mass neutron-rich rubidium isotopes by the Coulomb excitation technique, using the Miniball array coupled to the REX-ISOLDE facility. This allowed the expected change in shape from a spherical to a deformed one at N=60 to be observed for excited states in these nuclei. These results aid the understanding of the deformation-driving role played by proton orbitals in this region. The ground states of neutron-rich nuclei in the mass 100 region undergo of a rapid change from a spherical to a deformed shape [1]. The nuclei 93−97Rb straddle this transition, which occurs at 60 neutrons [2]. The identification of the bandhead spins and the roles played by different neutron Nilsson orbitals of the Sr and Zr nuclei with N=59, 61 has an given insight into the mechanism responsible for this rapid shape change [3, 4]. The importance of the unique-parity deformation-driving downsloping νh11/2 orbitals here, which create a low-energy deformed minimum with ϵ2˜0.4, has been stated in many articles. As these orbitals are of unnatural parity they interact little with the neighboring neutron orbitals, but start to become filled around N=60. The filling of these orbitals should produce a gradual progression from a spherical shape to deformed one, which is not experimentally observed. Recently a phenomenological explanation for the rapidity of the onset of deformation has been proposed [3, 4] which invokes the importance of ν9/2[404] extruder orbital, which favors a more spherical shape. This explanation focuses only on the role played by the neutrons, however the proton-neutron interaction is known to play a major role in the onset of collectivity. More information on the deformation-driving role of the proton orbits of the region is therefore required. Furthermore, very recent mass data from ISOLTRAP at CERN-ISOLDE suggest that the Kr nuclei of this region may not undergo a rapid shape change [5]. For this reason we have chosen to study the isotopes 93−99Rb across the shape transition via Coulomb excitation. Practically no experimental information exists on the excited states of rubidium isotopes beyond A=93. The present study provides new data across the shape transition, on the spherical isotopes 93Rb and 95Rb and the well deformed nuclei 97Rb and 99Rb.

The experiment was performed using the Miniball array in Coulomb-excitation configuration. The nuclei 93,95,97,99 Rb were produced using a surface-ionization ion source and UCx target. They were subsequently post-accelerated to 2.83 MeV/u by REX-ISOLDE. Using ΔE vs. E identification one could identify that rubidium was practically the only element coming out of the ISOLDE target in this mass region. However, due to the very short half-life of some of the isotopes (e.g. T1/2 (99Rb = 50 ms) the beam composition was modified before reaching the Miniball target due to the decay in-flight and significant contamination was found.

In addition to previously known yrast levels in 93Rb and 95Rb [6] several other levels were populated by Coulomb excitation. Gamma-ray transitions in 97Rb and 99Rb were unambiguously identified providing the first information on excited states in these nuclei. The preliminary results of the experiment will be presented and compared to theoretical calculations.

References

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