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Gamma spectroscopy of neutron-rich Y isotopes: Identification of new multi-quasiparticle isomers

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For the neutron number N = 60, a sudden onset of the deformation has been observed in Y isotopes at the ground state, which is manifested by the presence of rotational bands (e.g. [1]). On the other hand, the occurrence of shape coexistence in nuclei with N = 58 and 59, in this region (e.g. [2]), suggests that the evolution of the deformation is a more gradual process. Our recent research has shown that already in the N = 57, 96Y isotope the coexistence of spherical and deformed structures is present and a rotational band is built on the top of a new (6+), 181-ns isomer [3]. In the current analysis, we focused on the neutron-rich Y isotopes with $N \geq 60$, in which the deformed structures are firmly established. For N = 60, i.e., in 99Y, in addition to the ground state rotational band, two other bands could be found above 11/2+ (1.6 ns) and 17/2+ (8 μs) isomers [4]. These isomers have been interpreted as three-quasiparticle states with $\pi 5/2[422]\nu 3/2[411]\nu 9/2[404]$ configuration. Our goal is to search for similar isomers with relatively high-spin in Y isotopes beyond N = 60 boundary.

The neutron-rich 100Y and 101Y isotopes have been produced in the fission of 235U active target [5] induced by thermal neutrons from the reactor at Institut Laue-Langevin. The level scheme up to excitation energy of 2.5 MeV has been established based on multi-fold gamma-ray coincidence relationships measured with the new, highly-efficient HPGe array FIPPS [6]. Additionally, the low-spin structures in 101Y have been examined using dedicated measurement where fission products were separated by the LOHENGRIN spectrometer.

By exploiting delayed- and cross-coincidence techniques [7], the extensive structures have been delineated. During the analysis, over 20 new gamma transitions, which feed previously known low-spin states, have been identified. Moreover, new isomeric states at higher excitation energy have been located. By using the delayed-coincidence method, it was possible to identify the structures above the isomers confirming their rotational characters. As in the case of 99Y isotope, the isomeric states could be interpreted as multi-quasiparticle type. The configurations of the new bandheads will be discussed based on the observed decay patterns, as well as Hartee-Fock-Bogoliubov calculations.

Existence of isomers in the 100Y and 101Y isotopes which are bandheads of rotational structures provides new information about deformation in neutron-rich nuclei around A = 100. It should be emphasized that this is in contrast with other isotopic chains with N > 60 and Z = 38-44, where the bandheads of the higher-located rotational structures are not isomeric.

References:

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