Spectroscopy of Neutron-Deficient Francium Isotopes

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In neutron-deficient nuclei around Z = 82, shape coexistence phenomena induced by proton excitations across the shell gap play a major role [1, 2]. In many cases in this region of nuclei, this results in nuclear isomerism, when two or even three closely-lying configurations have a large spin difference. Some of the studied cases are for example, odd-A Bi (Z=83) isotopes, in which an $1/2^+$ 2p-1h intruder state ($\pi 3s^{-1}_{1/2} \otimes 1h^2_{9/2}$ configuration) coexists at low energy with the $9/2^-$ 1p-0h ground state. These configurations can be efficiently investigated by combination of α- and γ-decay spectroscopy.

Shape coexistence also occurs in the neutron-deficient isotopes of Fr (Z=87); a recent study at RITU in Jyväskylä, Finland [3] identified an α-decaying $1/2^+$ intruder state in ^{201}Fr.

In our work, we investigated the shape coexistence phenomena in very neutron-deficient francium isotopes ^{200,201,202}Fr (Z=87). These isotopes were studied in the complete fusion-evaporation reaction ^{149}Sm(^{56}Fe,pxn)$^{205-(x+1)}$Fr at the velocity filter SHIP in GSI Darmstadt, Germany.
Besides significantly improved knowledge of the decay properties of these isotopes, the most interesting is the evidence of new microsecond isomeric state in ^{201}Fr. Based on the preliminary analysis, the most probable candidate spin-parity assignment for this state would be $(13/2^+)$. The main part of this work is concentrated on the study of its decay properties. This is important for systematics of low-lying excited levels in this region as the excitation energy for the $13/2^+$ level in francium isotopes has been known for N = 126 only [3]. It will be shown why the nuclear isomerism might be important for the nuclear structure studies near the closed shells as well as description of the basic techniques used for probing of this kind of nuclear phenomena.

References

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