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Shape coexistence in Sn isotopes around A=110

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A survey of decay properties of excited 0+ states in regions of the nuclear chart well known for shape coexistence phenomena was performed. It was focused on even-even nuclei around the Z=20 (Ca), 28 (Ni), 50 (Sn), 82 (Pb) proton shell closures and along the Z=36 (Kr), Z=38 (Sr) and Z=40 (Zr) isotopic chains [1]. The aim is to identify examples of extreme shape coexistence, namely, coexisting deformed and spherical (or close-to-spherical) nuclear states, the wave functions of which are well separated in the Potential Energy Surface (PES) spanned over deformation space. Due to this separation, the transition between such structures could be substantially hindered. This is in analogy to the 0+ fission shape isomers in the actinides region and to the superdeformed (SD) states at the decay-out spin in medium/heavy mass systems. In the survey, the Hindrance Factor (HF) of the E2 transitions de-exciting 0+ states or SD decay-out states is a primary quantity which is used to differentiate between types of shape coexistence. It is found that a limited number of 0+ excitations (in the Ni, Sr, Zr and Cd regions) exhibit large HF values (>10), few of them being associated with a clear separation of coexisting wave functions, while in most cases the decay is not hindered, due to the mixing between different configurations. More in detail, shape-isomer- like structures, of prolate deformed nature, have been observed at spin zero in the relatively light 64,66Ni nuclei [2,3], by performing gamma-spectroscopy investigation with different types of reaction mechanisms (i.e., proton and neutron transfer, neutron capture and Coulomb excitation). An analogous situation is expected to occur in 112-116Sn isotopes, for which preliminary results will be discussed, from experiments performed at IFIN-HH (Magurele, Romania) with ROSPHERE, and at Legnaro National Laboratory (Padua, Italy) with the AGATA tracking array.
According to theory predictions based on state-of-the-art Monte Carlo Shell Model (MCSM) calculations [4], it is the action of the monopole tensor force which stabilizes and deepens isolated, deformed local minima in the PES. The existence of such minima may thus lead to a significant separation of the wave functions of states residing in these minima and, eventually, to shape isomerism.

[1] S. Leoni, B. Fornal, A. Bracco, Y. Tsunoda, and T. Otsuka, to be published in Prog. Part. Nuc. Phys. [2] S. Leoni, B. Fornal, N. Marginean et al., Phys. Rev. Lett. 118, 162502 (2017)
[3] N. Marginean, et al., Phys. Rev. Lett. 125, 102502 (2020)
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