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Shape isomerism as a probe of microscopic origin of nuclear deformation

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The phenomenon of shape isomerism, being the best example of shape coexistence in nuclei, is related to the existence of a high barrier in the nuclear potential energy surface (PES), separating the primary energy minimum (the ground state) from a secondary energy minimum at large deformation. Shape isomers at spin zero have clearly been observed, so far, only in actinide nuclei - they decay mainly by fission, although in two cases, 236U and 238U, gamma-ray branches with very hindered transitions are known [1,2].
Inspired by various mean-field theoretical approaches [3-5] as well as by the state-of-the-art Monte Carlo Shell Model (MCSM) calculations [6], we have recently identified a shape-isomer-like structure at spin zero in a light nucleus 66Ni by using gamma-ray spectroscopy and employing the two-neutron transfer reaction induced by an 18O beam on a 64Ni target [7]. Being guided by the MCSM calculations, we have extended our studies to other Ni isotopes, making use of the two-neutron and one-proton sub-barrier transfer reactions. The new data should pin down, in great detail, evolution of the shape coexistence phenomenon in Ni isotopes.
Shape isomerism at spin zero might be a more common phenomenon. In fact, the mentioned mean-field theoretical models [3-5], as well as the recently published macroscopic-microscopic calculations [8], predict relatively deep secondary PES minima in nuclei in few other regions of the nuclear chart. For example, such minima associated with a sizeable deformation should exist in nuclei Pt, Hg and Pb with neutron number around N=110, and in Pd, Cd and Sn with N□66. A possibility for identifying gamma decay out of some of these minima, by using reactions induced by radioactive beams, will be discussed.
The experimental investigations aimed at searching for shape isomers, together with the development of the state-of-the-art microscopic theoretical approaches, should shed light on the microscopic origin of the appearance of deformed structures in nuclei.

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Primary authors: Prof. SFERRAZZA, Michele (Université Libre de Bruxelles); Dr MARGINEAN, Nicolae (IFIN-HH Bucharest); LEONI, Silvia (MI); Prof. OTSUKA, Takaharu (Department of Physics and Center for Nuclear Study, University of Tokyo)

Presenter: Prof. FORNAL, Bogdan (Institute of Nuclear Physics, Polish Academy of Sciences (IFJ PAN))

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