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Islands of shape coexistence in covariant density functional theory

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Using covariant density functional theory with the DDME2 functional and labeling single particle energy orbitals by Nilsson quantum numbers [1], a search for particle-hole (p-h) excitations connected to the appearance of shape coexistence is performed for Z=38 to 84 nuclei [2]. Islands of shape coexistence are found near the magic numbers Z=82 and Z=50, restricted in regions around the relevant neutron midshells N=104 and N=66 respectively, in accordance to the well accepted p-h interpretation of shape coexistence in these regions, which we call neutron induced shape coexistence, since the neutrons act as elevators creating holes in the proton orbitals. Similar but smaller islands of shape coexistence are found near N=90 and N=60, restricted in regions around the relevant proton midshells Z=66 and Z=39 respectively, related to p-h excitations across the 3-dimensional isotropic harmonic oscillator (3D-HO) magic numbers N=112 and N=70, which correspond to the beginning of the participation of the opposite parity orbitals 1i13/2 and 1h11/2 respectively to the onset of deformation [3].
We call this case proton induced shape coexistence, since the protons act as elevators creating holes in the neutron orbitals, thus offering a possible microscopic mechanism for the appearance of shape coexistence in these regions [3]. In the region around N=40, Z=40, an island is located on which both neutron p-h excitations and proton p-h excitations are present.

[1] K.E. Karakatsanis, G.A. Lalazissis, V. Prassa, and P. Ring, Phys. Rev. C 102 (2020) 034311.

[2] D. Bonatsos, K.E. Karakatsanis, A. Martinou, T.J. Mertzimekis, and N. Minkov, in preparation.

[3] D. Bonatsos, K.E. Karakatsanis, A. Martinou, T.J. Mertzimekis, and N. Minkov, Phys. Lett. B (2022) in press. arXiv: 2204.00805 [nucl-th].

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