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Isospin Symmetric Island of inversion at the $N=Z$ line

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The development of collectivity along the $N = Z$ is one of the subjects that has recently attracted great experimental efforts. In particular, heavy $N=Z$ nuclei in the mass region $A=80$ are expected to be some of the most deformed ground states which have been found [1] in mid-mass nuclei, typically $8p-8h$, $12p-12h$ for e.g. the cases of ^{76}Sr , ^{80}Zr . This strong enhancement of collectivity with respect to lighter $N=Z$ nuclei has its origin in cross shell excitations across the $N=40$ shell gap to $g_{9/2}$, $d_{5/2}$ and $s_{1/2}$ which are intruder quadrupole partners generating deformations. These structures can be interpreted in terms of algebraic Nilsson-SU3 self-consistent model to describe the intruder relative evolution in the vicinity of ^{80}Zr [2]. In this presentation, we will expose some of the latest developments in microscopic nuclear structure calculations for exotic nuclei far from stability at the $N=Z$ [3]. The new theoretical calculations for the very region of ^{80}Zr will be presented for the first time within the interacting shell model framework using an enlarged model space outside a ^{56}Ni core comprising the pseudo-SU3 $p_{3/2}f_{5/2}p_{1/2}$ and quasi-SU3 $g_{9/2}d_{5/2}s_{1/2}$ orbitals for both protons and neutrons. We will present and compare results from both exact Shell Model diagonalization [4] and our newly developed DNO Shell Model approach employing beyond mean field techniques [5]. These theoretical calculations allow a very good description of the rapid transition ($A=60-100$) from spherical to deformed structures which can be interpreted in terms of “simple” many particles - many holes configurations. The whole Island of Collectivity in the region and sudden shape change recently observed between ^{84}Mo and ^{86}Mo is interpreted as an effect on the $N = 50$ gap induced by the addition of the two neutrons, a fingerprint of three-body forces.

[1] R. D. O. Llewellyn et al., Phys. Rev. Lett. 124, 152501 (2020).

[2] A. P. Zuker et al., Phys. Rev. C 92, 024320 (2015)

[3] D. D. Dao, F. Nowacki, A. Poves in preparation

[4] E. Caurier, G. Martínez-Pinedo, F. Nowacki, A. Poves, and A. P. Zuker, Rev. Mod. Phys. 77, 427 (2005).

[5] D. D. Dao and F. Nowacki, Phys. Rev. C 105, 054314 (2022).

Collaboration

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