Proposition de sujet de stage M2 (2022) à l'Institut Pluridisciplinaire Hubert Curien (IPHC)

QUEST OF THE QUANTUM PHASE TRANSITION IN KR ISOTOPES

The shape of the nucleus continues to be a primary subject of nuclear physics studies providing intriguing and challenging questions when going to exotic nuclei. One of such questions is transition from spherical to deformed shapes as a function of proton and neutron numbers. The shape transition in the system is manifested by a sudden change in the systematics of the excited states, for instance the first excited 2+ level going down abruptly.
Such changes were experimentally observed in the neutron-rich Zr (Z=40) and Sr (Z=38) isotopes at N=60. The theoretical studies done within large-scale Shell-Model [1-2], Monte-Carlo Shell Model [3] and other approaches [4] provide a coherent description of the shape-coexisitng forms before N=60 and of the sudden shape change at N=60. As there is an abrupt change in the quantum properties of the ground state between N=58 and N=60, thus as as function of the N, one can talk about the Quantum Phase Transition (QPT) in the shape of these nuclei.

On the other hand, the experimental systematics of 2+ excitation energies in Kr (Z=36) isotopes does not seem to reveal QPT [5] but the shape change seems to be much smoother around N=60. The purpose of this internship is to perform large-scale Shell-Model calculations for the Kr chain, in the same spirit as done before in [1-2], characterize the development of the collectivity along this chain and find the microscopic origin of the disappearance of the QPT when moving from Z=40,38 to Z=36.

This work can be continued as a PhD project, extending the subject to further calculations of interest for experimental groups working with exotic nuclei as well as for the r-process simulations carried out in collaboration with Université Libre de Bruxelles.

[1] K. Sieja, PRC79 (2009) 064310.
[2] K. Sieja, to appear in Advances in Nuclear Physics, Universe (2022).
[3] T. Togashi et al., PRL117 (2016) 172502.
[4] J.E. Garcia-Ramos and K. Heyde, PRC100 (2019) 044315.
[5] J. Doudouet et al., PRL118 (2017) 162501.

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