Emergence of Simple Patterns in Complex Atomic Nuclei from First Principles

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Over the past decade, major progress in the development of realistic internucleon interactions along with the emergence of petascale computing resources have advanced considerably predictive capabilities of *ab initio* methods. However, a widespread application of *ab initio* studies in medium mass nuclei and achieving an accurate description of clusterization and nuclear collective states from the first principles, still remain beyond computational reach. The progress is hindered by the nearly combinatorial growth of many-nucleon basis, that comes with the addition of oscillator shells and the number of nucleons. We developed a novel symmetry-adapted framework that augments *ab initio* no-core shell model with many-nucleon basis constructed using SU(3)-based coupling scheme. In this talk, I will present results of *ab initio* symmetry-adapted framework that unveil a feature common to the low-energy structure of nuclei that has heretofore gone unrecognized in other *ab initio* studies – the emergence of simple orderly patterns that favor strongly deformed configurations and low intrinsic spin values [1]. I will show how one can use this feature to limit the size of physically relevant model spaces while ensuring that important properties of atomic nuclei, e.g. enhanced BE2 strengths and nucleon cluster substructures [2], are appropriately accommodated in *ab initio* studies.

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2. A. C. Dreyfuss, K. D. Launey, T. Dytrych, J. P. Draayer, and C. Bahri, Phys. Lett. B 727 (2013) 511.