SEMINARIO DEL DEPARTAMENTO DE FÍSICA TEÓRICA

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Three-Nucleon Forces and the Evolution of Nuclear Structure in Exotic Nuclei

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Abstract: While the importance of three-nucleon forces has been well established in the physics of few-body systems, light nuclei, and nuclear matter, their impact in medium-mass nuclei represents one of the current frontiers of nuclear structure theory. I will discuss the first consistent and systematic applications of chiral three-nucleon (3N) forces in microscopic nuclear structure calculations in exotic medium-mass nuclei. I will show how the additional repulsion from the normal-ordered one- and two-body parts of the 3N force in T=1 systems provides a significant correction to the basic ingredients of configuration interaction calculations: the microscopic single particle energies and the monopole part of valence-shell effective interactions. As neutron number increases, the influence of 3N forces becomes more pronounced and has important implications in predicting fundamental properties of exotic nuclear systems.

This is explicitly manifested in a microscopic explanation of the oxygen anomaly where, with monopole adjustments given by the two-body part of 3N forces, the prediction of the neutron dripline in oxygen changes from N=20, with the NN-only theory, to the experimentally-observed N=16. Moreover, by including the one-body part of 3N forces in microscopic calculations of sd-shell single particle energies, we find that this dripline prediction is retained while theoretical spectra of the oxygen isotopes are uniformly improved with respect to experiment. This framework is then applied to a study of the calcium isotope chain, where a well-known failing of the NN-only microscopic theory is the inability to correctly predict 48Ca as a closed-shell nucleus, making N=28 the first standard magic number not predicted in any microscopic theory. Here the repulsive contributions from neglected 3N forces improve the predicted closed-shell properties in 48Ca and prove to be essential for a complete microscopic picture of the evolution of shell structure in the calcium isotopes.

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