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Valence particle/hole-core couplings in neutron-rich, exotic nuclei

The couplings between single-particle/hole degrees of freedom and collective and non-collective excitations are of primary importance in nuclear physics, as they are responsible for many phenomena observed in atomic nuclei, from the damping of giant resonances, to the quenching of spectroscopic factors and the anharmonicity of vibrational spectra [1].
While such properties have been investigated in the past in a limited number of stable nuclei, it is still under discussion whether neutron rich, exotic nuclei display similar features and how couplings with core excitations are influenced by the proton-to-neutron ratio and shell evolution.
To answer these questions, we present recent experimental results in the medium-heavy mass regions around the doubly-magic, neutron-rich ^{48}Ca and ^{132}Sn nuclei. In particular, we discuss new spectroscopic information on the ^{47}Ca, ^{49}Ca, ^{133}Sb and ^{131}Sn isotopes, obtained in different experimental campaigns, at ILL (France) and LNL (Italy), by using large γ-ray setups based on HpGe Detectors.
Experimental results will be interpreted by a new microscopic theoretical model, the Hybrid Configuration Mixing Model [2-3], specifically designed to describe the structure of nuclear systems with one valence particle/hole outside a core. The model includes couplings between valence nucleons and core excitations in a self-consistent way, by means of Hartree-Fock (HF) and Random Phase Approximation (RPA) calculations using the Skyrme effective interaction and it accounts for both collective phonons and non-collective configurations.
The agreement between experimental and theoretical energies, electromagnetic transition probabilities and spectroscopic factors will be outlined, especially in the case of ^{133}Sb and ^{49}Ca, showing the relevance of the new approach, as compared to traditional shell model calculations with a frozen core. Recent improvements of the model and possible future experimental developments with radioactive beams will be discussed.

[1] A. Bohr and B. M. Mottelson, Nuclear Structure. Volume II: Nuclear Deformations (W. A. Benjamin, New York, 1980).
[2] G. Colò et al., Phys. Rev. C 95, 034303 (2017).
[3] G. Bocchi et al., Phys. Lett. B 760, 273 (2016).

Summary

Primary author: Dr BOTTONI, Simone (University of Milano and INFN)

Co-authors: Prof. BRACCO, Angela (University of Milano and INFN); Prof. FORNAL, Bogdan (IFJ PAN Krakow); Dr MILLION, Bènèdicte (INFN Milano); Dr UR, Calin A. (ELI-NP); Dr MICHELAGNOLI, Caterina (ILL Grenoble); Dr CRESPI, Fabio C. L. (University of Milano and INFN); Prof. COLÒ, Gianluca (University of Milano and INFN); Dr BENZONI, Giovanna (INFN Milano); Dr JENTSCHEL, Michael (ILL Grenoble); Dr CIEPLICKA-ORYŃCZA, Natalia (IFJ PAN Krakow); Dr MUTTI, Paolo (ILL Grenoble); Prof. BORTIGNON, Pierfrancesco (University of Milano and INFN); Prof. LEONI, Silvia (University of Milano and INFN); Dr SOLDNER, Torsten (ILL Grenoble); Dr KÖSTER, Ulli (ILL Grenoble); Prof. URBAN, Waldemar (University of Warsaw); Dr NIU, Yifei (ELI-NP); Dr ISKRA, Łukasz (IFJ PAN Krakow)

Presenter: Dr BOTTONI, Simone (University of Milano and INFN)