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Structure of Ca isotopes between doubly closed shells

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Calcium nuclei between doubly closed shells, i.e. N=20 and N=28, offer a unique opportunity to investigate the evolution of nuclear structure from symmetric to neutron-rich systems. Along this isotopic chain, spherical configurations at shell closures are expected to be overcome by deformed structures in mid-shell nuclei, already at low excitation energy. This will significantly affect the interplay between single-particle and collective excitations, as well as particle/hole-core coupling schemes which appear in odd-mass isotopes. In this context, Ca nuclei lie in a mass region where different theoretical models, with different predictive powers, can be applied and turn out to be complementary to each other. This embraces ab initio approaches [1], shell-model calculations [2], DFT's [3] and beyond-mean-field models [4-5].
In this work, we present recent results on the low-spin structure of $^{41-49}$Ca nuclei, populated in a series of (n,γ), neutron-capture experiments performed at Institut Laue-Langevin in Grenoble. These studies required the use of very rare target materials, such as ^{46}Ca and ^{48}Ca, as well as a radioactive ^{41}Ca sample. High-resolution γ-ray spectroscopy was performed by using the high-efficiency EXILL [6-7] and FIPPS [8] HPGe composite arrays. Several new γ rays were found, and level schemes were substantially extended up to the neutron-capture state, approaching a complete low-spin spectroscopy for these isotopes. Moreover, γ-ray angular correlations were performed in order to pin down the multipolarity of a number of transitions, thus helping in the spin-parity assignment of the observed states. A selection of the experimental results is discussed and compared with theoretical calculations, including those obtained with the Hybrid Configuration Mixing model recently developed by the Milano group [4,5,7].

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