Cross-Shell Excitations: Spherical, Deformed and Superdeformed Structures Near Magic Nuclei ^{40}Ca, ^{56}Ni, and ^{100}Sn*

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For more than thirty years, shell model calculations have predicted that multiparticle-multihole excitations across magic numbers 20 and 28 would lead to very deformed and superdeformed states in the vicinity of doubly-magic nuclei ^{40}Ca and ^{56}Ni. These expectations were later confirmed in various cluster and mean field calculations that predicted the existence of new islands of superdeformation centered around ^{32}S and ^{60}Zn. However, it was only recently that advances in detector technology allowed exploration of cross-shell excited states, which are populated very weakly in fusion-evaporation reactions. In the past few years, a large collaboration consisting of researchers from ORNL, Lund University, McMaster University, LBNL, Washington University, ANL, University of Tennessee, and Koln University have succeeded in identifying these long-sought structures. Equally important, these experimental results have provided a unique testing ground to compare, confront and relate state-of-the-art calculations in the frameworks of large-scale shell model (Madrid-Strasbourg), Quantum Monte Carlo Diagonalization (Tokyo), VAMPIR (Tubingen), Hartree-Fock (Warsaw, University of Tennessee, Brussels), Relativistic Mean Field (Munich), and CSM (Lund). This talk will briefly review the highlights of these experimental and theoretical results, including the question of the importance of T=0 and T=1 pairing in these nearly N=Z nuclei, and discovery of exotic decays of superdeformed bands by emission of proton and alpha particles.

Spectroscopic study of doubly-magic nucleus ^{100}Sn has long been considered to be the “Holy Grail” of nuclear structure which will remain beyond our reach until the advent of the next generation of radioactive ion beam facilities. However, valuable insight into the single-particle energies around magic numbers N, Z=50 and core excitation across ^{100}Sn may be gleaned through studies of the low- to high-spin states in the vicinity of ^{100}Sn. In recent experiments, our collaboration has succeeded to observe, for the first time, core-excited states in ^{99}Cd (Z=48, N=51), and ^{101}In (Z=49, N=52). These results will be compared with large-scale shell model calculations performed by the Oslo Group.

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