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EVOLUTION OF THE SHELL STRUCTURE IN MEDIUM-MASS NUCLEI : SEARCH FOR THE 2d5/2 NEUTRON ORBITAL IN 69Ni

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It has been shown that the neutron 2d5/2 orbital has to be included in shell-model calculations to explain the appearance of large quadrupole collectivity observed in the neutron rich Fe and Cr of the N ≈ 40 region. This work initiated by Caurier et al. has been recently revisited. Calculations in a large valence space involving the fp proton shell and the fpgd neutron shells including a strongly
reduced 1g9/2 - 2d5/2 neutron gap down to ≈ 1.5 MeV affect the whole N = 40 region and point out a new island of inversion similar to those known for light nuclei around N = 8 and N = 20. A global mecanism could be deduced, in the frame of the shell-model approach, of the emergence of islands of inversion at Harmonic-Oscillator shell gaps driven by two particle-two hole neutron excitations into quadrupole-partner orbitals across these gaps.
Since now, no 5/2+ state has been assigned in previous studies of 69Ni, an ideal laboratory to search for the neutron 2d5/2 orbital. A (d,p) reaction onto a 68Ni beam produced at GANIL has been used to probe the single-particle energy of the 2d5/2 neutron orbital in 69Ni. Two 5/2+ states with important spectroscopic factors lying around 2.5 MeV excitation energy have been observed, for the first time, in 69Ni. The doublet is understood as the mixing of two main configurations of spherical nature. These results are in good agreement with large-scale shell-model calculations in which 2.5 MeV 1g9/2 - 2d5/2 gap for neutrons is included, and confirm experimentally Caurier's assumption of a reduced 1g9/2 - 2d5/2 neutron gap at N = 40.

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