A new island of inversion far from stability

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The study of neutron-rich isotopes of medium-mass nuclei is of current interest in modern nuclear physics. One of the principal interests in these studies comes from the fact that different theoretical calculations predict the disappearance of classical shell and sub-shell closures, such as N=28, 40 and 50, and the appearance of new ones, for example at N=16 and 32.

While the experimental information obtained for nuclear systems has been limited for decades to nuclei close to the stability line, the continuous experimental developments allow nowadays the study of exotic nuclei far from stability. Unexpected modifications to the shell structure have been already encountered and there is evidence that the usual magic numbers change when increasing the neutron number [1,2]. Responsible for these changes could be both the developments of a diffuse neutron surface that could fade the spin-orbit interaction as well as the proton-neutron monopole interaction that could reorder the single-particle orbits.

A neutron-rich region, where new magic numbers may appear and others disappear, is the one bounded by N = 28–40 and Z = 20–28. As a matter of fact, it has been shown that a new sub-shell closure is present at N = 32 but only for Z ~ 20 [1]. The appearance of this new shell gap has been explained [2] in terms of a strong spin-flip $\pi 1f_{7/2}-\nu 1f_{5/2}$ proton–neutron monopole interaction. On the other side it has been predicted that in the middle of this region nuclear deformation sets in, and that the sub-shell closure at N = 40 disappears. Near N=40, a new region of deformation is observed [3] due to changes in the shell structure in neutron-rich Cr and Fe isotopes. New experimental and theoretical results will be shown and discussed.

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