Exotic nuclear structure mechanisms and symmetries and their identifications through theory and experiment

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Our collaboration research projects exploit our earlier new discoveries published by us in refs [1-3] dealing with exotic shape symmetries in nuclei. More precisely, the nuclear shapes which are neither ellipsoidal prolate or oblate axial or quadrupole non-axial nor octupole pear-shape deformed are here called exotic – in contrast to those mentioned ones, studied over many years at the end of the previous century or at the beginning of the actual one. In particular our theory calculations predict that nuclei obtained out of doubly magic spherical ones by adding a few protons and/or neutrons loose their sphericity not by becoming quadrupole prolate or oblate deformed but instead octupole deformed with the quadrupole deformations α_{20} and α_{22} (alternatively β_2 and γ) vanishing. We have shown that the exotic symmetries associated with the octupole equilibrium deformations of the mentioned nuclei are C_{2v} implied by α_{31}, D_{2d} and T_d corresponding to α_{32} and D_{3h} induced by α_{33}. It turns out that all these symmetries together lead to the new quality of magic numbers which we refer to as 4-fold or universal: 4-fold because they are the same for all the 4 point group symmetries which generate different deformations; universal because they are deformation independent provided that the symmetries are those quoted.

Combining the properties of our nuclear mean-field Hamiltonian together with group theory arguments, we have derived the experimental criteria of identification of the exotic symmetries. In particular, after our own discovery of the T_d symmetry in ^{152}Sm nucleus already some years ago ref. [4], we have recently discovered the experimental evidence of the C_{2v} symmetry (nuclear symmetry equivalent to that of the water molecule) in ^{236}U and some of its neighbours, see our recently submitted article, ref. [5].

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[5] I. Dedes, J. Dudek, M. S. Martin, A. Baran, D. Curien, A. Gaamouci, A. Gozdz, A. Maj, A. Pedrak, D. Rouvel, K. Starosta, and J. Yang;
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