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Systematic Study of Nuclear Symmetries, Related Shapes, Their Competition and Generated Isomers

We present the nuclear structure theory project focussed on the large-scale, systematic, total energy calculations using realistic phenomenological mean-field theory approach. We present briefly the posing of the problem of the many-body nucleon-nucleon interactions together with its reduction to the mean-field plus pairing standard approximations. On a slightly technical level: we discuss elementary symmetries of our Hamiltonian such as time-reversal, `simplex' and `signature', allowing to accelerate the computing algorithms and at the same time profit from related conserved quantum numbers.

The main purpose of the realistic total energy calculations is to reveal the mechanisms of the shape coexistence and competition as well as a possible appearance of exotic symmetries. Whereas traditional approaches often address the issue of spherical vs. axial prolate and oblate shape coexistence, our interest is focussed on all other symmetries which need generally a description involving point-group theories and their representations.

As an illustration of those latter ones we present briefly the recent discovery by our group of the tetrahedral and octahedral symmetries in subatomic physics. These two particular symmetries are very unusual in that they imply the 4-fold degeneracies of single-nucleon levels (the standard being the Kramers 2-fold degeneracy) and, moreover, a totally new, unprecedented in nuclear physics a pattern of rotational bands.

We finish by presenting illustrations of the numerical results involving multidimensional deformation spaces with various multipole expansions of nuclear surfaces including all 4 octupole degrees of freedom (pear-shape, banana-, pyramid-like and triple-leave modes) various hexadecapole modes and higher ones up to the order lambda = 6. A surprising to us appear systematic and strong octupole instabilities of nuclei in the direct vicinity of the doubly-magic 208Pb nucleus; other modes are compared and discussed.

Uprzejmie zapraszam wszystkich pracowników, doktorantów i studentów Instytutu Fizyki.

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