Int. Workshop “Shapes and Dynamics of Atomic Nuclei: Contemporary Aspects”
ed. Nikolay Minkov, Heron Press, Sofia 2015

Shapes and Symmetries of Nuclei

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Abstract

An idea of quantum shape is revisited. Nuclear shapes and symmetries are strictly correlated notions. Even definition of a geometrical shape can be written in terms of transformations. It is especially important in case of quantum motions were shapes are ill defined objects because of probabilistic nature of quantum mechanics and the Heisenberg uncertainty relations. On the other hand, the distribution of nuclear matter in a nucleus is bounded in the space and it should define, to some extend, a ‘shape’ of the nucleus. A good characteristic, free from this problems, are intrinsic geometric transformations describing distribution of nuclear matter in the nucleus. The intrinsic geometric symmetries, which act in the intrinsic frame of a nucleus, are an appropriate tool, for this purpose.

There is a set of important questions about relations between shapes and symmetries. A few of them are:

- If symmetries of a nuclear Hamiltonian coincide with symmetries of quantum shape of a nucleus? The answer is not unique, it is dependent on details of the nuclear model.
- Definition of collective variables. In the collective models, in which collective variables are defined to describe a shape of a nucleus there is a problem of ‘unphysical’ shapes and their contribution to collective states.
- The projection methods like GCM allow to choose a class of required quantum shapes by applying constraints in terms of symmetries, however, it turns out that it has a great influence on observables, e.g. transitions among nuclear states.

These problem are still opened in some their aspects.

References

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