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

Coexisting Shapes and Shape-Phase Transition in Shell Models

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Abstract

To describe fluctuations about deformation equilibrium, especially for nuclei without a well-defined shape near the ground state, we have applied two kinds of shell models: large-scale shell model based on a spherical basis and projected shell model based on a deformed basis. Using the shell models, one may discuss the microscopic details that drive the shape evolution.

We investigate the oblate-prolate shape transition in ^{72}Kr using large-scale shell-model calculations, which describe well the large collectivity observed from the E2 transition between the first excited 4_1^+ and 2_1^+ states. The calculation predicts a prolately-deformed band built on the first excited 0^+ state and the ground-state band with an oblate shape. It is shown that the rapid change of shapes with rotation is caused by the mixing between the ground 0^+ state and the first excited 2^+ state. It is suggested that monopole interactions derived from the tensor force plays an important role for these shape changes.

To study shape-phase transition in heavy nuclei, improved shell-model wave functions are introduced by superimposing angular-momentum and particle-number projected states constructed with different quadrupole deformation and pairing gap parameters as two-dimensional generator coordinates. Using these as trial wave functions, we solve the Hill-Wheeler Equation and analyze obtained weight functions. The analysis of the obtained results for the excited 0^+ states of some rare-earth nuclei indicates clear features of quantum oscillation, with large fluctuations in deformation found for soft nuclei and strong anharmonicities in oscillation for rigidly-deformed nuclei.

This work is in collaboration with K. Kaneko, T. Mizusaki, R. Wadsworth, F.-Q. Chen, and P. Ring. It is partially supported by the National Natural Science Foundation of China (No. 11135005), by the 973 Program of China (No. 2013CB834401), and by the Open Project Program of State Key Laboratory of Theoretical Physics, Institute of Theoretical Physics, Chinese Academy of Sciences, China (No. Y5KF141CJ1).