Quadrupole shape dynamics in view from a theory of large amplitude collective motion

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The quadrupole shape motion is one of the fundamental modes of excitation in finite nuclei. The actual dynamics, however, is far from a simple oscillation since the nuclei are usually very soft with respect to the deformation, whose amplitude evolves largely in many cases. Transitional behavior between the rotor and the vibrator, shape coexistence, and fissions etc are such examples.

Microscopic description of the large amplitude quadrupole motions is a challenge for the nuclear structure theory, and we have made significant progress in last several years[1-4]. In short, we start with the time-dependent Hartree-Fock-Bololiubov equation including all nucleon degrees of freedom and effective two-body nuclear force, and arrive at the generalized Bohr Hamiltonian, whose constituent functions, i.e. the potential energy and the five inertial masses, are all microscopically derived. In practice, a large number of the QRPA calculations are performed for all the possible nuclear shapes in the β–γ plane. In result, the derived inertial masses are free from the shortcoming of the standard cranking mass calculation, and the experimental excitation spectra are reproduced quite well.

We shall illustrate our achievement for the case of ^{68}Se showing the oblate-prolate shape coexistence[1]. We then apply this theory to the current issues, e.g. the excited 0^+ states in neutron-rich $^{30\text{-}34}$Mg[2] and the evolution of collectivity in neutron-rich Cr isotopes with N~40[3], sometimes referred to as the islands of inversion. If time allows, we shall discuss our trial to the fission path.

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