Contribution ID: **297** Type: **Invited Presentation**

Quantum Self-organization and Nuclear Shapes

Thursday, 1 June 2017 13:45 (15 minutes)

The nuclear deformation is driven by the quadrupole-quadrupole (QQ) component in the effective nucleon-nucleon (NN) interaction. Intuitively speaking, the actual nuclear shape is determined by the following mechanism,
relevant driving force
deformation = −−−−−−−.
resistance
In the case of quadrupole deformation, the relevant driving force is the QQ force mentioned above, and a well-known example of the resistance is pairing interaction. There is another resistance power, that is, single-particle energies. If the single-particle orbits are separated too far, there is no sizable mixing among them, and hence no Jahn-Teller effect, namely, no deformation. Thus, single-particle energies, which can be viewed as the Nilsson levels at zero deformation, play crucial roles. Such single-particle energies have been considered to be close to constant within a nucleus. However, recent Monte Carlo Shell Model calculations on exotic Ni and Zr isotopes [1,2] showed that strongly-deformed bands are created and stabilized not only by strong effects of the QQ interaction but also by the change of single-particle energies of relevant orbits. For instance, in 98Zr, the relevant neutron single-particle orbits are spread over 5 MeV in its spherical ground state, whereas they become more degenerate within 2 MeV range in the first excited deformed 0+ state (Fig. 3 of [2]), due to massive proton excitations into g9/2 etc. We can regard this kind of phenomena as examples of the quantum self-organization, where atomic nucleus gains a certain shape (or collective mode in general) also by optimizing single-particle energies for this particular shape. This can be done if the NN interaction, particularly its monopole part, has rather strong orbital dependeces (e.g. tensor force) and the occupation numbers of relevant orbits can be reshuffled. This quantum self-organization can occur more frequently towards heavier nuclei with more orbits, exhibiting more beautiful rotational bands, for instance. The same mechanism can be applied to general many-body quantum systems with (i) mode-driving force and resistance controlling force, (ii) two Fermi liquids like protons and neutrons. In addition to shape coexistence and quantum shape phase transition, further developments will be discussed.

References:

[1] Tsunoda, Otsuka et al, PRC 89, 031301 (2014)
[2] Togashi, Tsunoda, Otsuka et al. PRL 117, 172502 (2016)

Primary author: Prof. OTSUKA, Takaharu (University of Tokyo)

Presenter: Prof. OTSUKA, Takaharu (University of Tokyo)

Session Classification: Breakout 2