Beyond mean-field description of impurity effect of Lambda hyperon on nuclear collective excitations

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Abstract

In the past decade, many high-resolution gamma-ray spectroscopy experiments have been carried out for Lambda hypernuclei. Data not only on the single-Lambda binding energy but also on the hypernuclear low-lying spectroscopy are accumulated which allow us to study the hyperon–nucleon interaction, properties of hadrons in nuclear medium, and in particular the impurity effect of hyperon on nuclear structure.

The self-consistent mean-field approach is nowadays one of the most important microscopic approaches for large-scale nuclear structure calculations and it has already been extended to study hypernuclei many years ago. In recent years, the impurity effect of Lambda hyperon on nuclear shape has drawn much attention. Both non-relativistic and relativistic mean-field approaches have been extended for hypernuclei with deformation degree of freedom. However, to quantify the impurity effect of Lambda on nuclear collectivity, a beyond mean-field approach is required to describe nuclear and hypernuclear low-energy spectroscopy.

Most recently, we have extended the triaxial relativistic mean-field approach implemented with a point-coupling interaction for Lambda hypernuclei. The impurity effect of Lambda hyperon on nuclear low-energy collective excitation is investigated by solving the five-dimensional collective Hamiltonian (5DCH) for nuclear quadrupole (beta, gamma) vibrational and rotational motions. The parameters of 5DCH are determined by the mean-field wave functions for the nuclear core in Lambda hypernucleus using the cranking approximation. We find that (1) Lambda hyperon reduces nuclear collectivity mainly by shifting the dominant components to the region of small deformation; (2) The relativistic approach predicts larger Lambda impurity effect than the non-relativistic approach; (3) The magnitude of impurity effect is not sensitive to the parameterization of nucleon-nucleon effective interaction, but to the hyperon-nucleon interaction. It provides the possibility to calibrate hyperon-nucleon interaction in nuclear medium with the data of impurity effect. The details of these works will be introduced in my talk. Moreover, I will mention briefly about our ongoing project on the low-lying spectroscopy for the whole Lambda hypernuclei.