Beyond-mean-field approach to low-lying spectra of Λ hypernuclei

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The development in Λ-hypernuclear spectroscopy has enabled one to explore several aspects of hypernuclear structure. The measured energy spectra and electric multipole transition strengths in low-lying states have in fact provided rich information on the Λ-nucleon interaction in nuclear medium as well as the impurity effect of Λ particle on nuclear structure.

Many theoretical methods have been developed to investigate the spectroscopy of hypernuclei, such as the cluster model, the shell model, the ab-initio method, the antisymmetrized molecular dynamics (AMD), and self-consistent mean-field models. Among them, the self-consistent mean-field approach is the only method which can be globally applied from light to heavy hypernuclei.

Even though the self-consistent mean-field approach provides an intuitive view of nuclear deformation, it is a drawback of this method that it does not yield a spectrum in the laboratory frame, since the approach itself is formulated in the body-fixed frame. That is, one has to transform the mean-field results to the laboratory frame in order to connect them to spectroscopic observables, such as $B(E2)$ values.

In this talk, we will present a new method for low-lying states of hypernuclei based on a beyond-mean-field approach [1,2]. The novelity of this method, which we call the microscopic particle-rotor model, is that low-lying states of hypernuclei are constructed by taking into account the excitations of the core nucleus, for which we employ the microscopic beyond-mean-field approach, that is, the generator coordinate method (GCM) with the particle number and angular momentum projections onto mean-field states. We will apply this method to study the low-lying spectrum of ${}^{9}_{\Lambda}$Be, ${}^{13}_{\Lambda}$C, ${}^{21}_{\Lambda}$Ne and ${}^{155}_{\Lambda}$Sm hypernuclei and will discuss the impurity effect in these hypernuclei. In particular, for all of these hypernuclei, we will show that the $B(E2)$ value from the first 2^+ to the ground states in the core nucleus is reduced by adding a Λ particle in the positive-parity states. We will also present detailed analyses for the transition densities and the potentials in the single-channel calculations, which provides clear characteristics the Λ-rotation coupling.

[1] H. Mei, K. Hagino, J.M. Yao, and T. Motoba, Phys. Rev. C**90** (2014) 064302.

[2] H. Mei, K. Hagino, J.M. Yao, and T. Motoba, arXiv: 1504.04924 [nucl-th].