Formation spectra of η-mesic nuclei by $(\pi^+$,p) reaction at J-PARC and chiral symmetry for baryons

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We investigate the properties of η-nucleus interaction in chiral models and their experimental consequences at J-PARC. One of the unique features of the η meson is that the η-nucleon channel strongly couples to the $N^*(1535)$ resonance. This feature enables us to investigate the in-medium properties of N^* through the formation of η-mesic nuclei. In this work, I calculate the η-mesic nuclei formation spectra by the $(\pi^+$,p) reaction [1], which is expected to be performed by using the secondary beam at the J-PARC project. We discuss the appropriate experimental conditions in order to see the in-medium properties of N^* and the properties of the η-nucleus interaction clearly in the formation spectra of the η-mesic nuclei. We also discuss carefully the η-mesic nuclei studies performed in 1980s [2] and show clearly how to improve the observations.

For in-medium properties of N^*, there are some theoretical models paying respects to the chiral symmetry. In the chiral doublet model [3], in which N^* is regarded as a chiral partner of nucleon, the effect of the partial restoration of the chiral symmetry reduces the mass difference of N and N^* in nuclear medium, and, as a consequence, the level crossing of the η-meson and N^*-h modes may take place in finite density [4]. This level crossing yields the curious shape of the η-nucleus optical potential, which has the repulsive core inside a nucleus and the attractive pocket in the surface, and also has the strong energy dependence [5].

On the other hand, the chiral unitary model [6], in which N^* is introduced as a resonance dynamically generated by meson-baryon scattering, predicts the different feature of the in-medium properties of N^*. We show that these two chiral models give quiet different features of the η-nucleus optical potential and we can clearly observe this difference in the formation spectra and get new information of the η-nucleus interaction and the chiral symmetry in medium.

We think our theoretical evaluation is quite important and useful to design the experiments at J-PARC for the formation of η-mesic nuclei.

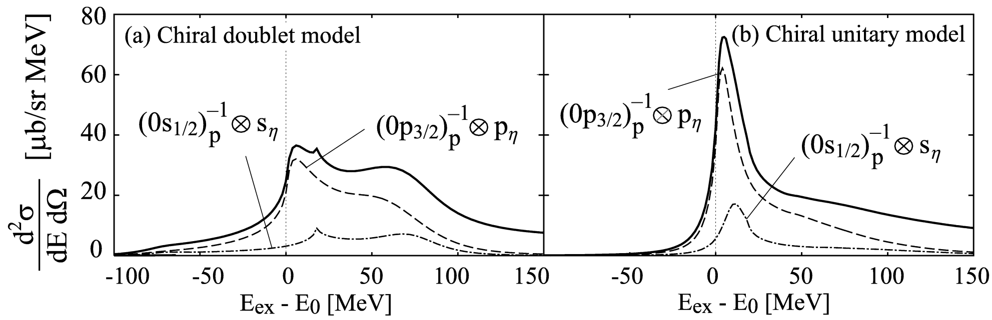

Figure 1: Formation spectra of the η-mesic nuclei by $(\pi^+$,p) reaction as functions of the excited energies with (a) the Chiral doublet model and (b) the Chiral unitary model.

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