Formation of $\eta'(958)$ mesic nuclei

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The $\eta'(958)$ meson is an interesting and important particle because of its exceptionally large mass and connection to the $U_A(1)$ problem, where the gluon dynamics is believed to play important role to give peculiarly larger mass to the η' meson than those of the other pseudoscalar mesons, π, K, and η. However, we have not yet understood the η' mass generation mechanism quantitatively.

Recently, two important developments have been reported in theoretical [1] and experimental [2] point of view for the study of the η' mass. Theoretically, it has been pointed out [1] that the anomaly effect can contribute to the η' mass only with the presence of the chiral symmetry breaking, which naturally leads to a conclusion of a relatively large mass reduction (~ 100 MeV) of the η' mass at normal nuclear density due to the partial restoration of chiral symmetry. The mass reduction at finite density is considered to be equivalent to the attractive meeson-nucleus interaction in the equation of motion, which can support the existence of the bound states, η' mesic nuclei. Actually, the recent study based on the theoretical optical potential has also concluded the possible existence of the bound states [3] assuming the sign of the real part of the $\eta' N$ scattering length which is not known. Thus, the study of the η' properties at finite density by observing the η' mesic nuclei is extremely interesting for the studies of the η' mass generation mechanism and the $U_A(1)$ problem. The formation reaction of the η' mesic nuclei was first considered in [4] and is considered to be possible in the actual experiments at GSI [2] recently.

Thus, in this report, we show the comprehensive results of the theoretical formation spectra of the η'-nucleus systems in the hadron reactions such as (p, d) [2] based on the latest theoretical considerations of the η' properties in nucleus [1,3]. The results shown here are important to give predictions and supports to the future experiment [2], and to make clear relations between the η' mesic nucleus formation spectra and the modifications of the η' properties at finite density, which will give us new information on the η' mass generation mechanism.

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