

Missing Mass Spectroscopy of η' Mesic Nuclei with (p, d) Reaction at GSI

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An η' meson has a peculiarly large mass, which is theoretically understood as the $U_A(1)$ axial anomaly effect. Since the strength of this effect for the η' mass is considered to be related to the chiral condensate [1], the η' mass may be reduced in nuclear medium, where the chiral symmetry is partially restored. According to the Nambu-Jona-Lasinio model calculation, the mass of η' at normal nuclear density is reduced by about $150 \text{ MeV}/c^2$ [2, 3]. Such large mass reduction implies a strong attractive potential between η' and a nucleus. Thus, η' meson-nucleus bound states (η' mesic nuclei) may exist.

As for the decay width, the CBELSA/TAPS collaboration deduced that the absorption width of the η' meson at the nuclear saturation density is around 15 - 25 MeV at the average η' momentum of $1050 \text{ MeV}/c$ [4]. This suggests that the decay width of η' mesic nuclei could be small as well, and they may be observed as narrow peaks experimentally.

We are planning a missing-mass spectroscopy of η' mesic nuclei with the $^{12}\text{C}(p, d)\eta' \otimes ^{11}\text{C}$ reaction at GSI [5]. A 2.5 GeV proton beam of the Heavy Ion Synchrotron (SIS) will be injected to a ^{12}C target. Then, to obtain the missing mass of the reaction, the momentum of the ejectile deuterons will be analyzed by the Fragment Separator (FRS) as a spectrometer. In this inclusive measurement, a signal-to-noise ratio is expected to be very small due to background processes dominated by quasi-free multi-pion production ($p + N \rightarrow d + \pi$'s). This can be overcome by a high-statistics measurement using an intense proton beam ($\sim 10^{10}$ /spill) and a thick production target ($\sim 4 \text{ g}/\text{cm}^2$). With this condition, if the mass reduction in the medium is around 150 MeV as predicted by the NJL model and the decay width is as small as 20 MeV, peak structures may be observed even in the inclusive spectrum [5].

In this contribution, we will describe the plan of this experiment, and report the feasibility study for several mass reductions and decay widths in the medium. Moreover, the status of the preparation for the first pilot experiment expected in 2013 - 2014 will be presented.

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