

Spectroscopy of η' -nucleus bound states at GSI-SIS

Hiroyuki FUJIOKA^(a) for the η -PRiME collaboration

^(a) Department of Physics, Kyoto University, Kyoto, Japan

The peculiarly heavy mass of the η' meson ($958 \text{ MeV}/c^2$), compared to other pseudoscalar mesons such as π , K , and η , is theoretically explained by the axial anomaly in QCD. This anomaly effect, pushing up the η' mass, may be weakened if the chiral symmetry breaking is partially restored at finite density and/or temperature [1]. According to the Nambu–Jona-Lasinio model, the η' mass drops by around $150 \text{ MeV}/c^2$ at nuclear saturation density [2,3].

The mass reduction in a nucleus is equivalent to an attractive interaction between the η' meson and the nucleus, which may lead to the possible existence of an η' -nuclear bound state. From an experimental point of view, the decay width of such a state should be narrow enough for the observation of a peak structure by missing-mass spectroscopy. Analyzing a transparency ratio measurement with photon beam, CBELSA/TAPS reports the absorption width of η' (with the average momentum $1050 \text{ MeV}/c$) to be around $15\text{--}25 \text{ MeV}$ at nuclear saturation density [4]. The decay width of η' -nucleus bound states may be small as well.

We plan to carry out a missing-mass spectroscopy measurement of the $^{12}\text{C}(p, d)^{11}\text{C} \otimes \eta'$ reaction at GSI-SIS [5]. A 2.5 GeV proton beam will be supplied by the SIS synchrotron and the outgoing deuterons will be momentum analyzed with good resolution by the fragment separator FRS. The overall mass resolution is estimated to be $\sigma \sim 1.6 \text{ MeV}/c^2$. If the mass reduction is around $150 \text{ MeV}/c^2$ and the decay width is smaller than $\approx 20 \text{ MeV}$, the observation of peak structures above a huge background coming from multi- π production may be possible in an inclusive measurement.

In this contribution, details of the proposed experiment and the feasibility of an inclusive measurement based on theoretical calculations [5] will be discussed.

- [1] D. Jido, H. Nagahiro, and S. Hirenzaki, Phys. Rev. C **85** (2012), 032201(R).
- [2] P. Costa, M. C. Ruivo, and Yu. L. Kalinovsky, Phys. Lett. **B 560** (2003), 171.
- [3] H. Nagahiro and S. Hirenzaki, Phys. Rev. Lett. **94** (2005), 232503; H. Nagahiro, M. Takizawa, and S. Hirenzaki, Phys. Rev. C **74** (2006), 045203.
- [4] M. Nanova *et al.*, Phys. Lett. B (2012) in print; M. Nanova *et al.*, Prog. Part. Nucl. Phys. (2012) in print.
- [5] K. Itahashi *et al.*, Letter of Intent for GSI-SIS (2011); K. Itahashi *et al.*, in preparation.

E-mail: fujioka@scphys.kyoto-u.ac.jp