



量子物理学・ナノサイエンス第 72 回特別セミナー

Search for η' -mesic nuclei with (p,d) reaction at GSI/FAIR

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日程 : 2020 年 1 月 9 日 (木) 16:00-

場所 : 南 5 号館 5 階 503CD 大会議室

概要

Possible existence of η' meson-nucleus bound states (η' -mesic nuclei) has recently attracted both theoretical and experimental interests, since their properties such as binding energies and widths would reflect nature of axial U(1) anomaly and chiral symmetry breaking in Quantum Chromodynamics (QCD). We started experimental programs to investigate η' -mesic nuclei at GSI Heavy Ion Research Center (Germany). The first experiment was performed in 2014 by using a 2.5 GeV proton beam to produce η' -mesic nuclei via the $^{12}\text{C}(p,d)\eta'x^{11}\text{C}$ reaction. The excitation energy of ^{11}C was obtained by measuring the momentum of the outgoing deuteron with the high-resolution spectrometer FRS. Despite the achieved high energy resolution and statistical sensitivity, no peak structure indicating the formation of η' -mesic nuclei was observed. Thus, upper limit for the formation cross section was determined and a constraint on the η' -nucleus interaction was deduced.

Presently, we are preparing for a future experiment with further improved experimental sensitivity. The key of this new experiment is simultaneous measurements of the forward outgoing deuteron from the $^{12}\text{C}(p,d)\eta'x^{11}\text{C}$ reaction and decay particles (protons) from η' -mesic nuclei. This semi-exclusive measurement will allow us to efficiently select signal events and thus suppress a large amount of physical background processes. The experiment is feasible by combining the FRS (or Super-FRS) spectrometer at GSI (FAIR) in Germany with a large acceptance detector system (WASA) surrounding a reaction target. Various developments are ongoing to realize this new experimental setup by the end of 2020 and to start production runs in 2021.

In this seminar, we will present the results of the first experiment and discuss the proposed future experiment. We will also introduce ongoing activities and developments to integrate the WASA detector system to FRS at GSI.

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