The Development of a New Aerogel Čerenkov Detector for the Spectroscopic Studies of Kaonic Nuclei

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Content

A series of experiments for the systematic investigation of the light kaonic nuclei is currently underway. Following the J-PARC E15 experiment, which clarified the existence of the "K^-pp" bound state, we are planning to conduct the J-PARC E80 experiment with the aim of studying the "K^-ppn" state [1]. This will serve as a stepping stone toward further experiments to explore heavier kaonic nuclei. Through these experiments, more detailed characteristics of kaonic nuclei with mass number dependence are expected to be revealed.

In the E80 experiment, a K^- beam of 1.0 GeV/c is incident on a liquid ^{4}He target at the K1.8BR beamline. The "K^-ppn" state is predicted to be produced via the ^{4}He(K^-, n) reaction, followed by its decay into Λd and Λpn. To detect the particles involved in the reaction, a Cylindrical Detector System (CDS) will be newly constructed. This CDS provides 4π acceptance and high resolution to enable exclusive measurement of the reaction and precise reconstruction of the "K^-ppn" state.

Furthermore, the configuration of the beamline will also be changed in order to utilize the K^- beam more efficiently. With this modification, beamline optics should be studied, and detectors are also necessary to be optimized to our experiment. One of the important detectors in the beamline spectrometer is an aerogel Čerenkov detector, which is used to distinguish between K^- and π^- at a beam. If this detector is installed outside the CDS solenoid magnet, the distance to the target becomes much longer than in previous experiments due to the length of the magnet, resulting in more kaons decaying before reaching the target. To reduce this effect, we consider a new aerogel Čerenkov detector near the target, specifically inside the solenoid magnet. Since this new detector must operate properly within the magnetic field, we plan to use MPPCs (SiPMs) instead of photomultipliers for the readout.

In this presentation, we will show the results of the light yield measurement using a prototype detector and introduce the plans of the detector test using the K^-/π^- beam at J-PARC in November 2025.

Reference

[1] F. Sakuma *et al.*, Systematic investigation of the light kaonic nuclei – via the in-flight ^{4}He(K^-, N) reactions –, Proposal for the J-PARC 30-GeV Proton Synchrotron (2020).

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