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Development of large acceptance spectrometer for systematic study of kaonic nuclei at J-PARC

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Bound states caused by attractive $\bar{K}N(I=0)$ interaction, such as $\Lambda(1405)$ and kaonic nuclei, are interesting systems with strangeness.
Many experimental attempts have tried to establish an existence of the lightest kaonic nuclei, "K^-pp". However, no clear conclusion was reached. Recently, J-PARC E15 collaboration searched for "K^-pp", using the in-flight $K^- +^3$ He reaction with an exclusive analysis of the Λpn final state. By reconstructing not only the Λp invariant-mass but also the momentum transfer to the Λp system, they definitely showed event concentration interpretted as "K^-pp" bound state with $B.E. = 42 \pm 3(\text{stat})^{+3}_{-4}(\text{syst})$ MeV and $\Gamma = 100 \pm 7(\text{stat})^{+19}_{-9}(\text{syst})$. Moreover, small spatial size of "K^-pp" is implied, which supports theoretical predictions that a high-density nuclear matter is realized in heavier kaonic nuclei.

In order to expand this successful experimental method to heavier kaonic nuclei, such as $\bar{K}NNN, \bar{K}NNNN, \ldots,$ and detailed study for fundamental properties of the $\bar{K}NN$ state, we are developping a new magnetic spectrometer.
Because an exclusive analysis requires detections of decay particles from the kaonic nuclei as many as possible, the new spectrometer will have larger solid angle of 93%. To realize it, superconducting a sorenoid magnet and some detectors, a cylindrical drift chamber and charged particle/neutron counters, are 3-4 meters long. Detection efficiencies for neutron would be improved at least 1.7 times better than that of the current spectrometer.

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