Measurement of the radiative decay of $\Lambda(1405)$ by using a large acceptance Hyperon spectrometer at J-PARC

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It has been a long story on the structure of the $\Lambda(1405)$, since first seen in bubble chamber experiments. The nature of the $\Lambda(1405)$ is still controversial about whether the $\Lambda(1405)$ is a three quark state coupled with the S-wave $\overline{K}$-N channel or an unstable $\overline{K}N$ bound state. Recent theoretical interpretations of the $\Lambda(1405)$ show that the $\Lambda(1405)$ should be a $\overline{K}$-N quasi-bound state rather than a simple three-quark state. The chiral unitary model suggests that the $\Lambda(1405)$ can be dynamically generated and it has two-pole structure in the $I = 0$ channel. The line shape of the $\Lambda(1405)$ has been measured in the photoproduction and hadronic beams and it is fairly agreed with the two-pole structure. But still it needs confirmation for its structure and pole position. The electromagnetic transitions rates of excited baryons to their ground baryon state are a clean probe to see the structure of the baryons. However the radiative decay has a very small branching ratio, which is of the order of 1%. While the radiative decay of the $\Sigma(1385)$ and the $\Lambda(1520)$ were reported, there are no direct measurements of the radiative decay of the $\Lambda(1405)$. Recent theoretical calculation showed that the $\overline{K}N$ compositeness of the $\Lambda(1405)$ relates with the radiative decay width of $\Lambda(1405) \rightarrow \Lambda\gamma$ [1]. The Hyperon-Time-Projection (HypTPC) is being built at the J-PARC hadron experimental facility to explore an existence of the H-dibaryon [2] and the 3-body hadronic nucleon resonances [3] as shown in Fig. 1. The HypTPC is suitable to measure the radiative decay of the $\Lambda(1405)$ due to the large acceptance and high resolution. Additionally, we are developing a gamma-array counter for improving the detection of the radiative decay.

In this presentation, we will discuss the detector R&D and the expected results of a new experiment to measure the radiative decay of the $\Lambda(1405)$ with the HypTPC at J-PARC.

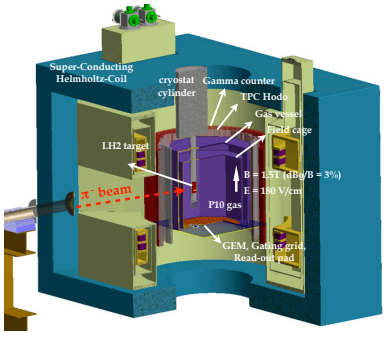

Figure 1: A cross-section view of the hyperon specrometer

[1] T. Sekihara and S. Kumano, Phys. Rev. C **89**, 025202 (2014)

[2] J.K. Ahn *et al.* (E42 collaboration), Proposal for J-PARC 50 GeV Proton Synchrotron

[3] K.Hicks *et al.* (E45 collaboration), Proposal for J-PARC 50 GeV Proton Synchrotron