Spectroscopic study of hyperon resonance below $\bar{K}N$ threshold via the $d(K^-, n)$ reaction at J-PARC

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The $\Lambda(1405)$ is the baryon of $I(J^p) = 0(1/2^-)$, $S = -1$, $m = 1405^{+1.3}_{-1.0}$ MeV and $\Gamma = 50.5 \pm 2.0$ MeV(PDG[1]). Because the $\Lambda(1405)$ is located at just below the $\bar{K}N$ threshold, there is a longstanding argument if the $\Lambda(1405)$ is a $\bar{K}N$ bound state[2]. On the other hand, a chiral unitary model claims the $\Lambda(1405)$ is a dynamically generated state of meson-baryon[3]. According to this model, the $\Lambda(1405)$ consists of two poles. One is coupled to the $\pi\Sigma$ state and the other is the $\bar{K}N$ state[4]. In the recent experiments, the peak position and line shape of the $\Lambda(1405)$ were reported, employing the different reaction, $pp \to K^+p(\pi\Sigma)^0$ in HADES[5] and $\gamma p \to K^+(\pi\Sigma)^0$ in CLAS[6]. They reported the different mass spectra depending on the final states. This fact does not directly mean controversial because the reaction mechanism forming the $\Lambda(1405)$ is unclear. To answer this question, it is necessary to measure the $\Lambda(1405)$ mass spectrum employing the reaction directly coupled to the $\bar{K}N$ (or $\pi\Sigma$) state. Therefore, we proposed an experiment by using the $d(K^-, n)$ reaction at the K1.8BR beam line of the J-PARC hadron facility(J-PARC E31[7]), where the K^- knocks a neutron out from the deuteron and the recoiled $\bar{K}$ reacts with a residual nucleon to form $\Lambda(1405)$. We detect the neutron knocked out forward and measure $d(K^-, n)X$. Simultaneously, we measure charged decay particles by the cylindrical detector system surrounding the target to identify all $\pi\Sigma$ decay final states. The E31 experiment will provide conclusive information on how the $\Lambda(1405)$ coupled to the $\bar{K}N$ state. Recently, we shortly took data of the (K^-, n) reaction on the D_2 target. We expect that the data contain a little amount of the $\Lambda(1405)$ production events and its statistics is enough to identify the $\Lambda(1405)$ production. We will present the first preliminary result on the $\Lambda(1405)$ spectrum produced via the $d(K^-, n)$ reaction at 1 GeV/c.

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