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Study of mesonic decay of KbarNN using J-PARC E15 data

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The lightest kaonic nuclear bound state, $\bar{K}NN$, was observed by measuring a non-mesonic decay of $\bar{K}NN \to \Lambda p$ in the J-PARC E15 experiment. The obtained binding energy, $B.E. \sim 40\,\mathrm{MeV}$ is compatible with those of theoretical predictions. On the other hand, the obtained decay width, $\Gamma_{\bar{K}NN} \sim 100\,\mathrm{MeV}$, is rather larger than the predictions. It is also noticeable that $\Gamma_{\bar{K}NN}$ is $\sim$ twice larger than the decay width of $\Lambda(1405)$ ($\equiv \bar{K}N$ quasi-bound system). To understand why the $\Gamma_{\bar{K}NN}$ is large, it is essential to measure other decay modes of $\bar{K}NN$, in particular, mesonic decay modes which are considered to be major decay branch of $\bar{K}NN$. Therefore, we analyzed data obtained in the J-PARC E15 to measure the $K^{-}{}^{3}\mathrm{He} \to \pi YNN'$ reactions, specifically $\pi^{\mp}\Sigma^{\pm}pn'$, $\pi^{+}\Lambda nn'$, and $\pi^{-}\Lambda pp'$. The invariant mass and momentum transfer distributions of πYN were well reproduced by employing model fitting functions for $\bar{K}NN$ production and quasi-free $\bar{K}$ absorption processes. We obtained cross-sections for four $\bar{K}NN \to \pi YN$ decay branches, and the decay branching ratios of $\bar{K}NN$ were found to be $\Gamma_{\pi YN}/\Gamma_{YN} = \mathcal{O}(10)$ and $\Gamma_{\pi\Lambda N} \sim \Gamma_{\pi\Sigma N}$. This indicates that the $\pi\Lambda N$ decay mode, which involves mesonic $\bar{K}N$ absorption with $I_{\bar{K}N} = 1$, significantly contributes to the $\bar{K}NN$ decay, making the $\bar{K}NN$ state approximately twice as unstable as $\Lambda(1405)$.

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