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Kaonic Nucleus Search via $^{12}\mathrm{C}(K^-, p)$ Reaction at J-PARC

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"Recent theoretical and experimental studies have provided insights into the properties of the $\bar{K}N$ interaction. Theoretically, it has been argued that the formation of a molecular-like quasi-bound state, $\Lambda(1405)$, arises from the strong attraction between $\bar{K}$ and nucleon with isospin I = 0 channel. Experimentally, the K-pp three-body system, the lightest Kaonic nucleus, was observed at J-PARC[1,2]. To further understand the many-body dynamics involving $\bar{K}$ and nucleons , it is essential to investigate Kaonic nuclei across a wide range of mass numbers, which also contributes to discussions on the presence of $\bar{K}$ in neutron star cores[3].

The J-PARC E05 experiment studied the $\bar{K}$-nucleus interaction by measuring an inclusive $^{12}\mathrm{C}(K^-, p)$ spectrum, which determined the $\bar{K}$-nucleus optical potential[4]. Additionally, they observed a significant excess in the spectrum around 90 MeV in the $\bar{K}$ binding energy region, which suggests a possible contribution from a bound state involving an excited hyperon (Y^*) in the core nucleus.

We can analyze the event excess, which was observed in the previous J-PARC E05 experiment, using the dataset in the J-PARC E42 experiment. We used a GEM-based Time Projection Chamber, HypTPC, to measure decay-charged particles. This coincidence measurement will significantly enhances the signal-to-noise ratio, enabling the identification of the event excess as a clear bump structure.

In this talk, we will present the status of our analysis. We have confirmed the consistency of the inclusive spectrum with the previous J-PARC E05 result. Additionally, we will show an analysis measuring decay particles using the HypTPC, allowing us to investigate the exclusive spectra for various decay modes. Currently, we are focusing on the identification of $Lambda$ or $Lambdap$ decay modes in which we are interested in the event excess search. We will report on the correlations between various physical quantities, such as Kaon binding energy, $Lambdap$ opening angle, and the momentum of decay particles, and compare the data analysis with simulation.

Ref.

[1] S.Ajimura *et al.* Phys. Let. B **789** (2019) 620-625

[2] T. Yamaga *et al.* Phys. Rev. C **102**, 044002 (2020)

[3] T. Muto et al., PTEP, 2022, 093D03 (2022)

[4] Y. Ichikawa et al., PTEP **2020**, 123D01 (2020)"

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