The formation of the deeply-bound $K^-pp$ state in $^3$He(in-flight $K^-,n$) reaction spectrum

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In the study of $\bar{K}$ properties in nuclear medium, it is important subject to verify the presence of the deeply-bound kaonic nuclei. The FINUDA collaboration at DAΦNE reported the evidence of a deeply-bound $K^-pp$ state by using the stopped $K^-$ reaction on several nuclear targets [1], but it is not confirmed due to the possibility of the different interpretation [2]. Among the various $\bar{K}$-nuclear systems, $K^-pp$ is the lightest and the most fundamental kaonic nuclei. Recently, a new experimental search of $K^-pp$ using the in-flight ($K^-,n$) reaction on $^3$He target is proposed for J-PARC [3]. Our purpose is to calculate the expected spectra for preparing the forthcoming J-PARC experiment.

The formation of the $K^-pp$ bound state by the $^3$He(in-flight $K^-,n$) reaction is investigated theoretically. The inclusive and semi-exclusive spectra at $p_{K^-} = 1.0 \text{ GeV}/c$ and $\theta_n = 0^\circ$ are calculated in the distorted-wave impulse approximation using the Green’s function method. We employ optical potentials between the $K^-$ and “$pp$” core-nucleus, and demonstrate systematically the dependence of the spectral shape on $V_0$ and $W_0$, which are the real and imaginary parts of the strength for the optical potential, respectively. Some examples of the calculated inclusive and semi-exclusive spectra are shown in Figure 1 [4].

![Figure 1: The calculated inclusive and semi-exclusive spectra as a function of the neutron momentum in the case of (left) $V_0 = -300 \text{ MeV}$ and $W_0 = -70 \text{ MeV}$ and (right) $V_0 = -350 \text{ MeV}$ and $W_0 = -100 \text{ MeV}$.](image_url)

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