Construction of $\bar{K}N$ potential and structure of $\Lambda(1405)$ based on chiral unitary approach

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The systems with an antikaon and nucleons have drawn a lot of attention. Various consequences are predicted for the $\Lambda(1405)$ resonance [1] and the $\bar{K}$-nuclei [2]. While the theoretical predictions of these systems are qualitatively similar to each other, quantitative differences are still large. The main reason for the differences is the uncertainty of the $\bar{K}N$ potential in the subthreshold energy region due to the weak constraint from the old experimental data. Recently, SIDDHARTA collaboration has measured the precise data for the $\bar{K}N$ scattering length [3]. Considering this new experimental data, we can reduce the potential uncertainty significantly.

The goal of this work is to construct the $\bar{K}N$ single-channel local potential with the new SIDDHARTA data. This local potential is useful for the calculation of the $\bar{K}$-nuclei and the extraction of the spacial structure of $\Lambda(1405)$. We construct the local potential [4] to reproduce the scattering amplitude from chiral unitary approach [5], which is the method to treat the nonperturbative phenomena resumming the interaction term from chiral perturbation theory. We establish the new procedure to reproduce the original amplitude even in the complex energy plane, which is considered to be important for the structure of $\Lambda(1405)$ and the $\bar{K}$-nuclei. Applying the new procedure to the SIDDHARTA data, we construct the reliable $\bar{K}N$ local potential for the quantitative calculations. With this new local potential, we analyze the wave function of $\Lambda(1405)$ shown in Fig. 1. We find that the structure of $\Lambda(1405)$ is dominated by the meson-baryon molecular state.

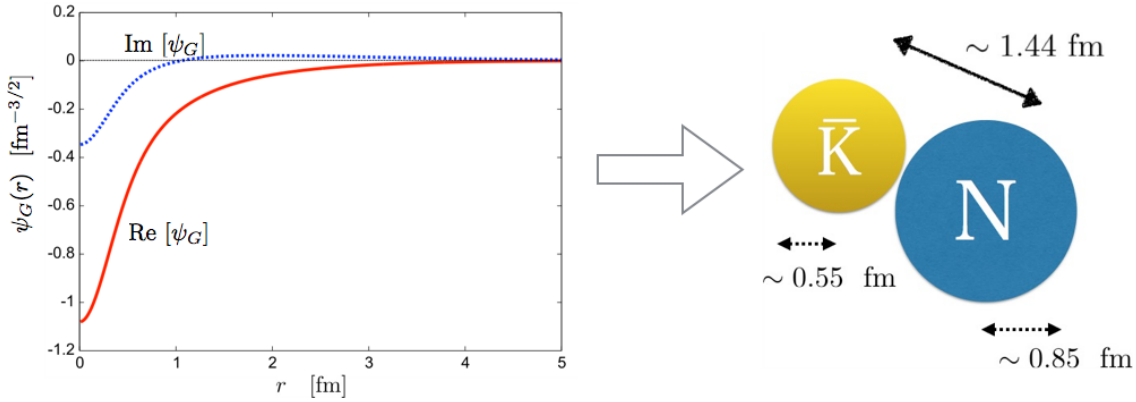

Figure 1: The $\bar{K}N$ wave function ψ_G and the schematic picture of $\Lambda(1405)$.

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