Quasi-bound states in the $\bar{K}NN$ and $\bar{K}\bar{K}N$ systems

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A quasi-bound state can exist in systems consisting of antikaon(s) and nucleon(s), including the lightest possible K^-pp system. Many theoretical efforts were devoted to study of this three-body system using different methods and inputs, and the predicted binding energies and widths differ from each other. Several experiments reported evidences of the K^-pp quasi-bound state observation, however the estimated characteristics of the state also differ between themselves and from all theoretical predictions.

The most recent E15 experiment at J-PARC [1,2] reported the first clear signal of the $\bar{K}NN$ quasi-bound state with binding energy about 40 MeV, and width about 100 MeV. The measured binding energy of the state is comparable with some of the theoretical predictions, while the experimental width is much larger than all of them. Our most recent results for the binding energies of the K^-pp state [3] obtained from Faddeev-type AGS equations [4] solution using two of three our antikaon-nucleon potentials as an input are close to the experimental values. However, the predicted widths are much smaller then the experimental width measured by the E15 experiment.

We tried to resolve the question, wether it is possible to obtain theoretical results closer to the experimental ones. To do this we performed fine tuning of the binding energies and widths of the quasi-bound states in three-body systems consisting of antikaons(s) and nucleon(s). Dynamically exact three-body Faddeev-type AGS equations [4] with three coupled particle channels were solved for description of the $\bar{K}NN$ and $\bar{K}\bar{K}N$ systems in different spin states. New models of the antikaon-nucleon interaction together with hyperon-nucleon and pion-nucleon potentials were constructed and used as an input. The width of the quasi-bound K^-pp state calculated with our one-pole $\bar{K}N$ potential reproduces the experimental width from E15 experiment.

Reference

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[2] T. Yamaga et al. (J-PARC E15 Collaboration), Phys. Rev. C 102, 044002 (2020).

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