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Four-body Faddeev-type calculation of the K̄NNN system

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The attractive nature of $\bar{K}N$ interaction has stimulated theoretical and experimental searches for K^- bound states in different systems. In particular, many theoretical calculations devoted to the lightest possible system $\bar{K}NN$ have been performed using different methods: Faddeev equations with coupled channels, variational methods, and some others, see a review \cite{review} and references therein. All of them agree that a quasi-bound state in the K^-pp system exists but they yield quite diverse binding energies and widths. The experimental situation is unsettled as well: several candidates for the K^-pp state were reported by different experiments, but the measured binding energies
and decay widths of such state differ from each other and are far from all theoretical predictions.

Detection of the heavier four-body $\bar{K}NNN$ system could be easier than in the case of $\bar{K}NN$ since direct scattering of K^- on three-body nuclei can be performed. Some theoretical works were devoted to the question of the quasi-bound state in the $\bar{K}NNN$ system with different quantum numbers, but more accurate calculations within Faddeev-type equations are needed. The reason is that only these dynamically exact equations written in momentum representation can treat energy dependent $\bar{K}N$ potentials, necessary for the this system, exactly.

We solved four-body Faddeev equations in GS form [1] in order to search for the quasi-bound state in the $\bar{K}NNN$ system. We used our experience with the three-body AGS calculations and our two-body potentials, constructed for them. Namely, three models of the $\bar{K}N$ interaction were used: two phenomenological potentials and a chirally motivated one. All three potentials describe low-energy K^-p scattering and $1s$ level shift of kaonic hydrogen with equally high accuracy. This will allow us to study the dependence of the four-body results on the two-body input. Dependence of the results on the nucleon-nucleon interaction model was studied as well.

[1] P. Grassberger, W. Sandhas, Nucl. Phys. B 2, 181 (1967).

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