Variational Calculation of K^-pp with Chiral SU(3)-based $K^{bar}N$ Interaction

A. Doté[1], T. Hyodo[2,3], and W. Weise[3]

[1] IPNS/KEK, 1-1 Ooho, Tsukuba, Ibaraki, Japan, 305-0801

[2] Yukawa Institute for Theoretical Physics, Kyoto University, Kyoto 606--8502, Japan

[3] Physik-Department, Technische Universität München, D-85747 Garching, Germany

Kaonic nuclei (nuclear systems with a strongly bound anti-kaon) have recently become a hot topic in hadron and nuclear physics when it was suggested, using a simple phenomenological $K^{bar}N$ potential model, that they might exist as deeply bound states with small width. However, experiments performed in search for such states have so far been inconclusive. An important prototype system for such investigations is K^-pp, the simplest K^{bar}-nuclear cluster. Recently this system has been studied using Faddeev and variational approaches with $K^{bar}N$ interactions constrained by phenomenology and properties of the $\Lambda(1405)$.

We present here an improved variational calculation[1] with realistic interactions as input:

- the Argonne v18 potential with its strongly repulsive short-range core as a realistic *NN* potential reproducing *NN* scattering and deuteron data;
- an updated effective $K^{bar}N$ interaction based on chiral SU(3) coupled-channel dynamics[2] which reproduces scattering data in the $S=-1$ meson-baryon sector and dynamically generates the $\Lambda(1405)$ as an $I=0$ $K^{bar}N$ quasibound state embedded in the resonant $\pi\Sigma$ continuum. This interaction is translated into the form of an equivalent single-channel, complex and energy dependent $K^{bar}N$ potential.

Systematic studies with four variants of chiral SU(3) coupled-channel models have been performed, with the result that the K^-pp cluster is not deeply bound and has a large decay width. Using the *s*-wave effective $K^{bar}N$ interaction governed by the Weinberg-Tomozawa chiral low-energy theorem we find a total binding energy of 20 $\pm$ 3 MeV and a decay width $\Gamma(K^{bar}NN \rightarrow \pi YN)$ = 40 - 70 MeV. In comparison with previous calculations, this relatively weak K^-pp binding is primarily related to the fact that, as a consequence of $K^{bar}N \rightarrow \pi\Sigma$ coupled-channel dynamics constrained by chiral $SU(3)\times SU(3)$, the $\Lambda(1405)$ appears not at its nominal position, 1405 MeV, but at 1420 MeV in the $I=0$ $K^{bar}N$ channel[2]. Corrections from *p*-wave $K^{bar}N$ interactions, dispersive effects and two-nucleon absorption ($K^{bar}NN \rightarrow YN$) are also estimated. As a result of these corrections, K^-pp binding energy B(K^-pp) is 20 - 35 MeV, and the width is possibly in a range of 60 - 120 MeV. Structure of this weakly bound system will be reported. A few disputable points will be presented: 1. Difference between our result and those obtained by other calculations. 2. Comparison with experimentally observed object.

[1] A. Doté, T. Hyodo and W. Weise, Nucl. Phys. **A804**, 197 (2008); arXiv:0806.4917v1.

[2] T. Hyodo and W. Weise, Phys. Rev. **C77**, 035204 (2008).