Quark mass dependence of H-dibaryon

Yasuhiro Yamaguchi[1], Tetsuo Hyodo[1]

[1]Yukawa Institute for Theoretical Physics, Kyoto University, Kyoto, 606-8317, Japan

The H-dibaryon is the exotic multiquark state with baryon number 2 and strangeness -2, as predicted by Jaffe [1]. Although the observation of the double hypernuclei excludes the existence of the deeply bound H-dibaryon [2], the recent lattice QCD simulations have found the bound state below the $\Lambda\Lambda$ threshold with large quark masses by HALQCD and NPLQCD collaborations [3-5]. It is expected that the obtained binding energy decreases as the quark mass approach the physical point [6,7].

In this talk, the quark mass dependence of the H-dibaryon mass is discussed using the energy effective field theory technique. The binding energy of the H-dibaryon with the quark mass dependence is calculated by the pionless EFT where a bare H-dibaryon field is coupled with two-baryon states. The EFT is applicable to the scattering amplitude of the two-baryon system near the threshold. We determine the parameters in this theory by fitting the recent lattice QCD results. As a result, we obtain the attractive scattering length at the physical point where the H-dibaryon is unbound. However we find the inconsistency between lattice data. The parameters determined only by the HALQCD results give the attractive scattering length at $(m_\pi, m_K) \sim (390\,\mathrm{MeV}, 550\,\mathrm{MeV})$ where the NPLQCD finds the bound state. In fact, the recent lattice calculation [4] shows that the H-dibaryon is unbound at $(m_\pi, m_K) \sim (410\,\mathrm{MeV}, 635\,\mathrm{MeV})$. The inconsistency should be resolved in future lattice studies.

[1] R. L. Jaffe, Phys. Rev. Lett. **38** (1977) 195 [Erratum-ibid. **38** (1977) 617].

[2] H. Takahashi, J. K. Ahn, H. Akikawa, S. Aoki, K. Arai, S. Y. Bahk, K. M. Baik and B. Bassalleck *et al.*, Phys. Rev. Lett. **87**, 212502 (2001).

[3] T. Inoue *et al.* [HAL QCD Collaboration], Phys. Rev. Lett. **106** (2011) 162002; T. Inoue *et al.* [HAL QCD Collaboration], Nucl. Phys. A **881** (2012) 28.

[4] K. Sasaki [HAL QCD Collaboration], Nucl. Phys. A **914**, 231 (2013).

[5] S. R. Beane *et al.* [NPLQCD Collaboration], Phys. Rev. Lett. **106** (2011) 162001; S. R. Beane *et al.* [NPLQCD Collaboration], Phys. Rev. D **85** (2012) 054511.

[6] P. E. Shanahan, A. W. Thomas and R. D. Young, Phys. Rev. Lett. **107**, 092004 (2011); P. E. Shanahan, A. W. Thomas and R. D. Young, JPS Conf. Proc. **1**, 013028 (2014).

[7] J. Haidenbauer and U. G. Meissner, Phys. Lett. B **706**, 100 (2011); J. Haidenbauer and U. G. Meissner, Nucl. Phys. A **881**, 44 (2012).