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Investigation of KbarNN resonances with a coupled-channel Complex Scaling Method + Feshbach projection

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In strange nuclear physics and hadron physics, kaonic nuclei (nuclear system with anti-kaons (Kbar)) have been a hot topic since the formation of dense state are expected due to the strong KbarN attraction. To reveal the nature of kaonic nuclei, lots of efforts have been devoted to the study of a prototype system of kaonic nuclei, "K-pp". Especially, now is the very exciting time because new experimental results are being reported from two groups of J-PARC (E15 and E27).

We have started a study of kaonic nuclei with a coupled-channel Complex Scaling Method (ccCSM) which was proposed in our previous work [1]. This method can treat simultaneously coupled-channel problem and resonance problem which are important ingredients for the K-pp study. Recently, we have developed a handy method, so-called ccCSM+Feshbach method. The K-pp is actually a coupled-channel system of Kbar NN and pi YN. (Y=Lambda, Sigma hyperon) Such a coupled-channel problem can be well reduced to a single-channel problem of KbarNN by a tricky use of ccCSM to be realized the Feshbach projection completely.

Up to now, by a careful study with the ccCSM+Feshbach method using an energy-dependent potential based on chiral SU(3) theory [1], we have obtained results as follows: The K-pp is not so deeply bound with ~30 MeV binding. The decay width depends on a parameter and ansatz for the treatment of energy dependence; 20~60 MeV. Analyzing the ccCSM wave function, we find that the mean distance of two nucleons in the K-pp is found to be ~2.2 fm which is almost equal to the NN distance in normal nuclear matter.

So far, we have considered only the KbarNN with spin 0 and isospin 1/2. In the conference, we will report KbarNN resonances with other quantum numbers, such as spin 1 which may appear in the the J-PARC experiments. We hope to discuss on comparison of our result and the J-PARC experimental results. In addition, we will mention to the relativistic effect and the preliminary result of the full coupled-channel calculation, if possible.

Reference
[1] A. Dote, T. Inoue and T. Myo, Nucl. Phys. A912, 66 (2013).

Primary author: Dr DOTE, Akinobu (KEK Theory Center)

Co-authors: Dr INOUE, Takashi (Nihon University, College of Bioresource Sciences); Dr MYO, Takayuki (Osaka Institute of Technology)

Presenter: Dr DOTE, Akinobu (KEK Theory Center)

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