

1. Title of research

Structure of tetra and pentaquark system with quark model

2. List of participant

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3. Period of research

From Sep.18, 2019 to Mar. 31st, 2020

4. Main location of collaboration implementation

RCNP and Kyushu Univ.

5. Publication list and talks

• ‘Compact ssscc-bar pentaquark states predicted by a quark model, Q. Meng, E. Hiyama, K.U. Can, P. Gubler and M. Oka, Physics Letter B, 798, 135028 (2019).

Talks:

• E. Hiyama, “Five-body structure of sssc_c system”, Perspectives in Hadron Physics, Sep.23,2019, International Center for Interdisciplinary Science, Viet Nam

• Q. Meng*, E. Hiyama, K.U. Can, P. Gubler and M. Oka, ‘Pentaquark system ssscc-bar’, JPS fall meeting, Sep. 17, 2019, Yamagata Univ., Japan.

• Q. Meng*, E. Hiyama, K.U. Can, P. Gubler and M. Oka, ‘Structure of doubly heavy tetraquark systems’, March 17, 2020, Nagoya Univ. Japan

6. Description of output

Since the observation of the tetraquark system (X(3872)) by BELLE group, and the pentaquark system of Θ^+ by RCNP, we have been obtained many exotic multi-hadron systems. Especially, one of the recent hot topics is observation of Pc by LHCb in 2015 and there were many theoretical effort to describe structure of these systems. Some of our present group also tried to study these systems with non-relativistic constituent quark model together with Gaussian Expansion method. However, it was difficult to find a resonant state in the observed energy region. While, we found a sharp resonant state in much higher energy region than the observed energy region. This work has been already published in Phys. Rev. C98, 045208 (2018) as collaboration research by

RCNP. From this fact, we have the following question: The calculated sharp resonant states predicted by our model are reliable or not? Now, we have no experimental data in the higher energy region predicted by us. To answer this question, one of the useful tool is to compare our result by quark model with that by Lattice QCD. The Lattice QCD calculation prefers the tetra and penta quark system with heavy mass such as charm or bottom.

Then, in 2019, we calculated $\text{sssc}\bar{c}$ pentaquark system which have ever never observed yet. To calculate this system, first we used 5-body quark model. The two-body interaction is used to reproduce the observed meson-baryon systems. Furthermore, we take into account of meson-baryon scattering channel. To obtain a resonant state, we use real scaling method.

As a result, we predicted four sharp resonances, $J^P=1/2^-(E=5180 \text{ MeV}, \Gamma=20 \text{ MeV})$, $5/2^-(5670 \text{ MeV}, 50 \text{ MeV})$, and $1/2^+(5360 \text{ MeV}, \Gamma=80 \text{ MeV})$. As a next step, we should compare the results with those give by Lattice QCD in the future.