

MERIT Errantry Report

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Introduction

I stayed TRIUMF in Vancouver for 10 days to join the workshop, Progress in Ab Initio Techniques in Nuclear Physics (28th Feb. - 3th Mar.) and to give a seminar on 7th March at TRIUMF theory group. TRIUMF, located in the campus of University of British Columbia, is one of the world's leading physics laboratories. Its large user community is composed of international teams of scientists studying elementary particle physics, nuclear physics, accelerator physics, and so on.



図 1 TRIUMF

workshop: Progress in Ab Initio Techniques in Nuclear Physics

In the workshop, Progress in Ab Initio Techniques in Nuclear Physics (<http://abinitio.triumf.ca/2017/index.html>), I gave a poster presentation and a talk. I showed that the characteristic effect of tensor component in nuclear force can be understood by the description of nuclear force based on chiral effective field theory. In general, various models for nuclear force, including chiral EFT, have many kinds of uncertainties. However, as I discussed in the poster and talk, tensor forces are robust against the softening procedure, renormalization procedure with many-body perturbation theory, and the way to fold one nucleon degree of freedom for three-nucleon forces (3NFs). This fact provide us a solid ground to understand

the appearance and disappearance of magic numbers in neutron-rich nuclei. I discussed with various researchers not only from TRIUMF, but also from TU Darmstadt, Michigan State University, and so on.



图 2 The workshop, Progress in Ab Initio Techniques in Nuclear Physics

Theory group seminar

I gave a talk as the TRIUMF theory group seminar on 7th March. The main topic of my seminar is how to include the effect of 3NFs into shell-model calculation and the validity of the approximation for 3NFs.

The three-body force, more precisely three-nucleon force, is the characteristic one which arises when there exist nucleons more than three. It stems from, roughly speaking, the fact that nucleons have inner structure, quarks. When one would like to understand quantum many-body system, it can be achieved by accumulation of two-body force between each constituent particle. When it comes to nuclear many-body system, however, the effect of 3NFs become as much important as 2NFs, and it is indispensable to take account of 3NFs. This makes nuclear physics very complicated and also interesting.

TRIUMF is nothing but a central community of the study about 3NFs and its inclusion into various methods. This is the reason why I applied for MERIT errantry to TRIUMF. In most *ab initio* studies they are engaging, three-body forces are included up to so-called normal ordered two-body part with respect to the proper reference state e.g., double magic nuclei. On the other hand, I have studied normal ordering to symmetric nuclear matter and the effect of 3NF is included as the correction to 2NF in this approach. I discussed the difference between these two ways to fold one nucleon-leg and the validity of latter approximation, normal ordering with respect to symmetric nuclear matter.

We have already started to collaborate with Professor Petr Navrátil, the leader of TRIUMF theory group, about the treatment of 3NF and I will continue to study towards to understand nuclear structure based on microscopic description of nuclear forces.

Summary

It snowed for a few days when I stayed in Vancouver and it made coniferous trees very beautiful. According to what I heard, snow is unusual in Vancouver. There is a big supermarket near TRIUMF and it's very peaceful around UBC, so I really like the surrounding environment of TRIUMF.

I was really impressed with research activity in TRIUMF. Every result they showed as preliminary one was so impressive and progressive for me. In addition to this, I got various comments and questions during my seminar and I have really enjoyed many discussions with them. It is fair to say that Japan is behind in the study about nuclear structure starting from nuclear force alone. In this situation, I had very valuable experience during my stay in TRIUMF. I will continue to study more in order to contribute to addressing the long standing issue in nuclear physics, understanding nuclear force from underlying theory, QCD, and understanding nuclear structure from nuclear force.

Acknowledgments

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