平成 26 年 7 月 2 日

（独）理化学研究所
研究担当理事　川合 眞紀

平成 25 年度実施 准主任研究員の中間レビューの結果について

准主任研究員制度設置規定（平成 25 年規定第 14 号）に基づき准主任研究員の中間レビューを実施し、評価結果は以下のとおりです。

１．評価対象：肥山ストレンジネス核物理研究室．肥山 詠美子 准主任研究員

１）評価体制

実施日：平成 26 年 2 月 25 日（火曜日）

4 名の所外有識者を評価委員とするヒアリングレビューを実施。

評価者：

Avraham GAL, Professor
The Hebrew University, Israel

Hisashi HORIUCHI, Professor
Osaka University, Japan

Teiji KUNIHIRO, Professor
Kyoto University, Japan

Satoshi NAKAMURA, Associate Professor
Tohoku University, Japan

２）評価結果の概要等

General comments: （arranged in random order）

【Reviewer 1】

Dr. Hiyama and her group have been developing a powerful calculation technique for few-body systems, Gaussian Expansion Method (GEM). GEM is a quite general technique which can be applied to any kind of particles with various types of interaction.

Dr. Hiyama’s group worked extensively on light hypernuclear systems with GEM in last 5 years and obtained high-accuracy predictions for the energy levels of ${}^{7}_{\Lambda}$He, ${}^{6}_{\Lambda}$H. These predictions were compared with resent experimental results and triggered active discussion on charge symmetry breaking (CSB) of the ΛN interaction. In addition to S=-1 systems, calculations of S=-2 system such as ${}^{10}_{\Lambda\Lambda}$Be, ${}^{11}_{\Lambda\Lambda}$Be and ${}^{12}_{\Lambda\Lambda}$Be were performed. They served effectively to disentangle possible states of double Λ hypernucleus, ${}^{10}_{\Lambda\Lambda}$Be, which was observed by the emulsion experiment at KEK.

Predictions from her group on hypernuclear systems stimulated experimental efforts much and resulted in new experimental proposals. In last 5 years, collaboration works between Dr. Hiyama’s group and experimentalists went quite well.

Recent activities are highly encouraged to extend research field to heavier hypernuclei such as ${}^{41}{}_{\Lambda}Ca$, ${}^{46}{}_{\Lambda}Sc$ beyond the GEM's scope. GEM is very powerful tool but development of other calculation techniques will make future synergy effects.

Her group's activities were not limited in study of hypernuclei and GEM was applied to problems in atomic physics such as 3/4-body problem of ${}^{4}He$ and d-${}^{3}He$ μCF. It is quite interesting finding that 3-body/4-body energy level calculations show similar linear correlations, known as the Tjon line, for atomic system as well as for nuclear system.

Research level of the group is quite high and widely accepted as world's top-class works. Lab members are apparently satisfied with environment and enjoy collaboration with Dr. Hiyama. Though the group has been so far successfully managed, more efforts on synergy works between PDs and students are encouraged.

【Reviewer 2】

The research orchestrated by Associate Chief Scientist Dr. Emiko Hiyama who directs the Strangeness Nuclear Physics (SNP) Laboratory at RIKEN is focused on solving non-relativistic few-body problems. Dr. Hiyama has been developing and using the Gaussian Expansion Method (GEM) to provide accurate solutions, on par with the best results obtained by worldwide competing groups, in a variety of Physics subjects, primarily but not exclusively in SNP which covers the field of hypernuclei. Theoretical SNP research is particularly important and timely in Japan, given the high profile of experimental activity in this field of research undergoing at J-PARC. Of the other research fields covered by Hiyama's group activity I would like to express deep appreciation of the recent results in the field of Cold-Atom Physics derived for ${}^{4}He$ trimers and tetramers.

【Reviewer 3】

Strangeness Nuclear Physics Laboratory conducted by Associate Chief Scientist Dr. Emiko Hiyama deals with many research subjects other than the strangeness nuclear physics which is the central subject of the laboratory.

This wideness of the research subjects is an important characteristics of this laboratory as is stressed by Dr. Hiyama. As is demonstrated in the diagram of the research strategy program of the laboratory, Dr. Hiyama places the solution method of few-body problem named ''Gaussian Expansion Method With Infinitesimally-Shifted Gaussian Lobe Basis'' at the center of the research strategy program. She aims to solve, with her Gaussian expansion method, important few-body problems in various fields of physics for which high-precision calculations are required. This aim has been successfully achieved during past five years to be reviewed this time. This achievement is of high quality in many respects. The researches in respective fields have contributed not only to answer unsolved questions but also to advance the frontiers of the fields. The productive accomplishment of this laboratory has been supported by the growth of the number of young members of the laboratory who work in various fields. The success of this laboratory is related to the unique system of RIKEN, because in the ordinary university system it is rare to have this style of laboratory which is partly based on a calculational method (which is here Gaussian Expansion Method With Infinitesimally-Shifted Gaussian Lobe Basis) and partly on a central specific subject of physics (which is here strangeness nuclear physics).

The central research subject of the laboratory is the strangeness nuclear physics, namely hypernuclear physics. Various kinds of themes of this subject have been intensively pursued. Main goals of the research are firstly the study of the baryon-baryon interaction obtained from precision calculations of hypernuclear structures and secondly the study of the structure of many-baryon systems on the basis of obtained knowledge of baryon-baryon interaction. A very important theme of the studies in the category aiming the second goal is the study of nuclear structure by the use of lambda particle as a probe of nuclear structure of neutrons and protons. When a lambda particle is added to a nucleus, unbound resonance levels can become bound hypernuclear levels, which enables us to study the properties of unbound levels by studying the bound hypernuclear levels. A good example is the fruitful study of $^{7}{}_{\Lambda}$Li by Dr. Hiyama. Here the E2 transition in $^{7}{}_{\Lambda}$Li is the quantity which reflects the structure of ^{6}Li in which E2 transition is not easily available because the 2^{+} state of ^{6}Li is an unbound resonance state. The research program of $^{6}{}_{\Lambda}$H is also a good example which presents an attractive method to study the exotic unbound nucleus ^{5}H. Another attractive and important proposal of Dr. Hiyama to use a lambda particle for studying nuclear structure is the comparison of two kinds of hypernuclear levels which are due to the addition of a lambda particle to nuclear levels with normal deformation and those with superdeformation. Dr. Hiyama has shown very useful results that the comparison of the energy gains due to the addition of a lambda particle presents us important knowledge of nuclear structures in wide range of mass number from ^{9}Be and ^{12}C to $A \lesssim 40$.

As mentioned above, the research principle of this laboratory is partly based on a calculational method which is the Gaussian Expansion Method With Infinitesimally-Shifted Gaussian Lobe Basis. But actually the researches of this laboratory are now based on various types of calculational method not restricted to Gaussian Expansion Method and also the theoretical approaches are not only by few-body approaches. This is due to the expansion of research subjects of the hypernuclear physics which cover various nuclei up to $A \lesssim 40$. Now the research metods include shell model, THSR cluster model, and RBHF and RMF approaches. This expansion of the research subjects are supported by the growth of the number of young members of the laboratory in recent years.

The management of the laboratory is gradually changing mainly because of the expansion of the research subjects and the corresponding growth of the number of young members of the laboratory in recent years. Thanks to many successful results of researches, the laboratory is active and well organized during this gradual change of the laboratory. Young researchers say that the wideness of the research subjects is very instructive and stimulating for themselves and for their researches. It is desirable to have a young researcher with tenure-like position who helps Dr. Hiyama.

As mentioned above, the research on the hypernuclear physics in this laboratory is now expanding with promising prospects. At the same time the future plans of other research subjects look also promising. For example very interesting accomplishments of the study of the ground and excited states of trimer and tetramer of ^{4}He atom give us promising prospect of advances of the research in the field of ultra cold atomic physics. Altogether, we look forwards to the future development of this unique laboratory which is thanks to the unique system of RIKEN.

【Reviewer 4】

Strangeness Nuclear Physics Laboratory (SNPL) lead by Dr. Emiko Hiyama is a method-oriented laboratory based on precise numerical methods. She has developed a quite powerful method called GEM to precisely solve quantum mechanical problems in a-few-body systems, in hyper nuclear physics, atomic physics and so on. Her achievement in the last five years is great, and is well appreciated internationally; she has published four (invited) review papers in this period. She was also awarded 33rd Saruhashi prize for her achievement in ``Establishing an Accurate Calculation Method for Quantum Few-Body Systems and Its Application".

The laboratory is rather well managed by Dr. Hiyama, All the postdocs of SNPS expressed their satisfaction for the atmosphere of the laboratory and the leadership by Dr. Hiyama. I recommend to conduct internal seminars given by the members in the laboratory, which would help to make fruitful collaboration between the laboratory members coming from various fields of physics.

She has already started an international research project for the cold-atom physics with French people. This project originates from her precise calculations of the trimers and tetramers leading to the first.

As a whole, she has made great scientific achievements and conducted her laboratory rather well. She has already started an international collaboration in relatively new fields to her. The laboratory may eventually evolve to a world-wide unique place dedicated for solving quantum many-body problems in wide-range of physics fields based on precise numerical methods.

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