Institute Laboratory Assessment Interim Review

Theoretical Physics Laboratory

Laboratory Head: Hikaru KAWAI (D. Sci)

Date: January 5, 2010

Place: Nishina Hall, Nishina Center, Wako, RIKEN

Reviewer:

Hirotaka Sugawara: Director, JSPS Washington Office, U.S.A.

Ichiro Sanda: Professor, Department of Physics, Kanagawa University, Japan

Akira Ukawa: Vice President, University of Tsukuba, Japan

Henry Tye: Horace White Professor of Physics, Cornel University, U.S.A.

Report

(Order of the reviewers is arbitrary)

Reviewer 1,2,3

A. Research

Given the budgetary constraint in building up a new laboratory, Kawai has done an exceptional job in building up a focused research program.

1. Superstring theory

   Kawai, Tada and their coworkers have tackled a very difficult task of solving the type IIB Matrix Model. Kawai was one of the originators who proposed this model as the theory of everything in the reductionist sense. It is novel and very ambitious. Any progress in this challenging field should be considered very important and thus academically very significant. So far, enough significant progresses have been made so that further effort along this direction is definitely warranted.

2. Application of the superstring theory

   Hashimoto is working on superstring implications to nuclear physics. Using gauge-gravity duality, he has demonstrated that superstring theories can give predictions about nuclear physics parameters. In this sense it is new, novel, and significant. It can shed light on string theory as well as in nuclear physics. This direction can be very fruitful, especially since the gravity dual of QCD remains

to be identified. Riken should be congratulated for its foresight with which Hashimoto was promoted to the position of an Associate Chief Scientist.

3. QED

   Kinoshita has developed a program to compute higher order QED amplitudes. In particular, he has succeeded in computing 8^{th} order g-2. He and his coworkers are the only group who is computing 10^{th} order g-2. Nio is the successor to Kinoshita. Riken and Cornell (where Kinoshita is an emeritus professor) are only laboratories in the world with this expertise, with Kinoshita spending a growing amount of time in Riken. Computing QED perturbative effect to 10^{th} order is very challenging. It is a unique project that brings recognition to Riken. With concurrent experimental measurements, it is a program which must be continued. There is no reason that we can see why Nio is not a Research Staff. She should be promoted as soon as possible.

4. Supersymmetry (SUSY) on the lattice

   Non-perturbative computations of SUSY observables are necessary at LHC energies. Suzuki works on putting SUSY theories on the lattice. This is highly nontrivial as SUSY algebra is inconsistent with discrete space-time. He is making some progress by keeping a subalgebra which is sufficient to control SUSY breaking counterterms.

B. Laboratory managements

   It must be very difficult to run a laboratory in Wako City and at the same time be a full time faculty member at Kyoto University. Some of the problems which led to Kawai's resignation would not have occurred had Kawai been a full time scientist at Riken.

C. Recommendation towards searching for the new Chief Scientist

1. Find a full time scientist. Riken's search should be brave enough to emphasize brilliance over experience.
2. Theoretical particle research must be done with complete freedom of the researcher.
3. The theoretical physics laboratory is rather small. Riken should do all it can without splitting it into 2 laboratories.
4. If the laboratory wants to expand in the direction of nucleogenesis, it is impossible with the present scope of Riken's commitment. Budget and personnel must be increased. It is better, perhaps, to create such a group in the nuclear physics group.

Reviewer 4

1. Matrix Model is potentially a much deeper theory with string theory as its special limit. It is a theory of non-commutative space-time and, therefore, can naturally lead to the non-commutative geometry a la Conne which in turn is related to number theory. I described this situation in my recent work (hep-th arXiv:1001.0429). Although it is a long way from its full understanding, I expect that Riken theory group to stay as one of the centers of this research towards the full understanding of the matrix model. I hope that the next chief scientist will be chosen with the condition that he understands the matrix model or otherwise that he pushes this research area.
2. T. Kinoshita of Cornell initiated and pushed hard the higher order calculation of QED to such a degree that not many people can and are willing to follow his line. Fortunately, Riken created some human resources who are willing to continue this precious effort.
   I recommend strongly that this effort should be continued under new chief scientist.
3. ADS/CFT correspondence is an interesting consequence of stringy aspect of gauge-gravity theory. This is correct only in the $N \rightarrow \infty$ limit and so it is presumably a very bad approximation if applied to QCD which is the N=3 case. But, it is possible that some physical quantity is reflecting this aspect of gauge theory and it would be interesting to investigate that possibility both theoretically and experimentally.

All four members of the committee agreed on the following recommendations.

Kawai started the group with wide range of physics goals and, especially, the matrix model research and the QED higher order calculations are very unique.
An attempt to solve the matrix model is a very difficult task which few researchers are willing to undertake. It is however very novel and academically significant. Kawai and his coworkers made significant progress along this line.
Computing g-2 to 10^{th} order has fundamental significance. It is very important and novel. Riken has the unique group. We highly recommend Riken to keep working in this field.

The application of string theory to hadron and nuclear physics is opening a new direction for nuclear physics. It presents one of the unique opportunities to test fundamental ideas of string theory.

The Theoretical Physics Laboratory has been very successful. The matrix model and the QED calculation are unique in the world. Although the Lab includes only string theory, lattice gauge theory and QED, due to the limited resources, it is impossible to cover astrophysics without substantially weakening the present strengths. If the Nishina Center wants to push the direction of nucleosynthesis, it should be included in the nuclear theory laboratory, and, it may be prudent to broaden that direction to cosmology, which includes nucleosynthesis but is a rapidly growing and broadening field.

In conclusion, we recommend that the current trend of theoretical physics activities should be continued under the new chief scientist. We appreciate the free atmosphere of the lab, which allowed people to work on subjects of their own choosing, and we hope that the new leader keep this tradition.