

## 研究課題別事後評価結果

1. 研究課題名： 光合成における量子環境

2. 個人研究者名

Neill Lambert (理化学研究所開拓研究本部 研究員)

3. 事後評価結果

The “role of quantum coherence in light harvesting” is a hotly contested topic. It is difficult to study due to the complex environment in which light harvesting complexes interact. This project aims to develop new methods to study this type of problem, which will give insight on the role of the environment in light harvesting efficiency.

[どのような量子性をどのように扱ったのか] *Quantum View Points*

- To understand the role of quantum effects in the environment.
- To develop a new methodology that explicitly shows the importance of quantum degrees of freedom in the environment.

Dr. Lambert focused on the role of quantum coherence in light harvesting based on his work on the reaction-coordinate (RC) method. In this project, he set out to (A) extend its range of applicability, (B) investigate quantum advantage in light-harvesting, and (C) use the RC method as a platform for quantum simulation. As a result of this project for (A), Dr. Lambert made an important breakthrough in developing a new pseudo-mode (PM) method for simulating quantum environments distinct from the reaction-coordinate approach. For (B) he demonstrated an example of how important quantum environments are in FMO photosynthetic light-harvesting complex. He also found that the PM method was a superior platform for quantum simulation for (C). As an expansion of this project, Dr. Lambert extended his new method for applications in single-molecule transport and quantum thermodynamics including new ideas. To summarize, his research outcomes are shown as follows:

- Developed new quantum-environment methodology.
- Extended this to fermionic environments for the study of electron transport through molecules.
- Developed an open-source simulation library for the HEOM method.
- Developed theoretical methods for study of quantum thermodynamics experiments.
- Showed how quantum-environments can be used to optimize dynamical decoupling.

This project is good in general, especially regarding developing a new pseudo-mode (PM) method. Research Supervisor (RS) of this research area thinks this project was successful, however it could have been clearer regarding the quantum effect on FMO photosynthetic light-harvesting complex. RS suggests more detail is added in view of offering a clearer explanation as to the outcomes to each objective. Through this project RS hopes Dr. Lambert will lead more projects to find insight on the role of the environment on light harvesting efficiency.