研究課題別事後評価結果

１．研究課題名：　動物磁気感受のためのクリプトクロム時空間計測

２．個人研究者名

Lewis M. Antill　(埼玉大学大学院理工学研究科　特定プロジェクト研究員)

３．事後評価結果 *Project Evaluation*

This project aims to clarify the obscurities of animal magnetoreception by shedding light on the photochemical process of cryptochrome (the prime candidate protein) and the influence of the magnetic field thereon from the viewpoint of its most fundamental signal formation and propagation.

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

・Radical pairs (photochemical reaction intermediates) are magnetic field sensitive entangled electrons that can undergo coherent spin state mixing.
・These magnetic field effects can be observed with fluorescence spectroscopy.

［達成状況とインパクト］*Research Outcomes & Impact*

Dr. Antill succeeded in detecting a low field effect on Cryptochrome-like systems, the mechanism by which we believe birds detect the geomagnetic field. Through the development of a new instrument for detecting magnetosensitive photochemistry in biological environments, he could demonstrate the magnetic field effect with single-photon avalanche diodes (SPADs) for the first time, which offers a novel approach for studying magnetosensitive photochemistry on protein-ligands at the single-molecular level. For instance, the coherent quantum mechanical processes between flavin and protein. By combing fluorescence intensity, fluorescence anisotropy and magnetic field effect measurements, a much clearer picture of the nature of the protein-ligand dynamics was demonstrated than had previously been possible. His work was introduced in a science society magazine as an invited article.

Dr. Antill is also exploring candidate structures and oligomerization of cryptochrome using a combination of experimental and computational methods to identify its possible role in magnetoreception. Through the analysis of cryptochrome oligomerization and theoretical modelling, he suggests that an oligomerization equilibrium could regulate the magnetic sensing functions of cryptochrome. To summarize, his research outcomes are shown as follows:

- Developed high-sensitivity magneto-fluorescence fluctuation spectroscopy (M-FFS) for detecting small magnetic field effects on protein-ligand photochemistry.
- Created Cryptochrome-like systems for modelling biological magnetoreception. A low field effect was clearly observed.
- Formed a new protocol for synthesizing cryptochrome.
- Details of cryptochrome-oligomerisation have been clarified through experimental and theoretical collaboration.

Dr. Antill is now leading many international collaborations in this research field. Together with the above outcomes, this project was successful and highly commendable. Further cryptochrome-based investigations are expected on this magnetosensitive photochemistry platform in the future.