量子技術を適用した生命科学基盤の創出
平成 30 年度採択研究者

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実績報告書

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Quantum environments in photosynthesis
光合成における量子環境

§1. 研究成果の概要

Quantum effects in light-harvesting can have multiple origins: electronic ‘coherence’, i.e., an excitation is delocalized over multiple molecules, and vibronic coherence. When the latter arises the electronic ‘system’ and the vibronic ‘environment’ can also be entangled, i.e., exhibit quantum correlations on times scales that effect the energy transport. This is both a very difficult regime to model and a difficult regime to probe with experiments. To enable better theoretical understanding my research is focused on two main goals: the development of new theoretical methods and tools to describe this regime, and the parallel development of quantum technologies as a simulation platform.

My primary progress in 2018 has been in the development of a generalized pseudo-mode method. This approach simplifies the complex environment into a minimal set of modes. I have found however that this is not always straightforward, and in the most general case we need to describe some of these modes with superficially unphysical equations of motion. Fortunately, with my collaborators, I have shown these lead to physical system results. A proof of the validity, along with an investigation of the ground-state properties of two-level example strongly coupled to an environment, is now under review.

§2. 研究実施体制

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② 研究項目

・Analysis of vibronic‘environment’: dimer model

・Extending RC method: limited excitation number method

・Development of new pseudomode method.

・Quantum simulations: examples based on the RC/pseudomode methods