



Title of Project : Science of Hybrid Quantum Systems

Yoshiro Hirayama
(Tohoku University, Graduate School of Science, Professor)

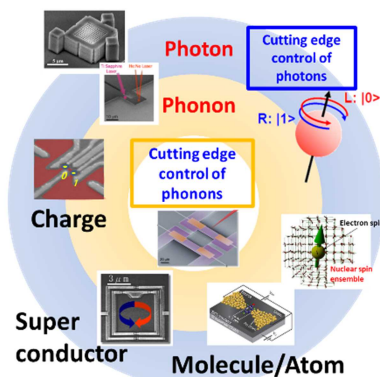
Research Project Number : 15H05866 Researcher Number : 20393754

【Purpose of the Research Project】

The purpose of this project is connecting the coherent manipulation of physics quantities for quantum enabled technology (QET) not for large scale quantum computation. A highly-sensitive metrology is received the most attention among the QET and the sensitivity can be enhanced by entanglement in the small-scale quantum hybridization. A quantum transducer coherently connecting various physics quantities is thus needed to create QET. We will establish the small-scale quantum coupling between different physics quantities by putting an emphasis not only on the *photon* but also the *phonon*, which has recently been remarkably developed.

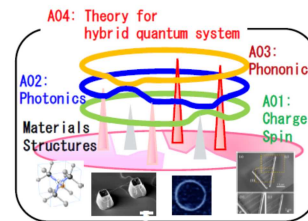
【Content of the Research Project】

In the scheme of the project pursuing the fundamental physics of hybrid quantum systems, the A01 research will demonstrate the manipulation of the quantum coupling between a charge, spin, and nuclear spin. We will also study the coherent control of these physics quantities by photon and phonon. The A02 aims at the establishment of a cutting-edge photon-control and extends it to the quantum coupling between physics quantities and photons. We will clarify the interaction between materials and electro-magnetic waves. The A03 aims at the establishment of a cutting-edge phonon-control and extends it to the quantum coupling between physics quantities and phonons. We will attempt to create phonon-based transducer and hybrid phononic systems.



The A04 supports a better understanding of the

experimental results and proposes a new direction for QET. Moreover, we clarify the limits of the quantum transducer and present some design rules. The theoretical studies will be used to create the project guidelines. We will collaborate with researchers in the field of nanomaterials and nanostructures because we will need new materials and structures for various quantum transducers.



【Expected Research Achievements and Scientific Significance】

This project focus on the small-scale quantum coupling between charge, cooper pair, spin, nuclear spin, photon, and phonon, that go beyond the existing frameworks, resulting in the highly-sensitive quantum metrology and QET. The new metrology will have a large impact on a wide range of fields. The establishment of a basic research area that is based on quantum coupling will pave the way for an attractive pure science like gravity detection. We will accelerate the world-wide movement towards the creation of QET in Japan.

【Key Words】

Nano-micro quantum system, New functional quantum material, Quantum effect, Quantum transducer, Quantum metrology, Quantum enabled technology, Solid-state physics, Quantum information, Charge, Spin, Nuclear spin, Photon, Phonon

【Term of Project】 FY2015-2019

【Budget Allocation】 1,045,300 Thousand Yen

【Homepage Address and Other Contact Information】

<http://quant-trans.org/hybridQS>