【Grant-in-Aid for Scientific Research (S)】

Science and Engineering (Interdisciplinary Science and Engineering)

Title of Project : Research for quantum media conversion in diamond nano quantum system

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Research Project Number : 16H06326 Researcher Number : 20361199
Research Area : Nano-structure physics
Keyword : Quantum information physics, Spintronics

【Purpose and Background of the Research】

Quantum communication network, which enables secure distribution of information including social security numbers, medical data, smart grid data, is necessary to be built towards big-data society based on internet of things (IoT).

In this research, we develop technologies for selective quantum state transfer from a photon to an integrated quantum memory, its long memory time, error correction, and quantum entanglement detection by geometric quantum manipulation of spin degenerate system. Quantum system in a nitrogen-vacancy center (NV center) is used to develop an integrated solid-state quantum memory with error resilience, which is necessary for realizing quantum information processing system.

【Research Methods】

The following targets are pursued with using an NV center in diamond, which shows superior advantage for quantum memories.

1. Quantum media conversion from a photon to a nitrogen nuclear spin with completely maintaining quantum state based on the quantum teleportation scheme.
2. Selective transfer of quantum state from a photon to an integrated quantum memory consisting of multiple carbon nuclei around an NV center.
3. Deterministic quantum entanglement detection by complete Bell state measurement between arbitrary nuclei in an integrated quantum memory.
4. Quantum error correction based on a logical qubit consisting of multiple nuclei.
5. Quantum wavelength conversion from a telecommunication wavelength to a diamond-absorption wavelength.

To achieve these targets, we develop our original scheme for geometric quantum manipulation of a degenerate logical qubit out of spin-1 electron system based on inherent interactions between a photon and an electron, or an electron and a nucleus.

【Expected Research Achievements and Scientific Significance】

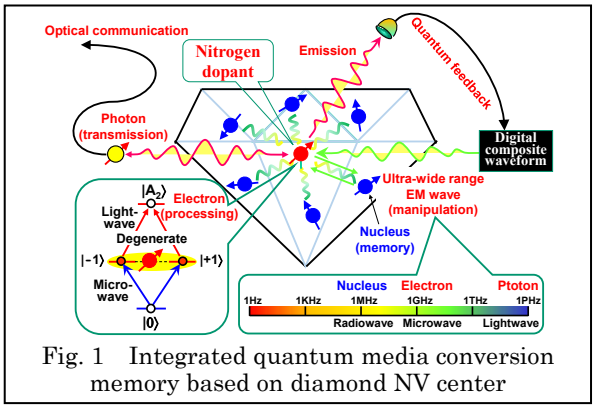

Fig. 1 Integrated quantum media conversion memory based on diamond NV center

The achievement of this project will be a breakthrough for building quantum communications to overcome the distance limit and for classical communications to overcome the capacity limit.

【Publications Relevant to the Project】

- Sen Yang, Hideo Kosaka, Jorg Wrachtrup, et.al., "High fidelity transfer and storage of photon states in a single nuclear spin", ***Nature Photonics***, nphoton.2016.103 (2016).
- Yuhei Sekiguchi, Hideo Kosaka, et.al., "Geometric spin echo under zero field", ***Nature Communications***, **7**, 11668 (2016).
- Hideo Kosaka, et.al., "Entangled Absorption of a Single Photon with a Single Spin in Diamond", ***Phys. Rev. Lett.***, **114**, 053603 (2015).

【Term of Project】 FY2016-2020

【Budget Allocation】 138,900 Thousand Yen

【Homepage Address and Other Contact Information】

http://kosaka-lab.ynu.ac.jp/