

Large-scale quantum hardware based on nanofiber cavity QED

Project manager

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leader's institution

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R&D institutions

Waseda University, NTT, AIST, NanoQT

Summary of the project

We plan to develop novel quantum computer hardware that can be scaled up and distributed, as well as promote social implementation using our unique nanofiber cavity QED technology. Further, we aim to realize a distributed fault-tolerant universal quantum computer with an enormous number of qubits, as well as quantum internet, by 2050.

The cavity quantum electrodynamics (QED) system is a hybrid quantum system of atoms and photons, and it has received significant research attention as a promising operating platform for quantum computers. In particular, arranging multiple atoms in the cavity while maintaining the strong coupling between individual atoms and the cavity and individually addressing the atoms functions as a multi-qubit quantum computer. Moreover, a distributed quantum computer can be constructed if multiple cavity QED systems are connected with low loss. These have been difficult to achieve with conventional cavity QED systems based on free-space optical cavities.

Herein, we are developing new quantum computer hardware that uses a nanofiber cavity QED system developed by our unique technology, which is unique and one of its kind, worldwide. The nanofiber cavity QED system involves the quantum mechanical interaction of photons that are confined in an optical fiber cavity (nanofiber cavity) with “nanofibers”, whose diameter is smaller than the wavelength of light at the center and the atoms that are arranged in a line near the surface of the nanofiber. The cavity can accommodate a large number of atoms while maintaining strong coupling between individual atoms and the cavity, and these atoms can be addressed individually. Furthermore, multiple cavity QED systems can be connected with low loss. These features are expected to enable scaling up and distribution.

Milestone by year 2030

We will scale up and distribute nanofiber cavity QED quantum computer hardware while also demonstrating the effectiveness of quantum error correction.

Milestone by year 2025

We will establish a PoC for nanofiber cavity QED quantum computer hardware and achieve elemental technologies for distribution.

R&D theme structure of the project

