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Nanofiber cavity quantum electrodynamics systems for distributed quantum computing

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Abstract

Distributed quantum computing, where many quantum processing units containing small to moderate number of qubits are connected to form a large-scale quantum network, is a promising approach to realize a quantum system with a large number of qubits required for fault-tolerant universal quantum computing.
Cavity quantum electrodynamics (QED) systems, where atoms and photons are confined and interacts within optical cavities, can be utilized to construct a distributed quantum computer, if one could place many atoms in a cavity while maintaining strong coupling between individual atoms and the cavity, individually address the atoms, operate quantum gates on selected atoms, and connect multiple cavity QED systems with low losses. These tasks have been difficult to achieve with conventional cavity QED systems based on free-space cavities. To overcome these difficulties with the conventional systems, we have been developing novel cavity QED systems based on optical nanofibers and neutral atoms. In this talk, I will present our experimental research on nanofiber cavity QED systems and prospects toward distributed quantum computing based on these systems.