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Development of frequency-multiplexed quantum repeater system

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Abstract

Quantum communication over long distances faces significant challenges, particularly photon loss in optical fibers. A promising solution to this issue is the quantum repeater, which enables entanglement swapping and distribution across distant nodes. By employing a frequency-multiplexed approach, it is expected to be possible to increase the throughput of quantum communication systems significantly, thereby overcoming many of the distance-related limitations. This study focuses on developing a frequency-multiplexed quantum repeater system based on Pr:YSO quantum memories (QMs). We aim to integrate Pr:YSO QMs with a frequency-multiplexed quantum repeater architecture to enhance quantum communication performance. The system relies on the generation of two-photon pairs through cavity-enhanced two-photon processes, carefully matched to the transition frequencies of Pr:YSO. And a key feature of the proposed system is the use of optical frequency combs for phase-locking and frequency stabilization across multiple elements.

In the talk, we will discuss the current status of the development of our quantum repeater and also introduce studies in real-world fiber optic networks in collaboration with industrial partners. By advancing these technologies, we aim to contribute to the realization of scalable, long-distance quantum networks.