Quantum networking with solid-state based quantum repeater nodes

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The distribution of entanglement between the nodes of a quantum network will allow new advances e.g. in long distance quantum communication, distributed quantum computing and quantum sensing [1]. To distribute quantum entanglement over long distances, quantum repeaters have been proposed [2]. The nodes of a quantum repeater are matter systems that should efficiently interact with quantum light, allow entanglement with photons at telecommunication wavelengths and serve as a quantum memory allowing long-lived and faithful storage of (entangled) quantum bits. In addition, for efficient distribution of entanglement, the nodes should allow multiplexed operation and ideally enable quantum processing capabilities between stored qubits.

In this talk, after introducing the context I will describe our recent progress towards the realization of quantum repeater nodes with multiplexed quantum memories, using cryogenically cooled rare-earth ion doped solids. Recent experiments include demonstration of long distance multiplexed quantum teleportation from a photonic telecom qubit to a solid-state collective qubit with active feed-forward [3] as well as the distribution of entanglement between a photon and a quantum memory over a 50 km link in the installed fiber network [4].

References

[1] S. Wehner, D. Elkouss and R. Hanson, Science 362, eeam9288 (2018)
[2] L.M, Duan, M. Lukin, I. Cirac and P. Zoller, Nature (2001)
[3] D. Lago-Rivera, J. Rakonjac, S. Grandi and H.de Riedmatten, Nature Commun. 14, 1889 (2023)
[4] J. V. Rakonjac, S. Grandi, S. Wengerowsky, D. Lago-Rivera, F. Appas and H. de Riedmatten, arXiv:2304.05416 (2023)