

Towards a quantum internet: status, challenges and progress

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Abstract

Future quantum networks [1] may harness the unique features of entanglement in a range of exciting applications such as blind quantum computation in the cloud, secure communication and enhanced metrology. To fulfill these promises, a strong worldwide effort is ongoing to gain precise control over the full quantum dynamics of multi-particle nodes and to wire them up using quantum-photon channels.

Here I will briefly introduce the field of entanglement-based quantum networks and discuss some of the current status and challenges. I will then give an overview of our latest work on the realization of a multi-node network in the lab including first protocols and teleportation [2,3], on increasing the distance between nodes to metropolitan scales, on development of next-generation devices with improved quantum spin-photon interfaces, and on the development of a quantum network control stack.

[1] Quantum internet: A vision for the road ahead, S.D.C. Wehner, D. Elkouss, R. Hanson, *Science* 362, eaam9288 (2018).

[2] Realization of a multi-node quantum network of remote solid-state qubits, M. Pompili, S.L.N. Hermans, S. Baier et al., *Science* 372, 259 (2021)

[3] Qubit teleportation between non-neighboring nodes in a quantum network, S.L.N. Hermans, M. Pompili et al., arXiv:2110.11373 (2021).
