Quantum network interfaces with trapped ions in cavities

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One promising approach to quantum networks is based on laser-cooled trapped ions in optical cavities, in which the cavity provides a coherent interface between single atoms and single photons. Such an interface enables the transfer of quantum information from ions onto photons for distribution over optical channels, and from photons onto ions for storage and processing.

I will present probabilistic and deterministic realizations of a quantum network interface, based on ion-photon entanglement [1] and ion-photon state transfer [2]. This context will allow us to examine, on the one hand, the strengths of the ion-cavity implementation, including capabilities for high-fidelity gate operations and coherent light-matter interactions. On the other hand, as with all experimental realizations, these experiments face significant challenges on the road to a scalable multi-node network, such as decoherence in the ion trap and scattering and absorption losses of photons in the cavity and along optical channels. I will discuss approaches to address these challenges, including the use of decoherence-free subspaces [3] and adiabatic passage [4].

References

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