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An ion-cavity interface for quantum networks

Trapped ions are a promising platform for local quantum information processing, while optical cavities offer a coherent interface between matter and light, enabling the transfer of quantum information from stationary qubits onto photons for long-distance distribution.

We demonstrate such an interface by coupling trapped ions to a cavity and have recently shown that a quantum state can be faithfully transferred from an ion onto a photon. In particular, this transfer can be improved by taking advantage of a collective effect between multiple ions, namely, superradiant emission into the cavity. In this proof-of-principle experiment, we tune the phase of a two-ion entangled
state between sub- and superradiance. The superradiant coupling is then used to enhance the transfer of quantum information onto a photon from a logical qubit encoded in the two ions.

Finally, prospects for linking together distant ions in cavities via a quantum network will be discussed. Toward this goal, I will outline a fiber-based ion-cavity experiment designed to access the single-ion strong-coupling regime.