CC-04-02

Entanglement of trapped-ion qubits separated by 230 m

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Abstract

Entanglement-based quantum networks hold out the promise of new capabilities for secure communication, distributed quantum computing, and interconnected quantum sensors. However, only a handful of elementary quantum networks have been realized to date. I will present recent results from our prototype network, in which two calcium ions are entangled with one another over a distance of 230 m, via a 510(2) m optical fiber channel linking two buildings. The ion-ion entanglement is based on ion-photon entanglement mediated by coherent Raman processes in optical cavities. I will discuss the advantages of trapped ions for quantum networks and the role that cavities play as quantum interfaces between light and matter. After examining the key metrics of fidelity and success probability, we will consider how this work may be extended in the future to long-distance networks of entangled quantum processors.