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Arthur L. Schawlow Prize in Laser Science Talk: Trapped Ion Quantum Networks with Light[1]

CHRISTOPHER MONROE, JQI and University of Maryland

Laser-cooled atomic ions are standards for quantum information science, acting as qubit memories with unsurpassed levels of quantum coherence while also allowing near-perfect measurement. When qubit state-dependent optical dipole forces are applied to a collection of trapped ions, their Coulomb interaction is modulated in a way that allows the entanglement of the qubits through quantum gates that can form the basis of a quantum computer. Similar optical forces allow the simulation of quantum many-body physics, where recent experiments are approaching a level of complexity that cannot be modelled with conventional computers. Scaling to much larger numbers of qubits can be accomplished by coupling trapped ion qubits through optical photons, where entanglement over remote distances can be used for quantum communication and large-scale distributed quantum computers. Laser sources and quantum optical techniques are the workhorse for such quantum networks, and will continue to lead the way as future quantum hardware is developed.

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