

MAR11-2010-001375

Abstract for an Invited Paper
for the MAR11 Meeting of
the American Physical Society

Quantum Networks with Atoms and Photons

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Trapped atomic ions are among the most promising candidates for quantum information processing. All of the fundamental quantum operations have been demonstrated in this system, and the central challenge now is how to scale the system to larger numbers of qubits. By entangling atomic qubits through both deterministic phonon and probabilistic photon interfaces, the trapped ion system can be scaled in various ways for applications in quantum communication, quantum computing, and quantum simulations. I will discuss several options and issues for such atomic quantum networks, along with state-of-the-art experimental progress.