Abstract Submitted
for the DAMOP12 Meeting of
The American Physical Society

Ion-photon entanglement and state mapping in an optical cavity
TRACY E. NORTHUP, ANDREAS STUTE, BERNARDO CASABONE, BIRGIT BRANDSTÄTTER, KONSTANTIN FRIEBE, RAINER BLATT[1], Institute for Experimental Physics, University of Innsbruck — Quantum networks require a coherent interface between quantum states of light and matter. In order to realize such an interface, we couple a single calcium ion to two orthogonal polarization modes of a high-finesse optical resonator. Trapped ions have the advantage of well-developed techniques for coherent state manipulation and readout, while the cavity setting enables an efficient mapping process. We demonstrate on-demand, high-fidelity entanglement between an ion and a photon. Both amplitude and phase of the entangled state are fully tunable due to the use of a bichromatic Raman field. In contrast to previous work, the phase of the entangled state is independent of the photon detection time. In a second step toward cavity-based quantum networks, an ion is prepared in a superposition state, and this state is mapped coherently onto a photon, with characterization via process tomography. Finally, prospects for single-ion strong coupling are discussed.

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Date submitted: 27 Jan 2012 Electronic form version 1.4