Abstract Submitted
for the DAMOP10 Meeting of
The American Physical Society

Multipartite entanglement for one photon shared among four optical modes K.S. CHOI, S.B. PAPP, A. GOBAN, H. DENG, Quantum Optics Group, MC 12-33, California Institute of Technology, Pasadena, CA 91125, USA, P. LOUGOVSKI, S.J. VAN ENK, Department of Physics, University of Oregon, Eugene, OR 97403, USA, H.J. KIMBLE, Quantum Optics Group, MC 12-33, California Institute of Technology, Pasadena, CA 91125, USA — Access to multipartite entanglement enables advances in quantum information science and also contributes to the understanding of strongly correlated systems. A critical requirement for these scientific advances, however, is an efficient and unambiguous method to characterize the purported entangled states. We report the detection and characterization of heralded entanglement in a multipartite quantum state composed of four optical modes that coherently share one photon, a so-called W state [1]. By controlling the phase coherence between bipartite components of the W state, we observe smooth transitions from quadripartite to bipartite entanglement. These observations are possible for our system because our entanglement verification protocol makes use of quantum uncertainty relations to simultaneously detect entangled states that span the Hilbert space of interest [2]. We further describe an experiment that generates entanglement for collective excitations stored in four spatially distinct atomic ensembles. [1] Science 324, 764 (2009); [2] New J. Phys. 11, 063029 (2009)

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Date submitted: 26 Jan 2010 Electronic form version 1.4