Abstract Submitted
for the DAMOP14 Meeting of
The American Physical Society

Experimental entanglement of 60 modes of the quantum optical frequency comb and application to generating hypercubic-lattice cluster states[1] OLIVIER PFISTER, MORAN CHEN, PEI WANG, WENJIANG FAN, University of Virginia, NICOLAS MENICUCCI, University of Sydney — In the race to build a practical quantum computer in the laboratory, the ability to create very large quantum registers and entangle them is paramount, along with the ability to address the issue of decoherence. With particular regard to scalability, the field-based, continuous-variable (CV) flavor of quantum optics offers notable promise, in particular by enabling "top down," rather than "bottom up," entangling approaches of quantum field modes. It is also important to note the relevance of continuous variables to universal quantum computing, with the recent discovery of a fault tolerance threshold for quantum computing with CV cluster states and nonGaussian error correction. In 2011, some of us generated simultaneously 15 independent 4-mode cluster states over 60 modes of the quantum optical frequency comb (QOFC) of a single optical parametric oscillator (OPO). In this work, we used a single OPO to generate a 60-mode dual-rail cluster state, which is the largest entangled system to date whose subsystems are all simultaneously available. Using the exact same setup, we also generated two copies of a 30-mode dual-rail cluster state. We will then present a new proposal to "weave" such massively scalable continuous-variable cluster states into hypercubic-lattice quantum graphs

[1]Work supported by NSF grants PHY-0855632 and PHY-1206029

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Date submitted: 28 Jan 2014 Electronic form version 1.4