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Scalable Quantum Computing Over the Rainbow OLIVIER PFISTER, University of Virginia, NICOLAS C. MENICUCCI, Perimeter Institute, Waterloo, Canada, STEVEN T. FLAMMIA, IQI, Caltech — The physical implementation of nontrivial quantum computing is an experimental challenge due to decoherence and the need for scalability. Recently we proved a novel theoretical scheme for realizing a scalable quantum register of very large size, entangled in a cluster state, in the optical frequency comb (OFC) defined by the eigenmodes of a single optical parametric oscillator (OPO). The classical OFC is well known as implemented by the femtosecond, carrier-envelope-phase- and mode-locked lasers which have redefined frequency metrology in recent years. The quantum OFC is a set of harmonic oscillators, or Qmodes, whose amplitude and phase quadratures are continuous variables, the manipulation of which is a mature field for one or two Qmodes. We have shown that the nonlinear optical medium of a single OPO can be engineered, in a sophisticated but already demonstrated manner, so as to entangle in constant time the OPO's OFC into a finitely squeezed, Gaussian cluster state suitable for universal quantum computing over continuous variables. Here we summarize our theoretical result and survey the ongoing experimental efforts in this direction.

Olivier Pfister
University of Virginia

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