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Progress toward scalable optical quantum computing[1]

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Quantum computing holds great promise for solving certain problems which would be intractable using classical computing architectures. Compared to other carriers of other quantum information (e.g., ions, spins, or superconductors) photons have the simultaneous advantage and disadvantage of interacting with the environment and each other only weakly. They are thus relatively immune to decoherence, but it is difficult to achieve the required qubit-qubit interactions. Fortunately, in 2001 Knill, Laflamme, and Milburn proposed a scheme that was scalable at least in principle, if not in practice (too many resources per gate were required). Since then, the ideas were merged with those of "one-way quantum computing" to realize a scalable approach based on "cluster states", with much more modest though still very challenging - resource requirements. Here I will describe some of the challenges and recent successes, both in implementing the necessary resources (i.e., high-efficiency detectors, single- and entangled-photon sources, and fast logic), and in applying these to realize some basic quantum computing primitives (single- and two-qubit gates and some simple algorithms).

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