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Efficient quantum computing using coherent photon conversion

NATHAN K. LANGFORD, University of Vienna, Austrian Academy of Sciences, University of Oxford, SVEN RAMELOW, University of Vienna, Austrian Academy of Sciences, ROBERT PREVEDEL, University of Vienna, University of Waterloo, WILLIAM J. MUNRO, NII and NTT Basic Research Laboratories, GERARD J. MILBURN, University of Queensland, University of Vienna, ANTON ZEILINGER, University of Vienna, Austrian Academy of Sciences — Single photons make very good quantum information carriers, but current schemes for photonic quantum information processing (QIP) are inefficient. We describe a new scheme, *coherent photon conversion (CPC)*, using classically pumped nonlinearities to generate and process complex multiquanta states[1]. One example based on four-wave mixing provides a full suite of QIP tools for scalable quantum computing from a single, versatile process, including: deterministic multiqubit entanglement gates based on a novel photon-photon interaction, high-quality heralded multiphoton states without higher-order imperfections, and robust, high-efficiency detection. Using photonic crystal fibres, we present observations of quantum correlations from a four-colour nonlinear process suitable for CPC and study the feasibility of reaching the deterministic regime with current technology. The scheme could also be implemented in optomechanical, electromechanical and superconducting systems.

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