Realization of a parametric interaction between two photons from independent sources

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Photons are ideal carriers of quantum information, as they can be easily created and manipulated and can travel long distances without being affected by decoherence [1]. They are the workhorse of quantum communication. However, under normal circumstances, they do not interact with each other. Realising such an interaction is not only fundamentally fascinating but holds great potential for emerging technologies. In fact, even a weak interaction between single photons can be used to perform quantum communication tasks more efficiently than what can be achieved with ideal linear optics and probabilistic sources [2]. For example, one could herald entanglement over a long distance, and move a step closer to futuristic applications such as device-independent quantum key distribution. Nonlinear interactions at the single-photon level are mainly being explored in atomic systems. However, the wavelengths, bandwidth, temperature and scale of these atomic systems make them incompatible with quantum communication applications. Here we take a different approach and use a state-of-the-art nonlinear waveguide to demonstrate a parametric interaction between a single photon and a single-photon-level coherent state from independent sources. The measured system efficiency is $1.5\text{x}10^{-8}$, made up for by a high repetition rate of $4.3\text{x}10^{8}$/s . This provides an integrated, room-temperature, high-bandwidth device operating at telecom wavelengths.

[1] Nicolas Gisin and Robert Thew, Quantum communication. Nature Photonics, 2007, 1(3) 165-171

[2] Nicolas Sangouard, Bruno Sanguinetti, Noé Curtz, Nicolas Gisin, Rob Thew and Hugo Zbinden. Faithful Entanglement Swapping Based on Sum-Frequency Generation. Physical Review Letters, 2011, 106(12) 120403