

# Single photon temporal wavepacket control for qudit encoding

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## Abstract

We present a method of remote temporal wavepacket narrowing by utilizing spectrally entangled photon pairs produced in the parametric down-conversion process. The technique can be applied to extend the range of quantum communication protocols and encode information in qudit.

Careful preparation of the photon wavepackets used in quantum communication can significantly enhance quantum protocols. However, photons emitted by some realistic sources are spectrally broadband. Due to this drawback, the signal is affected by temporal broadening during its propagation through dispersive media. This effect can considerably limit the efficiency of temporal filtering in long-distance applications. Recently we proposed a method to suppress this limitation [1, 2]. Here, we demonstrate how tailoring the spectral entanglement and applying a time-resolved heralding procedure can substantially narrow the wavepacket of the propagated photons in comparison with the classical case [3]. Next we show how one can use a temporal mode of single photon to encode information. The theoretical analysis is based on the analogy between diffraction (paraxial propagation in space) and dispersion (propagation in time through a dispersive medium).

We measured the reduction of the width of the heralded wavepacket to approximately 29% as compared to the case of non-heralding scenario. This experimental technique combined with a proper control of the pump spectral mode can be used to generate and measure entangled qudit pairs encoded in temporal modes of photon pair [4]. This method and a technique of entangled photon pairs production allows one to generate correlated states of multilevel systems.

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