Narrow-band source of polarization-entangled photons with counterpropagating domain engineering

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Abstract Photonic entanglement is central resource to quantum information sciences, such as quantum communication and quantum computation. The entangled photons generated in conventional spontaneous parametric down-conversion usually yield THz bandwidth which becomes very dim in many applications call for narrow-band entanglement sources. Here we demonstrate the polarization-entanglement photon source with counterpropagating phase matching, which results in an inherent bandwidth of 7.1 GHz at telecom wavelength. The entanglement is measured to violate the Bell inequality by up to 18.5 standard deviations, with Clauser–Horne–Shimony–Holt S-parameter of 2.720±0.039. The quantum state tomography further characterizes the entanglement, with fidelity F=(95.71±0.61)%.

The bandwidth of entangled light source which plays a central role in quantum information is a crucial characteristic that determines its application prospect. That's because the interaction between light and matter, which is at the heart of many applications of quantum information, requires a narrow-band light source. This restrict has been loosed to GHz in the last few years[1,2]. Even though, to be honest, it is still a challenge for conventional spontaneous parametric down-conversion which yield a bandwidth about THz. Hence, for the first time, we proposed a state-of-art domain-engineering technology for the counterpropagating phase matching in the polarization-entanglement generation.

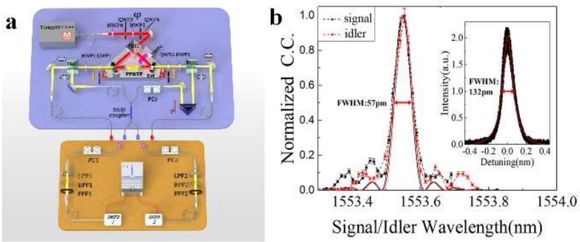

Fig. 1. **a.** The experimental setup of the preparation and representation of the photons. **b.** The spectrum of the down-converted photons.

In order to representation the bandwidth of the photon source, the spectral of signal and idler has been proceeded by measuring the coincidence counts after spectral filtering with a result of 57 pm (7.1 GHz). The Hong-Ou-Mandel (HOM) interference has been measured with a base-to-base width of 155 ps and a visibility of 97.1%. The visibilities of polarization correlation measurement are (96.6 ± 0.45)%, (99.5 ± 0.19)%, (97.1 ± 0.53)% and (97.2 ± 0.53)%, respectively. The quantum state tomography further characterizes the entanglement, with fidelity F=(95.71 ± 0.61)%.

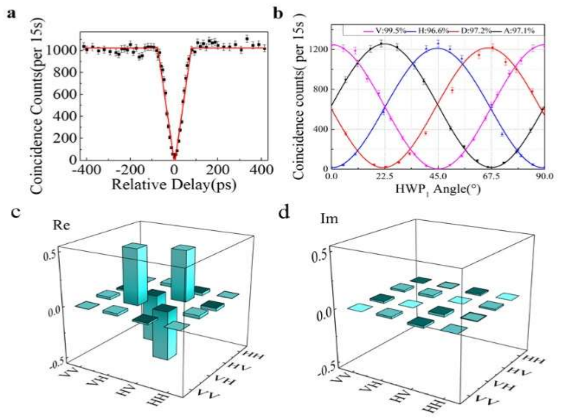

Fig. 2. **a.** HOM interferometer. **b.** Entanglement correlation measurement. **c.d.** The real (c) and imaginary (d) parts of the reconstructed density matrix for the polarization states

Reference

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[2] E. Saglamyurek *et al*. "Broadband waveguide quantum memory for entangled photons," Nature 469(7331), 512-515 (2011).