

Compact source of narrow-band counterpropagating polarization-entangled photon pairs using a periodically poled KTP waveguide

Yi-Chen Liu^{1,2}, Dong-Jie Guo^{1,2}, Zhenda Xie^{1,2+} Yan-Xiao Gong^{1,2+} and Shi-Ning Zhu^{1,2}

¹ National Laboratory of Solid State Microstructures, Nanjing University, Nanjing, China.

² Collaborative Innovation Center of Advanced Microstructures, Nanjing, China.

Abstract

We report the first polarization-entangled photon-pair source with counterpropagating domain engineering. This results in a spontaneous parametric down conversion with 7.2 GHz inherent narrow bandwidth at telecom wavelength, and enables deterministic polarization entanglement generation without two-photon interference. The quantum state tomography shows a singlet state generation a fidelity of $F=(95.91\pm 0.61)\%$, with a source brightness of $5.4\times 10^3/(\text{GHz mW s})$. The Clauser–Horne–Shimony–Holt S-parameter is measured to be $S = 2.720\pm 0.039$.

Polarization-entanglement [1] is the key resources for not only the fundamental quantum mechanics studies, but also the quantum information technologies such as the quantum communication [2]. We experiment a compact source of narrow-band counterpropagating polarization-entangled photon pairs in telecommunications band using a periodically poled KTP waveguide. A Hong-Ou-Mandel interference [3] is measured with base-to-base width of 155 ps, which corresponds to the spectral linewidth of 7.2GHz. A quantum state tomography was performed and the fidelity between the experimental state and the ideal $|\rightarrow$ calculated is $(95.91\pm 0.61)\%$. Violation of this inequality ($S>2$) is a direct proof of entanglement. Our measured result is which confirming a strong violation of Bell inequality by 18.5 standards [4]. It improves that we have got the high quality and narrow-band polarization-entanglement generation with counterpropagating domain engineering based on a PPKTP waveguide.

In summary, we utilizing backward SPDC processes in a PPKTP waveguide to demonstrated a narrowband polarization-entangled photon pair sources can be applied to quantum repeaters. Due to the principle of reverse phase matching, signal photons are naturally separated from idler photons allows realization of naturally separate of photon pairs, an interference-free device can be built. For photon sources to become practical in long distance communication, it is important to reduce the complexity of experimental implementations.

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