Triple photons

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Triple photon generation (TPG) is based on a third-order nonlinear optical interaction, which is the most direct way to produce pure quantum three-photon states. These states can exhibit three-body quantum entanglement and their statistics go beyond the usual Gaussian statistics of coherent sources and optical parametric twin-photon generators, offering new tools for quantum mechanics (Fig. 1 – left). Furthermore, from the application point of view, the generation of entangled photon pairs heralded by the detection of a third photon can be used in advanced quantum communication protocols. We made the first experimental demonstration of TPG in 2004 using a bi-stimulation scheme in a bulk $KTiOPO_4$ (KTP) crystal [1], followed by the quantum theory [2, 3].

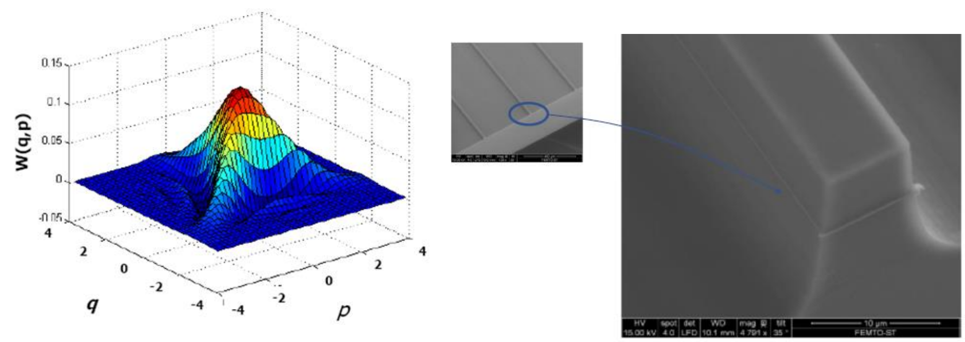

Figure 1. (left) Wigner function of a degenerate three-photon quantum state [4]. (right) Image of an oriented KTP ridge waveguide with a 7 x 5 μm^2 cross section.

The new challenges are now to achieve a spontaneous TPG and the corresponding quantum experiments and protocols using oriented ridge KTP waveguides, which ensures both birefringence phase-matching and light confinement (Fig. 1 – right). A rate of 100 triplets *per* second at 1596 nm is expected when pumping a 1-cm long waveguide with a 5-W 532 nm beam in the CW regime. Superconducting nanowire detectors single photon detectors (SNSPD) working at 2.5 K will be used [5, 6]. The waveguides are cut by a precision dicing saw [7]. We performed the first characterization of these waveguides from second-harmonic generation measurements, which showed their good quality [8].

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