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Spectral and spatial properties of the noncollinear emission from Type-0 spontaneous parametric downconversion in periodically-poled lithium niobate

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In recent years, two-photon coincidence experiments have advanced both the understanding and subsequent applications of entangled photons. In particular, for femtosecond-timescale coincidence measurements, such as two-photon absorption or sum-frequency generation, special, spectrally-broadband (or temporally ultra-short) sources of entangled photons are required [1,2].

Periodically-poled lithium niobate (PPLN) is an important medium in many frequency conversion applications. It can also be used for the process of spontaneous parametric downconversion (SPDC) to create photon pairs, entangled in both energy and time. Here, we design an entangled photon source which utilizes a 5 mm bulk PPLN:MgO crystal (with Λ=6.97µm), pumped with a 532 nm laser, to produce photon pairs centred around 1064 nm with a FWHM spectral bandwidth of 60 nm. Although this crystal is designed for collinear downconversion, we also observe a strong noncollinear emission at a relatively large opening angle. Here, the spectral and spatial properties of Type-0 SPDC for PPLN were mathematically modelled. These results are in good agreement with the parametric emission experimentally imaged on a CCD beam profiler.

Thus, by an advantageous choice in collimating lenses capable of fully collecting the conical emission, greater frequency conversion efficiencies can be achieved. This is especially relevant in such cases as entangled two-photon absorption or sum frequency generation of entangled photon pairs, where the collection and subsequent focusing of maximal downconversion emission is paramount.

[1] Barak Dayan. "Theory of two-photon interactions with broadband down-converted light and entangled photons"Physical Review A 76, 043813 (2007).

[2] Kevin A. O'Donnell, Alfred B. U'ren., "Time-resolved up-conversion of entangled photon pairs"Physical Review Letters 103, 123602 (2009).

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