Phase-compensated ultra-bright source of entangled photons: erratum

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Abstract: An erratum is presented to correct the calculation of the external phase difference between down-converted photons propagating through a pair of birefringent crystals.

OCIS codes: (270.0270) Quantum Optics; (190.0190) Nonlinear Optics.

References and links

1. J. B. Altepeter, E. R. Jeffrey, and P. G. Kwiat, "Phase-compensated ultra-bright source of entangled photons," Opt. Express **1**3, 8951-8959 (2005).

In our recent paper [1], we demonstrated the brightest (at the time) high-purity source of polarization entangled photons based on down-conversion. The high-quality entanglement was achieved through the use of a novel combination of crystals to minimize decoherence caused by angle-dependent birefringent phases. To design the compensation crystals we modeled the phases acquired by the entangled photons as they propagate through the down-conversion crystals. The calculation for one of the phases—the external phase which results because the extraordinary and ordinary rays exit the crystals at different points—was incorrect in the original paper. The external phase, Φ_Δ, given by Eq. (7) is only correct for the compensation crystals, in which both the ordinary and extraordinary rays propagate through the entire crystal. For the down-conversion crystals, however, the external phase depends only on the extraordinary Poynting vector, and is given by:

$$\Phi_{\Delta,dc} \quad = \quad \frac{2\pi}{\lambda}\Delta_{dc} = \frac{2\pi d}{\lambda}\left(\hat{z} - \frac{1}{\cos(\beta)}\hat{S}_e\right)\cdot\hat{k}_\alpha.$$

Figure 1 is an addition to Fig. 2 from the original paper that correctly illustrates the origin of the external phase for down-conversion crystals.

The corrected formula affects the predicted phasemap from the down-conversion crystals, giving a slope of 18°/mm (the previous value was 14°/mm), which shows better agreement with the experimentally obtained slope of 17°/mm. The new phasemap slope also explains, at least in part, the 3°/mm slope that remained after phase compensation, because the compensation crystals were designed to correct a 14°/mm slope. In principle, using compensation crystals having a 300-μm thickness and a 33.9° cut angle should produce an even higher state fidelity than what was demonstrated in the original paper.

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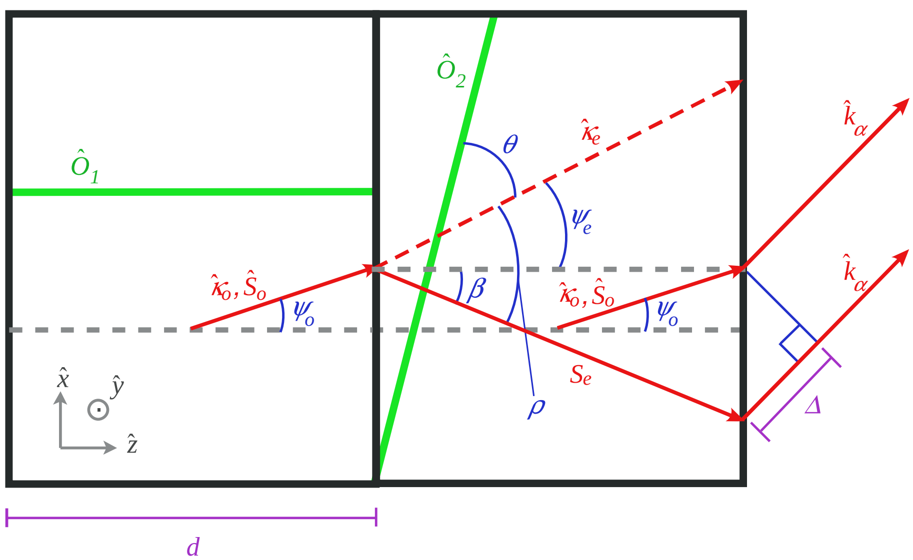

Fig. 1. Diagram illustrating all relevant vectors, angles, and variables used for calculating angle-dependent phase differences due to the pair of birefringent down-conversion crystals, having optic axes $\hat{O}_1$ and $\hat{O}_2$.

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