Measurement of noise-induced loss of polarization coherence

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ABSTRACT
Coherence is one of the most fundamental aspects of any theory based on waves, i.e., electromagnetic theory, both in the classical and quantum regimes. Apart from its fundamental importance, it is a resource that can be used in certain applications. One such an application is Optical Coherence Tomography (OCT). This thesis deals with a quantum version of it, based on works by Leonard Mandel and colleagues [1-4], that in the 90's developed ideas around the effect of induced coherence in nonlinear interferometers. The fundamental aim of this thesis is to implement a Quantum Optical Coherence Tomography (Q-OCT) scheme. Fully experimental work that constitutes a practical application of a purely theoretical quantum principle, as it is induced quantum coherence.

BACKGROUND

SPDC, INDUCED COHERENCE & Q-OCT
Complementarity is closely related to the theory of measurement and distinguishability in quantum physics. “Which-path” information of a single photon is only possible by decreasing the visibility of the interference fringes. These constitute the basis of nonlinear interferometry experiments using signal and idler photons generated by two SPDC crystals, developed at first in the 90’s by L. Mandel and colleagues [1-4]. When the idler photons of both crystals are superposed and aligned (then indistinguishable), the idler from the first crystal can induce coherence between the two signals, without inducing any further emission. Therefore, blocking the first idler photon destroys the interference.

MANDEL BASED Q-OCT SCHEME
Periodically Poled Lithium Niobate (PPLN) Type-0 collinear crystals have been used as SPDC sources. 532 nm pump photon is down-converted into a 810 nm signal photon and 1550 nm idler photon.

CONCLUSIONS

- An OCT setup using a coherent light source and not a low-coherence light source as classical OCT does, has been performed.
- Q-OCT does not require the laser or the detector to operate at the same wavelength as that of the light reaching the object.
- This experiment conforms a proof-of-principle of induced coherence, complementarity and which-path information.
- In our system we measure coherence instead of reflectivity, even though this loss of coherence can be finally linearly related to the reflectivity of the sample.

REFERENCES


