

Laboratoire Matériaux et Phénomènes Quantiques Séminaire Général

Structured photon-pair sources for applications in quantum sensing and imaging

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12 Decembre 2019 à 11h00 – Salle Luc Valentin (454 A)

Correlated photon pairs are the basis for many applications using quantum optics. One area of interest is in using their advantageous properties in quantum imaging and spectroscopy schemes. Here, it has been shown that using non-classical correlations enables to perform imaging and spectroscopy at wavelengths for which no detector is available and at signal-to-noise ratios better than possible with classical light. In these first demonstrations, simple bulk nonlinear crystals were used to create the needed photon pairs by spontaneous parametric down-conversion (SPDC).

On the other hand, in recent years it was demonstrated countless times that micro- and nanostructured optical elements can enhance the performance of classical optical applications due to an enhanced control of the propagation and interaction properties enabled by structuring. In my talk, I will show two examples where using structured photon-pair sources with optimized properties creates advantages also for quantum spectroscopy and imaging.

First, I will discuss how quantum spectroscopy with undetected photons can be realized in integrated optical waveguides. I will demonstrate that a single waveguide can simultaneously act as photon-pair source and sensing element, where the control of the nonlinearity and the dispersion relation possible in waveguide structures enables optimization of the sensitivity.

As a second example, I will discuss our efforts towards the realization of photon-pair sources in nonlinear resonant metasurfaces. Such metasurfaces are built from periodic arrangements of nonlinear nanoresonators, which enable to locally control nonlinear optical interactions and reach significant conversion efficiencies in layers of only few hundreds of nm thickness. This is particularly interesting for applications in quantum imaging, where the optimal spatial resolution can only be achieved with very thin photon-pair sources

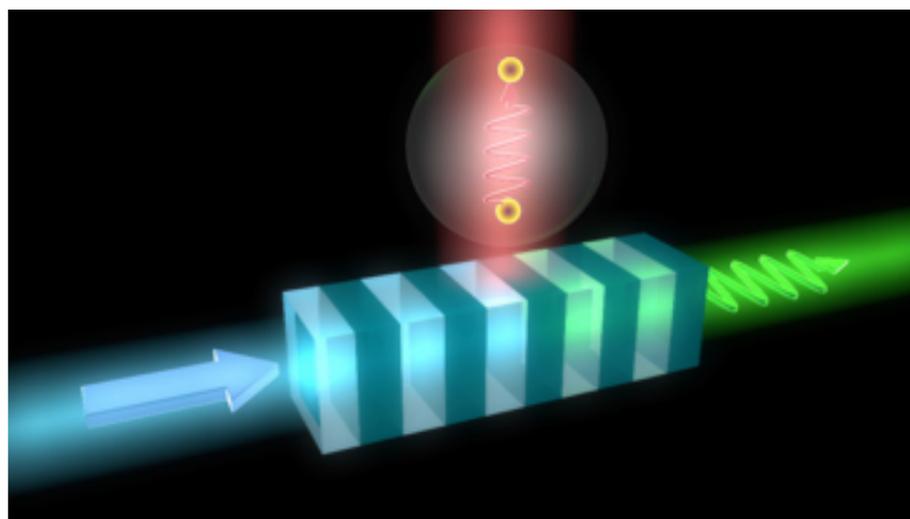


Fig. 1: Artistic sketch of a periodically structured SPDC photon-pair source, which is strongly influenced by coupling to a single emitter and thus can serve as a sensor indicating the presence of the emitter.