Liquid filled photonic fibers for non linear devices (plénière)

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Combining the propagation engineering of hollow core photonic crystal fibres with the large variety of possible liquids filling the fibre core allows for a delicate tuning of new devices. Here, we illustrate the optimisation of such liquid filled hollow core fibres with two devices: efficient wavelength Raman converters and high purity sources of correlated photon pairs.

1. Introduction

Photonic bandgap fibres are a technologically mature technology [1]. The linear propagation of optical beams can be perfectly engineered: the bandgap can be accurately positioned and the dispersion can be finely tuned. Nevertheless, silica, from which fibres are made, does not allow a total control over the optical nonlinearities. To solve this issue, inserting a nonlinear material during the fabrication of the silica fibre was proposed. Photonic crystal fibres made from other materials, such as chalcogenides for working in the mid-infrared, were also demonstrated. Nevertheless, in the visible and near-infrared range a greater versatility is obtained with hollow core photonic crystal fibres. Our preferred choice to increase our control over the nonlinear parameters is to fill the hollow core with gases [2] or liquids [3][4]. The transmission band and the dispersion are optimized through both photonic structure and liquid refractive index, and the non-linear coefficients are adjusted by choosing the liquids or mixtures of liquids.

2. Efficient Raman wavelength converters

During their propagation inside a liquid filling the fibre, pump photons are progressively transformed into Stokes photons at a longer wavelength by, first, spontaneous Raman scattering and, then, by stimulated scattering. The frequency shift between the pump and Stokes wavelengths depends on the selected Raman liquid and can be chosen among a very large panel up to a few thousands of cm^{-1}. Raman cascades (e.g. further scattering of the Stokes photons) allow reaching larger shifts. Using microlasers delivering 532 nm sub-nanosecond pulses of about 1 µJ, with either conventional photonic crystal fibres and Kagome fibres, with a few sets of liquids, we will describe the optimisations that already allowed us to built wavelength converters down to: 556 nm; 561 nm; 582 nm; 595 nm; 612 nm; 630 nm; 650 nm; 667 nm; 772 nm.

3. High purity sources of correlated photons

Parametric generation can be used to split two pump photons into two correlated signal and idler photons. In all silica fibres, the unavoidable presence of spontaneous Raman scattering degrades the quality of the produced photon pairs. Using liquid filled hollow core fibres circumvents this issue: conversely to a silica core fibre, the Raman spectrum of liquids is made of lines, rather than large bands. Raman noise can thus be more easily filtered. We will report our latest results using a deuterated acetone liquid filled fibre [5].

Reference

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