Nonlinear optics with tiny bits of glass: photonic crystal fibres

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Nonlinear optics effects in glasses reach some of their fundamental limits in photonic crystal fibres [1]. Photonic crystal fibres (PCF's) allow one to scale the nonlinear coefficient of single-mode waveguides over some 7 orders of magnitude, by confining the light as strongly as possible at one extreme to enabling it to propagate through an air core at the other. This versatility has resulted in several new application areas for optical fibres, and several others still under development.

Perhaps the most visually spectacular is the low-power generation of broadband optical supercontinua [2], which arises from a range of different nonlinear effects, depending on the fibre/pump laser configuration. It has recently become clear that the evolution of the shortest and longest wavelengths in such a supercontinuum are often intimately linked [3], enabling optimisation of the fibre design to produce shorter wavelengths than previously possible.

On the other hand, hollow-core fibres have been demonstrated as a means to deliver high-power femtosecond optical pulses as single-mode fibre solitons without significant temporal or spectral distortion [4]. The very low nonlinear response of this fibre design coupled with the fact that the material contribution to the modal dispersion is greatly reduced compared to standard fibres make this possible. The fibre can then be varied along its length to change the characteristics of the output pulses, using adiabatic or non-adiabatic soliton compression [5,6].

The paper will describe recent progress in these two areas and others, while reviewing the current state of the art.

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PRIMARY TOPIC: R
SECONDARY TOPIC: G
PREFERRED FORMAT OF PRESENTATION (ORAL/POSTER): Invited

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