Photonic Crystals in Chiral Space

P St J Russell[1]

[1] *Max Planck Institute for the Science of Light, Erlangen, Germany*
Contact Email: philip.russell@mpl.mpg.de

Two-dimensional photonic crystals that are extended and chirally twisted in the third dimension provide novel opportunities for controlling light, but are very difficult to realize using conventional planar techniques. Although arrays of individually chiral waveguides, formed by fs laser writing in bulk glass, have been employed to explore topological surface states, high waveguide loss restricts their usable length [1]. In contrast, low-loss chiral structures are straightforward to produce by drawing photonic crystal fibre from a spinning preform [2]. This has led to a series of novel experiments uncovering interesting and useful properties, for example, helical Bloch modes supported by chiral photonic crystal fibres with N-fold rotational symmetry are circularly and vortically birefringent, offering circular dichroism as well as robust preservation of polarization state and topological charge [3], and permitting enhanced control of nonlinear optical effects such as Raman and Brillouin scattering [4,5], four-wave-mixing [6], and supercontinuum generation [7]. A further intriguing effect is exponential localization of light in chiral arrays of exponentially coupled waveguides, *e.g.*, coreless twisted photonic crystal fibre [8]. Indeed, localization of light in chiral PCF turns out to be a universal phenomenon, supporting whole families of helical Bloch modes, each with its own azimuthal and radial order [9].

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