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Polarisation singularities in disordered photonic crystal waveguides for on-chip spin-photon entanglement. DARYL BEGGS, BEN LANG, ANDREW YOUNG, RUTH OULTON, University of Bristol — A polarisation singularity occurs at a position in a vector field where one of the parameters of the local polarisation ellipse (handedness, eccentricity or orientation) becomes singular. With the vector nature of electromagnetic fields, optics is an obvious place for the study of polarisation singularities, and they can be found in systems ranging from tightly focused beams to speckle fields. Here we demonstrate that photonic crystal waveguides support on-chip polarisation singularities. As Bloch waves, the eigenmodes of photonic crystal waveguides possess a strong longitudinal, as well as transverse, component of their electric field. The spatial dependence of both these components and the phase between them ensures a rich and complex polarisation landscape in the waveguide. Recently, the use of polarisation singularities found in photonic crystal waveguides is generating much interest for integrated quantum information applications, as they can couple the spin-states of electrons confined to quantum dots to the optical modes of the waveguide. For example, at a circular-point (C-point), the sign of the local helicity is governed by the propagation direction of the optical mode, which allows for spin-photon coupling to one direction only. However, any real system will inevitably contain imperfections, and it is not obvious that the polarisation singularities will persist in the disordered waveguides. Here, we use calculations of the eigenmodes of disordered waveguides to demonstrate that the polarisation singularities persist far beyond realistically expected levels of disorder.

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