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Aspects of photonic topological insulators

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Great excitement surrounding optical topological protection has recently emerged from the promise of endowing photonic devices with quantum Hall-like robustness. Here, I will present the prediction and realization of a photonic topological insulator for light. Topological insulators (TIs) are solid-state materials that are insulators in the bulk, but conduct electricity along their surfaces - and are intrinsically robust to disorder. In particular, when a surface electron in a TI encounters a defect, it simply goes around it without scattering, always exhibiting – quite strikingly – perfect transmission. The structure is composed of an array of coupled helical waveguides; the helicity generates an artificial circularly-polarized force on the photons that breaks time-reversal symmetry. This leads to bands with non-zero Chern number, and thus topologically-protected edge states (protected in the quantum Hall sense – not by any symmetry). Due to the time-dependent force, the band structure must be solved in the Floquet sense; the result bears close resemblance to that of the quantum anomalous Hall effect. I will also present experimental results on the first realization of a “topological Anderson insulator” (in a similar setting), where the addition of disorder can make a trivial system topological. Time permitting, I will discuss the question of what it means to have topological interface states in non-Hermitian systems, and show new experiments exploring their properties.