Quantifying the robustness of light transport in photonic nanostructures

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The reason why topological photonics [1] has triggered so much attention is its potential to engineer topological edge states that are somehow robust against disorder and imperfection. However, how much robust is topological transport compared to standard photonic non-topological transport? This is an open and relevant question that we address here.

Any real photonic nanostructure is unavoidably affected by some degree of imperfection due to the limited tolerance of any fabrication process. Disorder appears in these systems as white noise, i.e., random normal fluctuations of the different structural parameters. Even fluctuations within the nanometre range [2] induce strong multiple scattering and energy dissipation hampering their optical performance. In photonic-crystal waveguides, backscattering due to disorder is a killer factor for slow light. In these systems, the ideally-propagating Bloch mode breaks down into a set of random cavities due to the interference induced by backscattering. The backscattering mean free path – ξ – is the figure of merit that quantifies this process [3]. ξ is crucial to understand the role of disorder for slow light as it imposes a crossover between ballistic transport and multiple scattering when the waveguide length equals ξ beyond which the slow-light waveguide is virtually useless. In this talk, I will explain how to calculate this parameter in different photonic waveguides as a proper measure to quantify the robustness of light transport topological or not [4]. In addition, I will show our recent calculations of ξ in a conventional and a topological waveguide (Fig. 1). Based on our results, we can confirm that the limitation imposed to standard waveguides by disorder may be overcome by exploiting topological effects purely arisen from engineering the lattice geometry.

References

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Figures

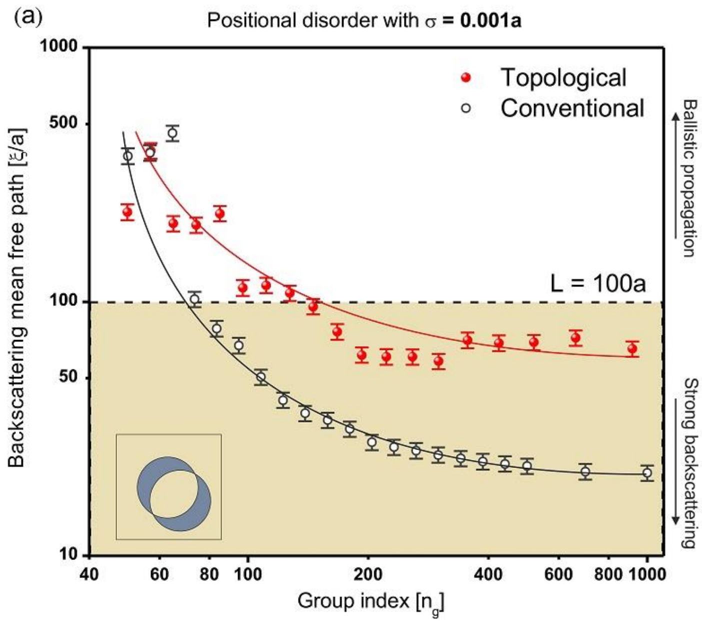

Fig. 1: Backscattering length calculated for different frequencies corresponding to different values of the group index in a valley and a conventional photonic crystal waveguide. The positions of the pillars have been randomized around their ideal values with a standard deviation of σ = 0.001a.