



Topology and Symmetry in Photonic Systems

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Topology has recently emerged as a new tool to characterize global properties of physical systems, e.g., physical responses that are robust to perturbations of the system parameters [1-9]. Typically a nontrivial topology is rooted in some particular symmetry or combination of symmetries of the system, e.g., the system invariance under discrete translations (periodicity in space), or the invariance under the time-reversal operation (reversibility in time), under a space transformation (parity, or other transformation of coordinates), or a transformation of the fields (electromagnetic duality), or others. Topological systems can support either unidirectional or bi-directional propagation channels – depending on the relevant topological class – immune to the unwanted effect of back-reflections, irregularities and imperfections. Thereby, topological platforms can host exciting new physics and phenomena, and can lead to novel devices and waveguides with improved performances and unique properties.

In this work, I will present an overview of the role of symmetry in the topological classification of photonic systems, and highlight how symmetry constraints the optical response, e.g., the scattering matrix, and leads to different topological classes of photonic platforms [6, 8, 9]. Furthermore, I will highlight how discontinuities of spectral response of a system combined with suitable symmetries can lead to “fractional” topologies, characterized by fractional Chern numbers and by a fractional bulk-edge correspondence [9, 10]. At the conference, I will also highlight that low-dimensional systems (e.g., one-dimensional photonic crystals) may be regarded as projections of higher-dimension topological systems (with synthetic dimensions), and explain how the topological properties can be observed in real-space.

References

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