Topological Photonics

Alexander Szameit
Institute for Physics, University of Rostock, Albert-Einstein-Straße 23, 18059 Rostock, Germany

Abstract: The recent experiments on photonic topological insulators signified a new direction. We present the progress in this area, including also the first observation of topological Anderson insulators, with an emphasis on universal ideas common to optics, cold atoms and quantum systems.

The discovery of topological insulators relying on spin-orbit coupling in condensed matter systems has created much interest in various fields, including in photonics. In two-dimensional electronic systems, topological insulators are insulating materials in the bulk, but conduct electric current on their edges such that the current is completely immune to scattering. However, demonstrating such effects in optics poses a major challenge because photons are bosons, which fundamentally do not exhibit fermionic spin-orbit interactions (i.e., Kramer's theorem). At microwave frequencies, topological insulators have been [1] in magneto-optic materials, relying on strong magnetic response to provide topological protection against backscattering – in the spirit of the quantum Hall effect. However, at optical frequencies the magneto-optic response is extremely weak, hence a photonic topological insulator would have to rely on some other property. Indeed, numerous theoretical proposals have been made for photonic topological insulators [2], but their first observation [3], made by our group, relied on a different idea: Floquet topological insulators [4]. Later that year, another group reported imaging of topological edge states in silicon photonics [5]. These experiments have generated much follow up, among them – as the arguably most intriguing one the area of "topological photonics" – our first experimental observation of topological Anderson insulators (predicted in [6]], where a system becomes topological only when disorder is introduced [7]. The purpose of this talk is to review these developments, discuss new conceptual ideas, and suggest applications.

REFERENCES

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Picture of my work: