
Experimental characterization of topological systems (from microwaves to optics)

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Abstract

In the first part, we introduce topologically nontrivial materials whose band structure may give rise to states that are confined to the material's boundary and protected against disorder and scattering. Quantum spin Hall effect (QSHE) is an example of phenomenon in which such states appear in the presence of time-reversal symmetry in two dimensions.

We design a microwave experiment mimicking QSHE and explore the spatiotemporal dynamics of unidirectional transport of optical angular momentum (or pseudospin) by edge states.

Pseudospin-polarized signal propagation is shown to be immune to scattering by defects introduced along the edge.

In the second part, we discuss on the topological charges of the optical phase vortices associated to a speckle pattern resulting from coherence beams impinging on random diffusers.

The intensity maxima and zeros of speckle patterns are interchanged by applying spiral phase delays of charge ± 1 , therefore being called "complementary" patterns.

It is shown that identical results are obtained when substituting the spiral phase masks by periodic temporal modulations, specifically by a phase mask. Finally, with the properties of Fourier series, a phase retrieval algorithm is proposed to find the topological charges of intensity patterns.

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