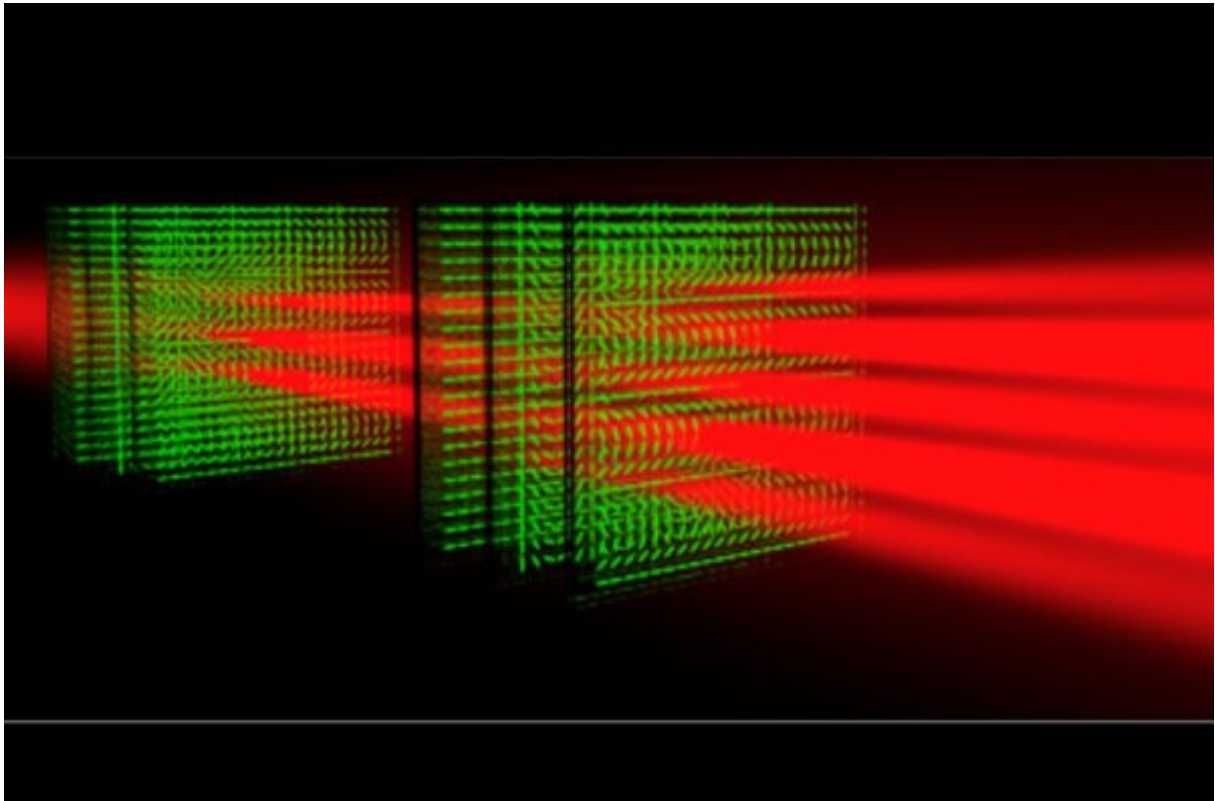




Two-dimensional topological quantum walks in the momentum space of structured light

A study in *Optica* reports on a novel photonic platform, capable of producing quantum walks of structured photons in two spatial dimensions, and exhibiting quantum Hall behavior.

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Research on topological insulators is moving at fast speed, promising a broad spectrum of applications ranging from metrology to quantum computing. Topological insulators are a new phase of matter in which the bulk of the material is an insulator, but its edges conduct electricity through what is called a $\frac{1}{2}$ topological protected $\frac{1}{2}$ edge states, that are a direct manifestation of the nontrivial topology hidden in their band structure.

To understand the effects of topology, physicists are working simultaneously on a plethora of experimental architectures. Among these, quantum walks are powerful models where topological phases of matter can be simulated in static and out-of-equilibrium scenarios.

Most of the quantum walk architectures built so far generated one dimensional processes. However, there are currently efforts on increasing the dimensionality of these platforms to investigate the broad range of topological phenomena that exist in 2D and 3D.

In a study recently published in *Optica*, researchers from the Università degli Studi di Napoli Federico II, in collaboration with Maria Maffei, Alexandre Dauphin, led by ICREA Prof. Maciej Lewenstein, from ICFO and Pietro Massignan from the Universitat Politècnica de Catalunya (UPC), report on a novel photonic platform, capable of producing quantum walks of structured photons in two spatial dimensions, and exhibiting quantum Hall behavior.

In their study, the researchers report on the realization of a photonic platform generating a quantum walk on a two-dimensional square lattice, that emulates a periodically-driven quantum Hall insulator. The apparatus consists of cascaded liquid crystal slabs, patterned to give polarization-dependent kicks to the impinging photons. Suitable combinations of these plates allow to manipulate dynamically the evolution of a light beam, realizing a quantum walk between light spatial modes carrying a variable amount of transverse momentum. The authors demonstrate the non-trivial topological character of their photonic system by directly reading out the anomalous displacement of an optical wavepacket when a constant force is introduced in the system.

The simulation of other condensed matter systems, the investigation of the evolution of quantum light and the study of dynamical phase transitions are among the possible paths that the researchers of the study intend to explore in the next future.