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# From electrons to photons, and back to electrons

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There are many intriguing physical phenomena which are associated with topological features — global properties that are not discernible locally. The best-known examples are quantum Hall effects in electronic systems, where insensitivity to local properties manifests itself as conductance through edge states which are insensitive to defects and disorder. In the talk, we first discuss how similar physics can be observed for photons; specifically, how various quantum Hall Hamiltonians can be simulated in an optical system. We report on the imaging and measurement of topological photonic edge states and the generation of correlated-photon pairs, in silicon photonics platform. We then discuss how strong interaction between photons can be created by the integration of topological photonic structures with solid-state quantum emitters. Specifically, we demonstrate the chiral emission of a quantum emitter into topological edge modes and establish their robustness against sharp bends. In the end, we describe how photons, in a different role, could be exploited to probe and manipulate topological electronic states. In particular, we theoretically investigate the realization of a two-component fractional quantum Hall phases in monolayer graphene by optically driving the system, in a non-equilibrium regime. Moreover, we discuss how quantum optics toolbox can be applied to such correlated states of electrons.

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