Boundary states in one-dimensional periodically modulated photonic lattices

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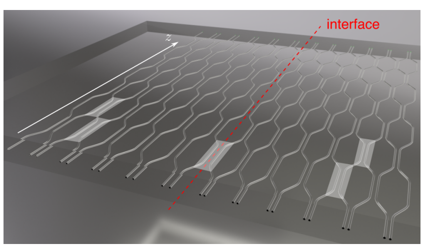
It was recently proposed that exotic topological states may arise when a (quantum) system is subjected to a non-adiabatic time-periodic potential. These *dynamical* systems can develop specific topological properties with no counterpart in the usual *equilibrium* topological insulators, as revealed by the existence of topologically protected boundary states while all the topological invariants defined for the effective equilibrium Hamiltonian vanish [1]. These concepts, first developed in the context of irradiated semimetals and semi-conductors [2] found a spectacular experimental manifestation in single-photon quantum walks [3], photonic lattices [4] and out-of-equilibrium cold atom physics [5].



Sketch of the experimental realization of a Floquet waveguide array.

In this work, we achieve, identify and experimentally manipulate chiral-symmetry protected anomalous Floquet boundary topological states in a one-dimensional periodically modulated photonic lattice (i.e. array of coupled optical waveguides, as depicted in the figure). In this scheme, the boundary states are trapped at the interface between two arrays of different bulk properties and propagate along the direction of the guides. Interestingly, we find that other non-topological states with a similar behavior, that are either accidental boundary states or bulk diffractionless states, can also be engineered and discriminated from the topological ones. Remarkably, it is found that the existence of these accidental boundary states is related to the bulk properties of the arrays from each side of the interface. Finally, we probe the topological transition between the Floquet anomalous phase and the trivial one which manifests itself by diffractionless bulk states that propagate with a fixed drift angle. We show how this striking property can be understood as a distinct topological property of the gapless Floquet system.

1. Carpentier, D. et al. *Topological index for periodically driven time-reversal invariant 2D systems*, PRL 114, 106806, 2015
2. Takashi Oka, T and Aoki, H. *Photovoltaic hall effect in graphene*, PRB 79, 081406, 2009
3. Kitagawa, T. et al. *Observation of topologically protected bound states in photonic quantum walks*, Nat. Comm. 3, 882, 2012
4. Rechtsman, M. C. et al. *Photonic floquet topological insulators*, Nature 496, 196, 2013
5. Jotzu, G. et al. *Experimental realisation of the topological Haldane model*, Nature 515, 237, 2014