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Topologically tunable polaritons based on two-dimensional crystals in a photonic lattice

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Abstract

The engineering of non-linear light-matter states in optical lattices has emerged as a key research strategy for the exploration of Hamiltonians in the spirit of quantum-simulation. It furthermore has revealed its potential to probe non-trivial topological phenomena. Excitons in atomically thin crystals have emerged as an ideal active medium for such purposes, since they couple strongly with light, and comprise strong optical nonlinearities.

In this experiment we study widely spectrally tunable (100 meV), room temperature exciton-polaritons using a WS_2 monolayer in a high-quality open cavity. We imprint an optical lattice in the photonic structure, which emulates the Su-Schrieffer-Heeger (SSH) Hamiltonian, and which comprises a domain boundary to host a topological, exponentially localized mode at the interface between two lattices characterized by different Zak-phases. We utilize the unique tilt-tunability of our implementation, to transform the SSH-lattice into a Stark-ladder. We verify, that this transformation couples the topological mode to propagating lattice modes, and effectively changes the topological class of our structure. Furthermore, it allows us to directly quantify the Zak-phase in our device from the energetically staggered band-energy spectrum.