Topology detection in cavity QED

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We explore the physics of topological lattice models in c-QED architectures for arbitrary coupling strength, and the possibility of using the cavity transmission as a topological marker. When the coupling between subsystems is small, the transmission can be used as a way to probe the properties of the fermionic system in a non-invasive way, while at large coupling rates, these properties are highly modified and hybrid excitations of the total system appear.

In this work, we develop an approach combining the input-output formalism with Mean-Field theory, which includes self-consistency and quantum fluctuations to first order, and allows to go beyond the small-coupling regime in the calculation of the cavity transmission. We apply our formalism to the case of a fermionic Su-Schrieffer-Heeger (SSH) chain, whose topological phase is characterized by the presence of two in-gap edge states, topologically protected against local perturbations.

Our findings confirm that the cavity can indeed act as a quantum sensor for topological phases, where the initial state preparation plays a crutial role.

Additionally, we discuss the persistence of topological features when the coupling strength increases, in terms of an effective Hamiltonian, and calculate the entanglement entropy.

Our approach can be applied to other fermionic systems, opening a route to the characterization of their topological properties in terms of experimental observables.

References

[1] B. Pérez-González, A. Gómez-León, G. Platero, "Topology detection in cavity QED", arXiv:2106.08709v2

Figures

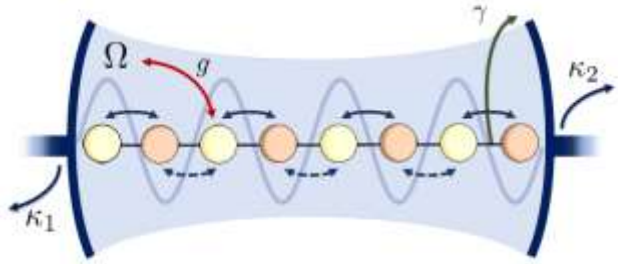

Figure 1: Schematic picture of a dimerized chain interacting the photons in a cavity. The cavity photons have frequency Ω and are connected to the input and output ports with factors κ. The fermions interact with the photons with strength *g* and γ represents the spectral broadening of the fermionic system.