

Quantum adventures out of equilibrium: photon pumping and new topological phases

In the 20th century, major breakthroughs in condensed matter physics were achieved by understanding equilibrium quantum effects in electronic systems, and how they may be influenced using the tools of materials synthesis.

Recent technological developments in synthetic quantum systems—including cold atoms and molecules, and superconducting qubits—have given us experimental access to tunable and controllable synthetic quantum systems which are colder, cleaner, and with longer coherence times than those found in materials systems. This has provided the ability to observe non-equilibrium quantum dynamics in action. Consequently, we have gained access to a new landscape of possibilities for experimentally realizable non-equilibrium quantum physics.

However, without the equilibrium state to orient ourselves, we lack a framework for understanding what phenomena are physical, and robust in this setting. In this talk I will show that tools of topological classification, more familiarly applied to band insulators, provide one such organisational principle for quantum dynamics.

I will introduce robust classes of topological dynamics, the phenomenology of quantised photon pumping, its utility and realization in experimental Nitrogen vacancy and Cavity QED systems, and how this classification framework allows us to define a new landscape of driven quantum matter. These examples highlight new directions in the growing landscape of physics probed by cutting edge experiments.