Many-body localization and non-Abelian symmetries

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Universal chiral quasi-steady states in periodically driven many-body systems

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We investigate many-body dynamics in a one-dimensional interacting periodically driven system, based on a partially-filled version of Thouless's topologically quantized adiabatic pump. The corresponding single particle Floquet bands are chiral, with the Floquet spectrum realizing nontrivial cycles around the quasienergy Brillouin zone. For generic filling, with either bosons or fermions, the system is gapless; here the driving cannot be adiabatic and the system is expected to rapidly absorb energy from the driving field. We identify parameter regimes where scattering between Floquet bands of opposite chirality is exponentially suppressed, opening a long time window where the many-body dynamics separately conserves the occupations of the two chiral bands. Within this intermediate time regime we predict that the system reaches a chiral quasi-steady state. This state is universal in the sense that the current it carries is determined solely by the density of particles in each band and the topological winding numbers of the Floquet bands. This remarkable behavior, which holds for both bosons and fermions, may be readily studied experimentally in recently developed cold atom systems.

Probing many-body localisation using ultracold atoms

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Floquet-engineering topological and spin-dependent bands with interacting ultracold fermions

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Periodically driving a system of ultracold fermionic atoms in an optical lattice allows for implementing a large variety of effective Hamiltonians through Floquet engineering. By periodically modulating a magnetic field gradient we experimentally realize spin dependent effective energy bands allowing for a tunable ratio of the effective mass for each internal state. We access the regime where one spin is completely localized whilst the other remains itinerant.
In addition, circular modulation in a honeycomb lattice leads to the appearance of complex next-nearest neighbor tunneling. This corresponds to a staggered magnetic flux in the lattice, allowing for the realization of Haldane's model of a topological Chern insulator. We propose a direct measurement of the topological edge modes in such an engineered quantum system. When spin dependence is included, time-reversal symmetry can be restored giving rise to the Kane-Mele model.
A crucial question is whether Floquet engineering can be extended to interacting systems, how the resulting Hamiltonians are modified, and whether the system thermalizes to a steady state. Here we use the tunability of ultracold atoms to investigate new Hamiltonians enabled by Floquet engineering with interacting fermions and study how heating in the system depends on the modulation and interaction.

Linear Response Theory in Periodically Driven Interacting Systems

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We discuss possibilities of extending Kubo's linear response theory in many body systems periodically driven by external fields. Examples that are planned to be discussed are 1) the Hubbard model, 2) an Electron-phonon model, and 3) a Holographic system (SQCD). In addition, we will discuss heterodyne responses which are ubiquitous in Floquet systems.

Heating and limited adiabaticity in Floquet systems

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In this talk I will discuss heating mechanisms in generic nonintegrable Floquet systems and, in particular, the role of many-body photon resonances. These resonances are also responsible for the absence of the adiabatic limit even in the regimes with suppressed heating. However, there is a broad window for the validity of adiabatic perturbation theory at fast driving frequencies. I will argue there are deep parallels between the energy localization transition and the MBL transition in static disordered systems. At the end I will discuss a new approach for finding Floquet Hamiltonians in spin chains based on the replica trick. This approach is non-perturbative in the driving frequency and allows one to get analytic insights to the structure of photon resonances.

Micromotion in topological Floquet systems

Rudner, Mark
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The Floquet operator of a periodically driven system acts as a generator for discrete time "stroboscopic" dynamics. The spectrum and eigenstates of the Floquet operator are often quite useful for describing and analyzing the long time dynamics of driven systems. However, the continuous "micromotion" that takes place within each driving period also plays a crucial role in many phenomena. In particular, the topological characteristics of periodically driven systems depend in an essential way on the evolution within a driving period. Furthermore, micromotion has important implications both for for scattering within a driven system and between system and bath degrees of freedom. In this talk I will describe how micromotion affects the topological classification of non-interacting Floquet systems, and may lead to new quantization phenomena. In particular, I will show that the magnetization density of a fully-localized two-dimensional Floquet system is quantized as an integer times the inverse driving period, with its integer part given by the 2D winding number invariant. I will then describe how micromotion affects equilibration in open Floquet systems, and discuss how coupling to appropriate bosonic and/or fermionic baths can help to stabilize Floquet topological insulator-like steady states.

Driven phases of quantum matter: Time crystals and Floquet SPT's

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Recent work suggests that a sharp definition of `phase of matter' can be given for some quantum systems out of equilibrium---first for many-body localized systems with time independent Hamiltonians and more recently for periodically driven or Floquet localized systems. We present a new family of driven localized Floquet phases. Perhaps the most interesting of these exhibit a spontaneous breaking of time translation symmetry, and may be regarded as ``time crystals''. Other phases are analogues of the 1d symmetry protected topological phases familiar from the equilibrium setting.