DY 36: Collective Quantum Dynamics: From Fundamentals to New Phenomena (Focus session joint DY/TT)

This session covers recent experimental and theoretical advances both in condensed mater physics as well as in cold atomic systems in the field of dynamical and nonequilibrium properties of quantum many-body systems. Collective quantum dynamics plays a central role in a number of different physical systems. First, dynamical systems will exhibit a rich set of phenomena which lie beyond static ground state properties, e.g. in non-thermal many-body localised systems. Second, dynamical properties of many-body systems can serve as experimentally accessible probes to detect characteristic fingerprints of otherwise featureless phases of matter, such as topologically ordered and fractionalized states of matter. Recent technological advances have had an impact on all of these aspects of the field, while continuing experimental progress in AMO and materials physics is valuable in providing access to new phenomena, as well as testing new theoretical findings.

Organization: Frank Pollmann, MPI-PKS, Dresden; Roderich Moessner, MPI-PKS, Dresden

Time: Wednesday 15:00–17:45 Location: HSZ 03

Invited Talk DY 36.1 Wed 15:00 HSZ 03
Many-Body Localization and Glassiness in Quantum Spin Systems — •Antonello Scardicchio — Abdus Salam ICTP, Trieste, Italy — INFN, Sezione di Trieste, Trieste, Italy

I will discuss the interplay of two phenomena arising in disordered quantum spin systems: the appearance of a glassy phase, and the complete suppression of transport due to many-body localization. I will review work done on some models, under various approximations (analytical and numerical), and summarize a universal physical picture for how the two dynamical phases can interplay. I will also comment on the implications for the performance of quantum computers.

Invited Talk DY 36.2 Wed 15:30 HSZ 03
Exploring Many-Body Localization in Two Dimensions — •Christian Gross — Max-Planck-Institut für Quantenoptik, Garching

The question of thermalization in closed quantum systems is currently a topic of intense research and ultracold atoms are an almost ideal experimental system for its study. In this context it is particularly interesting to study systems that do not thermalize. Many-body localized systems form a generic class of such systems, which is largely unexplored in higher dimensions and at high energy densities. Here we report on recent experiments with single site resolved ultracold lattice bosons in two dimensions subject to random disorder. Our data indicates a transition from thermalizing behavior at low disorder to localization at higher disorder and a diverging length scale at the transition. Finally we discuss ongoing experimental effort and possibilities to characterize the MBL phase close to the transition point.

Invited Talk DY 36.3 Wed 16:00 HSZ 03
Floquet Engineering and Control of Topology in Solid State Systems — •Takashi Oka[1,2], Leda Bucciantini[1,2], Sthitadhi Roy[2], and Sota Kitamura[3] — [1]Max Planck institute for the Physics of Complex Systems, Dresden, Germany — [2]Max Planck institute for Chemical Physics of Solids, Dresden, Germany — [3]The university of Tokyo, Department of Tokyo, Tokyo, Japan

Periodically driven quantum system is attacting interest as a way to create new state of matter with exotic topological and dynamical properties.

1. Emergent Weyl points and Fermis arcs in a Floquet Weyl semimetal [1]: We find that a series of infinite numbers of Weyl points emerges, moves and annihilates in a Floquet Weyl semimetal that can be realized by applying circularly polarized laser to a three dimensional Dirac mateiral.

2. Landau quantization in an oscillating magnetic field [2]: We find that Landau quantization is not restricted to a static magnetic field but can be realized in oscillating fields and find a state that is analogous to the integer quantum Hall effect (QHE) when the ratio between the cyclotron frequency and the laser frequency is given by magic numbers.

[1] L. Bucciantini, S. Roy, S. Kitamura, and T. Oka, in prep.
[2] T. Oka, and L. Bucciantini, Phys. Rev. B 94, 155133 (2016)

15 min. break.

Invited Talk DY 36.4 Wed 16:45 HSZ 03
Hydrodynamic Regimes of Electron Transport — •Andrew Mackenzie — Max Planck Institute for Chemical Physics of Solids, Nöthnitzerstr 40, Dresden

In this talk I will discuss recent experiments showing that in some ultra-pure metals, it is possible to reach a regime of transport in which the viscosity of the electronic fluid plays a significant role in determining its flow. The conditions for this to happen are rather stringent, but there is some prospect of achieving them in a broader range of materials than those so far studied, so I will also try to give a sense of the future directions that the field might take.

Invited Talk DY 36.5 Wed 17:15 HSZ 03
Dynamical Phase Transitions — •Stefan Kehrein — Univ. Göttingen

Phase transitions play a central role in the theory of equilibrium statistical mechanics. They are indicated by non-analytic behavior of the free energy in the thermodynamic limit, for example at a critical temperature. The goal to understand and classify equilibrium phase transitions led to the fundamental concept of universality with its far-reaching implications in many different fields of physics.

Interestingly, similar non-analytic behavior of the dynamical free energy at certain critical times has been found in the real time evolution of the quantum Ising model [1]. This behavior has been denoted dynamical phase transition and has since been theoretically investigated in numerous other non-equilibrium quantum many-body models. Recently, the first experimental observation of dynamical phase transitions was reported in an ultracold fermionic quantum gas that was quenched between a static and a Floquet Hamiltonian [2].

This talk will give an overview over the current theoretical understanding of such dynamical phase transitions, the role of non-zero temperature and non-integrable perturbations, and possible experimental verifications.

[1] M. Heyl, A. Polkovnikov, and S. Kehrein, Phys. Rev. Lett. 110, 135704 (2013)
[2] N. Fläschner, D. Vogel, M. Tarnowski, B. S Rem, D.-S. Lühmann, M. Heyl, J. C. Budich, L. Mathey, K. Sengstock, and C. Weitenberg, arXiv:1608.05616