SYPS 1: PhD-Symposium: Floquet Physics - how time-periodic systems can make a difference

Time: Monday 14:00–16:00 Location: RW HS

Invited Talk SYPS 1.1 Mon 14:00 RW HS

Floquet engineering of interacting quantum gases in optical lattices — •André Eckardt — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden

Time periodic forcing in the form of coherent radiation is a standard tool for the coherent control of small quantum systems like single atoms. In the last years, periodic driving has more and more also been considered as a means for the coherent manipulation of many-body systems. In particular, experiments with atomic quantum gases in optical lattices subjected to driving in the lower kilohertz regime have attracted a lot of attention [see, e.g., RMP 89, 011004 (2017)]. Milestones include, i.a., the observation of dynamic localization, the coherent control of quantum phase transitions, and the realization of artificial gauge fields and topological band structures for charge-neutral atoms. It is the fact that atomic quantum gases are very well isolated from their environment and highly controllable in a time-dependent fashion that allowed for these recent advances. I will give an introduction to the concept of Floquet engineering, which underlies these experiments, present examples like the realization of artificial magnetic fields fields and the coherent control of interactions, and discuss also challenges related to interaction-induced heating.

Invited Talk SYPS 1.2 Mon 14:30 RW HS

Experiments on driven quantum gas and surprises — •Cheng Chin — 929 E. 57th St., Chicago, IL 60637, USA

How much does one have to perturb a regular Bose-Einstein condensate to display novel behavior? By driving the sample periodically, it turns out that even small modulation suffices to bring about lots of interesting quantum phenomena. In this lecture we will discuss a few case,

A. Modulation of external potential: When atoms are loaded into a potential with a particular length scale, even weak modulations at a chosen time scale can make a drastic difference. Examples in this lecture will include quantum phase transition and inflation.

B. Modulation of atomic interaction: This is a cool idea that leads to a cool observation. By oscillating the magnetic field near a Feshbach resonance, we see a sudden fireworks-like emission of atoms from a Bose condensate. What is going on, my lord?

C. What if we can modulate both potential and interactions? Share with us your ideas and see you in Erlangen 18.

Invited Talk SYPS 1.3 Mon 15:00 RW HS

Exploring 4D Quantum Hall Physics with a 2D Topological Pumps — •Oded Zilberberg[1], Michael Lohse[2,3], Christian Schweizer[2,3], Immanuel Bloch[2,3], Hannah Price[4,5], Yaacov Kraus[6], Sheng Huang[7], Mohan Wang[7], Kevin Chen[7], Jonathan Guglielmon[8], and Mikael Rechtsman[8] — [1]ETH Zürich, Zürich, Switzerland — [2]Max-Planck-Institut für Quantenoptik, Garching, Germany — [3]Ludwig-Maximilians-Universität, München, Germany — [4]Università di Trento, Povo, Italy — [5]University of Birmingham, Birmingham, United Kingdom — [6]Holon Institute of Technology, Holon, Israel — [7]University of Pittsburgh, Pennsylvania USA — [8]The Pennsylvania State University, Pennsylvania, USA

A prominent example of topological phases of matter is the two-dimensional integer quantum Hall effect. It is characterized by the first Chern number that manifests via quantized transverse conductance. Generalizing the quantum Hall effect to four-dimensional systems leads to the appearance of a novel non-linear Hall response that is quantized as well, but described by a 4D topological invariant - the second Chern number. In my talk, I will report on the prediction and first observation of a dynamical 4D integer quantum Hall effect using 2D topological charge pumps. In two experiments, using ultracold bosonic atoms in an optical superlattice and coupled waveguide arrays, the quantized bulk and corresponding boundary responses were realized, respectively. These responses exhibit 4D symmetry and pave the way for additional realizations of engineered systems with synthetic dimensions.

Invited Talk SYPS 1.4 Mon 15:30 RW HS

Floquet Discrete Time Crystals in a Trapped-Ion Quantum Simulator — •Guido Pagano[1], Jiehang Zhang[1], Paul Hess[1], Antonis Kyprianidis[1], Patrick Becker[1], Jacob Smith[1], Aaron Lee[1], Norman Yao[2], Tobias Grass[1], Alessio Celi[3], Maciej Lewenstein[3], and Christopher Monroe[1] — [1]Joint Quantum Institute, University of Maryland Department of Physics and National Institute of Standards and Technology, College Park, Maryland 20742 — [2]Department of Physics, University of California Berkeley, Berkeley, CA 94720, USA — [3]ICFO-Institut de Ciencies Fotoniques, The Barcelona Institute of Science and Technology, 08860 Castelldefels, Spain

Linear arrays of trapped and laser cooled atomic ions ($^{171}Yb^{+}$) are a versatile platform for studying strongly correlated many-body quantum systems with long range interactions. By off-resonantly driving motional normal modes with spin-dependent optical dipole forces, we generate tunable long-range spin-spin interactions, which are largely insensitive to the number of ions in the trap. We achieve a higher degree of control with a tightly-focused laser beam imparting a unique light shift on each ion, which we use for state initialization or to introduce controlled disorder into the system. Using these techniques in a Floquet setting allows us to observe time-crystalline phases, where the spin system exhibits persistent time-correlations either under Many-body-localized dynamics or in a prethermal regime. Moreover Floquet engineering in trapped-ion simulators can be also used to study topological systems by realizing complex-valued spin-spin interactions.