O 59: Mini-Symposium: Coherent band structure engineering with light I

Time: Wednesday 10:30–12:30 Location: R2

Invited Talk O 59.1 Wed 10:30 R2

TBA — •Netanel Lindner — Technion, Haifa

O 59.2 Wed 11:00 R2

Electronic Liquid Gyro-Crystals — •Iliya Esin[1,2], Gaurav Gupta[2], Erez Berg[3], Mark Rudner[4], and Netanel Lindner[2] — [1]California Institute of Technology, Pasadena, USA — [2]Technion, Haifa, Israel — [3]Weizmann Institute of Science, Rehovot, Israel — [4]University of Copenhagen, Copenhagen, Denmark

We show that coherent time-periodic driving can be used to induce non-equilibrium correlated states with spontaneously broken symmetry in lightly doped semiconductors. In the presence of a resonant driving field, the system spontaneously develops quantum liquid crystalline order featuring extreme anisotropy whose directionality rotates as a function of time. The phase transition occurs in the steady state of the system achieved due to the interplay between the coherent external drive, electron-electron interactions, and dissipative processes arising from the coupling to phonons and the electromagnetic environment. We obtain the phase diagram of the system using numerical calculations that match predictions obtained from a phenomenological treatment and discuss the conditions on the system and the external drive under which spontaneous symmetry breaking occurs. Our results demonstrate that coherent driving can be used to induce novel non-equilibrium quantum phases of matter with dynamical broken symmetry.

Invited Talk O 59.3 Wed 11:15 R2

Engineering emergent states in quantum materials with classical and quantum light — •Michael Sentef — Max Planck Institute for the Structure and Dynamics of Matter, Hamburg

Light-matter coupling enables the coherent manipulation of quantum states. For classical light, this is known as Floquet engineering, with potential applications ranging from engineered photon-photon interactions in Rydberg gases to Floquet topological states in a variety of platforms. In the limit of quantum light, quantum-electrodynamical cavities could enable the creation of polaritonic light-matter hybrid states, again ranging across platforms, from polaritonic chemistry with molecules to cavity superconductivity in quantum materials.

In this talk, I will discuss the status of our understanding of light-matter engineering of emergent states in quantum materials. I will show examples for the manipulation of fundamental interactions (Hubbard U) and their potential role in experiments on light-induced superconductivity [1,2] and dynamical phase transitions [3,4] driven by classical light, and discuss the quantum-to-classical crossover of Floquet engineering of the spin-exchange interaction [5].

[1] Buzzi et al., Phys. Rev. X 10, 031028 (2020). [2] Tindall et al., Phys. Rev. Lett. 125, 137001 (2020). [3] Tancogne-Dejean et al., Phys. Rev. Lett. 121, 097402 (2018). [4] Beaulieu et al., arXiv:2003.04059. [5] Sentef et al., Phys. Rev. Research 2, 033033 (2020).

O 59.4 Wed 11:45 R2

Tracking topological signatures by time- and angle-resolved photoemission spectroscopy — •Michael Schüler — Stanford Institute for Materials and Energy Sciences (SIMES), SLAC National Accelerator Laboratory, Menlo Park, CA 94025, USA

The impressive progress in high-resolution and multi-dimensional angle-resolved photoemission (ARPES) allows insights into the nature of the quantum states in the solid itself. We will discuss how topological properties are manifest in circular dichroism in ARPES. Based on state-of-the-art calculations, we demonstrate how momentum-resolved Berry curvature can be mapped out for prototypical two-dimensional materials. Furthermore, topological properties can be induced by tailored light. However, realizing the induced Floquet-Chern insulator state and tracing clear experimental manifestions has been a challenge. We tackle this gap between theory and experiment by employing microscopic nonequilibrium Green's functions (NEGF) calculations including realistic electron-electron and electron-phonon scattering. Combining our nonequilibrium calculations with an accurate one-step theory of photoemission allows us to establish a direct link between the build-up of the topological state and the dichroic pump-probe photoemission signal.

O 59.5 Wed 12:00 R2

Electromagnetic dressing of the electron energy spectrum at high momenta — •David Schmitt[1], Marius Keunecke[1], Marcel Reutzel[1], Alexander Osterkorn[2], Tridev A. Mishra[2], Christina Möller[1], Wiebke Bennecke[1], G. S. Matthijs Jansen[1], Daniel Steil[1], Salvatore R. Manmana[2], Sabine Steil[1], Stefan Kehrein[2], and Stefan Mathias[1] — [1]1. Physikalisches Institut, Georg-August-Universität Göttingen, Göttingen, Germany — [2]Institut für Theoretische Physik, Georg- August-Universität Göttingen, Göttingen, Germany

The coherent manipulation of quantum states is a promising route towards new emerging phases of solids. The concept of *Floquet engineering* has been used in various theoretical approaches. However, the experimental identification of such light dressed eigenstates is challenging. In this contribution, we discuss the generation of photon dressed sidebands throughout the full surface Brillouin zone when probed with two-color time- and angle-resolved photoelectron spectroscopy. We put special focus onto the differentiation of the laser-assisted photoelectric effect, the generation of Flouqet-Bloch bands, and scattering amplitude between both cases at large in-plane momenta, i.e. at the edges of the surface Brillouin zone.

O 59.6 Wed 12:15 R2

Time-Resolved Plasmoemission Spectromicroscopy — •Pascal Dreher, David Janoschka, Jan-Henrik Herrig, Michael Horn-von Hoegen, and Frank Meyer zu Heringdorf — Faculty of Physics and Center for Nanointegration, Duisburg-Essen (CENIDE), University of Duisburg-Essen, 47048 Duisburg, Germany

Photoemission in intense light fields has received a lot of attention in the past and the coherent interaction of electrons with the field after the emission process has been revealed. Within a solid, strong nonperturbative interactions of the intense driving light field with the electronic band structure can also occur under suitable driving conditions. Ultimately, observing such dressing of electronic bands by light requires electronic state resolution as well as precise control over the intense periodic driving field.

Here, we explore nanofocusing of femtosecond surface plasmon polariton (SPP) pulses on flat surfaces in combination with time- and angle-resolved photoemission spectromicroscopy as a possible route towards strong-field control over electronic states within a solid. We observe coherent nonlinear electron emission from the Au(111) Shockely surface state into SPP-dressed free-electron final states by the absorption of up to seven SPP quanta. The ponderomotive shift of the observed electron spectra is used to determine the transient field strength in the nanofocus. We present first results on time-resolved plasmoemission spectroscopy, which provides us with direct access to the coherent nonlinear dynamics of electrons within the intense SPP nanofocus.