Physikalisches Kolloquium — Physics Colloquium

Einladung — Invitation

Monday, 12 February 2024

Lecture Hall N24/H13, at 16:15
Coffee and cookies will be served in front of the lecture hall from 16:00

Collective phenomena in 2D quantum materials: Probing and imaging the effects of lattice disorder at the atomic scale

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Two dimensional (2D) quantum materials often show remarkable properties arising as a result of a complex interplay of charge, lattice, spin, orbital, and topological degrees of freedom. This interplay gives rise to numerous collective phenomena including superconductivity, anti-ferromagnetism, spin and charge density waves, among others. Understanding the interplay between these orders is currently one of the most challenging areas in materials research.

Introduction of controlled disorder is a useful tuning knob to understand the nature of this interplay. In cases where quantum materials show co-existing and/or competing electronic phases this can used to either promote or suppress one of the existing electronic phases. In many cases this may lead to atomic-scale spatial distribution of different electronic phases in the same crystal. This has prompted interest in using these tuning knobs to design atomic-scale landscapes to tune electronic phases. However, this requires a better atomic-scale understanding of the effects these parameters have on the structure of the materials as well as the respective electronic phases.

In this presentation, I will report on the use of atomic-scale imaging and spectroscopy using a Transmission Electron Microscope (TEM) to probe effects of lattice disorder on collective electronic phenomena in quantum materials. The emphasis will be on collective excitations as well as spatially periodic superstructures of electron charge density, known as surface plasmons and charge-density waves (CDW) respectively. I will show that the CDW electronic state can respond with an elastic-like response to lattice disorder arising from external perturbations. This will often lead to development of strain, topological defects such as dislocations and domain walls, as well spatial disorder. I will also show that that these defects can modulate surface plasmon excitations. This provides an exciting possibility to locally manipulate the properties of surface plasmon polaritons with atomic scale electronic defects

Host: Prof. Dr. Ute Kaiser, Institute of Quantum Optics (Electron Microscopy)

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