Fritz-Haber-Institut der Max-Planck-Gesellschaft

Physikalische Chemie — Direktor: Prof. Dr. Martin Wolf

MAX-PLANCK-GESELLSCHAFT

Department Seminar:

Monday, May 20, 2019, at **11:00** a.m.;
— all are invited to meet at around 10:40 for a chat with coffee & cookies —

Prof. Dr. Simon Wall

Ultrafast Dynamics In Quantum Solids,
ICFO Institute of Photonic Sciences,
Barcelona.

Is VO_2 a quantum material? Re-examining the properties of VO_2 on nanometer length scales and femtosecond timescales

PC Seminar Room G2.06, Building G, Faradayweg 4 R. Ernstorfer

Abstract:

Quantum materials, or correlated materials, are at the forefront of current condensed matter physics research. These materials exhibit various unexplained and interesting phenomena, such as high temperature superconductivity, but understanding how these properties arise has remained a challenge. The reason for this is two-fold: the materials can be challenging to work with, often showing phase segregation and phase coexistence; and the Mott-Hubbard model, which is believed to capture the essential physics, is difficult to solve using classical computers.

However, what is the evidence that the Mott Hubbard model captures the key features of quantum materials? Here we re-examine this assumption for a "classic" quantum material, VO_2, with a wide range of techniques that examine the nanoscale, ultrafast and thermal properties of the material. Resonant soft-X-ray holographic imaging is used to image the thermally driven phase transition on the nanometre length scale in VO_2 thin films, shows that defects drive phase segregation during the thermal phase transition (L. Vidas et al., *Nano Letters* 2018). I will discuss how heating plays a major role in our understanding of the ultrafast phase transition threshold fluence and finally, I will discuss how vanadium disorder occurs with the first few tens of femtoseconds after optical excitation indicating strong electron phonon coupling (S. Wall et al., *Science* 2018). Importantly, all of the effects observed do not need the physics of quantum materials to be explained. Along the way I will also introduce some of our newer work on extending these methods to other quantum materials.