Physikalisches Kolloquium — Physics Colloquium

Einladung — **Invitation**

Monday, 28 November 2022

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

Bringing light into electron microscopy: Towards quantum optics with free electrons

Dr. Armin Feist

Max Planck Institute for Multidisciplinary Sciences,
Georg-August-University, Göttingen

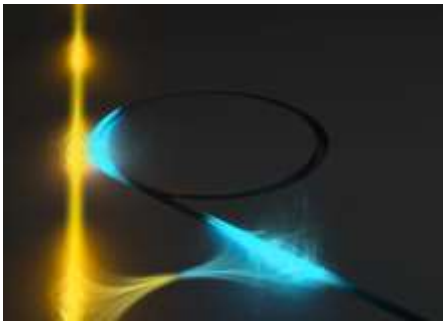
https://www.mpinat.mpg.de/3723511/armin-feist

The tailored interaction of light and matter is pivotal in various physical systems, ranging from coherent control schemes in atomic physics to steering the flow of energy in solid-state devices. In particular, joining free-electron beams with femtosecond lasers facilitates ultrafast transmission electron microscopy (UTEM) and opens the field of free-electron quantum optics.

In this colloquium, I will briefly introduce the UTEM methodology that combines state-of-the-art TEM with optical pump-probe spectroscopy [1,2] and show selected applications relying on coherent electron-light coupling. High-coherence few-electron pulses are generated at a laser-triggered Schottky field emitter [2], and event-based electron spectroscopy reveals strong multi-particle Coulomb correlations [3]. The inelastic scattering of such ultrashort electron pulses allows for nanoscale imaging of optical modes and coherent electron beam shaping [4]. Recent progress in continuous-wave optical phase modulation of electrons at high-*Q* integrated photonic micro-resonators will be discussed [5], enabling nanoscale-µeV spectroscopy. Furthermore, scattering at an empty cavity creates electron-photon pair states [6]. In analogy to spontaneous parametric down-conversion, this facilitates heralded single electron or photon sources, opening the pathway towards a new class of hybrid quantum technology.

References:

[1] A. H. Zewail, *Science*. **328**, 187–193 (2010).
[2] A. Feist et al., *Ultramicroscopy*. **176**, 63–73 (2017).
[3] R. Haindl et. al. arXiv:2209.12300 (2022).
[4] F. J. García de Abajo, V. Di Giulio, *ACS Photonics*. **8**, 945–974 (2021).
[5] J.-W. Henke et. al., *Nature*. **600**, 653–658 (2021).
[6] A. Feist et al., *Science*. **377**, 777–780 (2022).



Host: Prof. Dr. Ute Kaiser, Electron Microscopy Group of Materials Science

Organisation: Prof. Dr. Jens Michaelis, Institute of Biophysics, jens.michaelis@uni-ulm.de, +49-731-50-23050