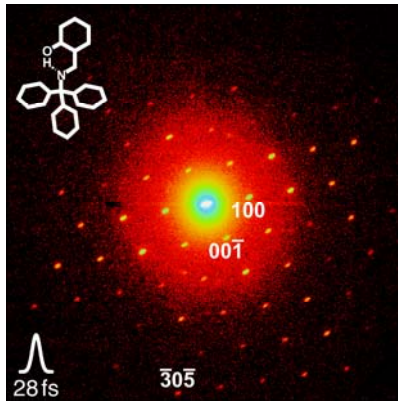


LMU München / MPI Quantenoptik /  
Munich-Centre for Advanced Photonics (MAP)

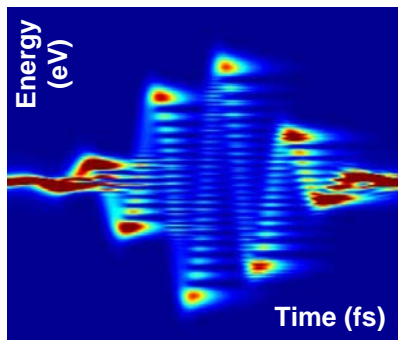
Doktorarbeit / PhD Thesis

## “Seeing Atoms and Electrons in Motion”



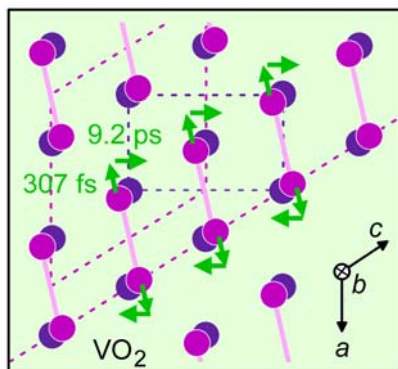
All matter around us essentially consists of atoms and electrons; their structure determines its properties on a fundamental level. However, our world is not static. Any reaction or process is essentially defined by movement paths on a (sub-)atomic level.

Our research group aims at a direct visualization of this motion and the associated phenomena with picometer ( $10^{-12}$  m) resolution and on attosecond ( $10^{-18}$  s) timescales. Our visualization approach uses femtosecond lasers and ultrashort electron pulses with only picometer de Broglie wavelengths. A sequence of diffraction patterns or electron microscopy images provides a “movie” of atoms/electrons in motion. Infrared or THz pulses, generated via nonlinear laser optics, initiate the transitions and control the electron beam.



We offer several opportunities for a PhD study:

- Generation of few-cycle carrier-envelope-phase-stable mid-infrared and THz pulses via nonlinear optics for driving electrons in single-layer materials such as graphene.
- Compressing single-electron wavepackets with laser fields for reaching attosecond+picometer resolution in electron diffraction.
- Pump-probe electron microscopy/spectroscopy of electromagnetic resonances and quantum interferences at plasmonic sub-wavelength structures.



Our research is located at the Max-Planck-Institute of Quantum Optics ([www.attoworld.de](http://www.attoworld.de)) and LMU in Garching, funded in part through a prestigious ERC consolidator grant ([www.ultrafast-electron-imaging.de](http://www.ultrafast-electron-imaging.de)). We are also part of the excellence cluster MAP ([www.map.lmu.de](http://www.map.lmu.de)).

We require excellent degrees, and enthusiasm for experiments with femtosecond lasers, THz pulses and electrons. Please contact us with a CV and all reports with marks; gerne auch auf deutsch.

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