The scientific scope of Ultrafast Science research unit (D4) is the studies of dynamics of electrons, lattice, and spins in condensed matter on the ultrafast timescales ranging from attoseconds ($10^{-18}$ s) to picoseconds ($10^{-12}$ s). Advanced experimental techniques used in our research unit range from attosecond XUV spectroscopy to femtosecond nano-optics to terahertz spectroscopy, implemented in many different modalities. All our research methods rely on highly-elaborate femtosecond laser infrastructure, established within the research unit.

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Module:

28-M-VBN, 28-M-VP – Vertiefung

Lecture:

Tuesday 14-16 and Thursday 14-16, D4-258

Exercises:

Friday 10-12, D01-295

Topics:

- Ultrafast lasers
- Principles of ultrashort-pulse optics
- Nonlinear optics and wave conversion
- Refresher on basics of solid state physics
- Advanced spectroscopy techniques: from terahertz to attoscience

Structure:

- Core lecture
  Series of guest lectures by renowned international speakers
  Exercises: lab experience, tutorials, journal club…

Selected Publications

H. A. Hafez et al., *Extremely efficient terahertz high-harmonic generation in graphene by hot Dirac*
Extremely efficient terahertz high-harmonic generation in graphene by hot Dirac fermions

X. Li et al., Observation of Dicke cooperativity in magnetic interactions
Science 361, 794 (2018)

A. Tomadin et al., The ultrafast dynamics and conductivity of photoexcited graphene at different Fermi energies
Science Advances 4, eaar5313 (2018)

M. Grechko et al., Coupling between intra- and intermolecular motions in liquid water revealed by two-dimensional terahertz-infrared-visible spectroscopy
Nature Communications 9, 885 (2018)

K.-J. Tielrooij et al., Out-of-plane heat transfer in van der Waals stacks through electron–hyperbolic phonon coupling

H. Kim et al., Direct observation of mode-specific phonon-band gap coupling in methylammonium lead halide perovskites
Nature Communications 8, 687 (2017)

T. Seifert et al., Efficient metallic spintronic emitters of ultrabroadband terahertz radiation
Nature Photonics 10, 483 (2016)

H. Tu et al., Stain-free histopathology by programmable supercontinuum pulses
Nature Photonics 10, 534 (2016)

Z. Jin et al., Accessing the fundamentals of magnetotransport in metals with terahertz probes

Z. Mics et al., Thermodynamic picture of ultrafast charge transport in graphene
Nature Communications 6, 7655 (2015)

Terahertz Physics
Prof. D. Turchinovich

Ultrafast Nanooptics
Prof. W. Pfeiffer

Attosecond Spectroscopy
Prof. W. Pfeiffer, Prof. U. Heinzmann
Molecular and Surface Physics

Prof. U. Heinzmann, Prof. H. Stiebig, Priv. Doz. N. Böwering

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