PHYSIKALISCHES KOLLOQUIUM

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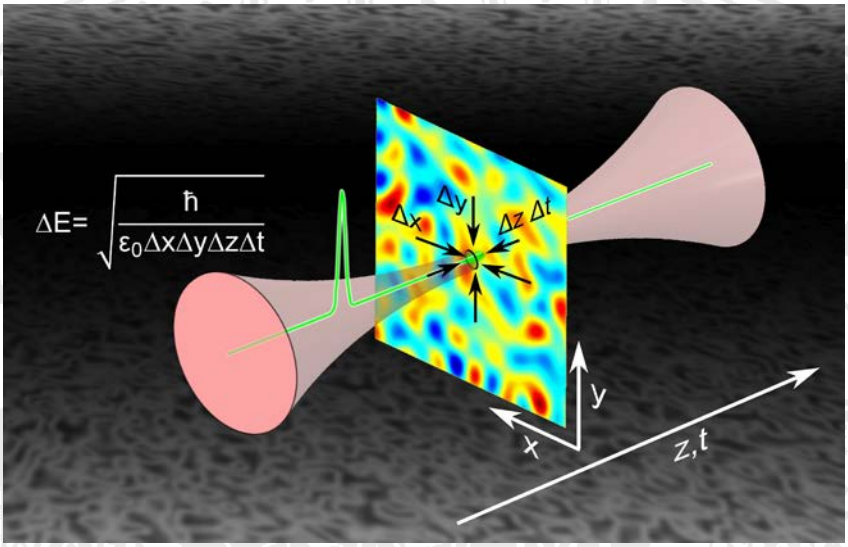
IM GROßEN HÖRSAAL



QUANTUM PHYSICS IN ALL FOUR DIMENSIONS OF TIME AND SPACE

PROF. DR. ALFRED LEITENSTORFER

DEPARTMENT OF PHYSICS AND CENTER FOR APPLIED PHOTONICS
UNIVERSITY OF KONSTANZ

A selection of experiments exploring a new regime of quantum physics will be presented, where extreme confinement in both time and space gives rise to new phenomena. We currently work on three different types of studies with increasingly fundamental character:
In an example for the first area, bulk GaAs is biased nondestructively up to 12 MV/cm with intense mid-infrared transients. We monitor the subcycle change in interband optical properties. Model calculations confirm the onset of Wannier-Stark localization of the electronic system as origin for an adiabatic blueshift of the absorption edge by 700 meV [1].
Latest progress in attosecond control of transport in the few-electron range [2] represents a second set of experiments. Here, we use single cycles of near-infrared radiation to direct the current between two nanometer-sized metallic contacts. This combination addresses extremely nonlinear optics with pulses of minute energy content in the pJ range. At the moment, we are progressing towards truly atomic spatio-temporal dimensions where novel quantum transport processes like dynamical Coulomb blockade might prevail.
The third context concerns subcycle quantum physics of the electromagnetic field. Reading out the nonlinear displacement of valence electrons in a semiconductor with few-femtosecond laser pulses allows direct sampling of vacuum fluctuations [3,4]. Synchronal noise patterns of squeezed mid-infrared transients may be generated and characterized as a first application of this new type of quantum technology [5]. Local deviations from the vacuum noise level arise due to acceleration of the reference frame combined with Heisenberg's uncertainty principle.

[1] C. Schmidt et al., submitted
[2] T. Rybka et al., Nature Photon. **10**, 667 (2016)
[3] C. Riek et al., Science **350**, 420 (2015)
[4] A. S. Moskalenko et al., Phys. Rev. Lett. **115**, 263601 (2015)
[5] C. Riek et al., Nature **541**, 376 (2017)