HL 28: THz Physics

Time: Monday 17:30–18:45 Location: POT 51

HL 28.1 Mon 17:30 POT 51

Density Dependence of the Excitonic 1s-2p Transition Energy in THz Spectroscopy — •Benjamin Breddermann, Mackillo Kira, and Stephan W. Koch — Department of Physics and Material Sciences Center, Philipps-University Marburg, Renthof 5, D-35032 Marburg

Spectroscopy with optical and terahertz (THz) frequencies provides a versatile tool to probe and control semiconductors on a microscopic level. The excitonic resonances depend very strongly on the carrier density n_{eh} excited to the semiconductor yielding several many-body phenomena. In other words, one finds excitation-induced dephasing (EID) that bleaches the excitonic resonances from both optical and THz spectra if n_{eh} is increased enough. All these phenomena are treated fully microscopically with the goal to investigate the influence of these many-body effects in the optical and THz spectra. We report results on the density dependent broadening and red-shift of the 1s-2p transition in the THz spectra and present comparisons with recent experiments.

HL 28.2 Mon 17:45 POT 51

Time-resolved ultrafast photocurrents and terahertz generation in electrically contacted, freely suspended graphene — •Leonhard Prechtel[1], Li Song[2], Nadine Erhard[1], Dieter Schuh[3], Werner Wegscheider[4], and Alex W. Holleitner[1] — [1]Walter Schottky Institut and Physik-Department, TU München — [2]Fakultät für Physik and Center for NanoScience (CeNS), LMU, München — [3]Institut für Experimentelle und Angewandte Physik, Universität Regensburg — [4]Laboratorium für Festkörperphysik, ETH Zürich

We investigate the ultrafast photocurrent dynamics of freely suspended graphene contacted by metal electrodes in the time-domain. At the graphene-metal interface we demonstrate, that built-in electric fields give rise to an ultrafast photocurrent with a FWHM of only a few ps. This suggests the use of graphene for ultrafast photodetectors and photoswitches. We further detect a photo-thermoelectric current with a decay time of about 0.2 ns. We also show that in optically pumped freely suspended graphene plasmon oscillations and terahertz-radiation are efficiently generated.

HL 28.3 Mon 18:00 POT 51

Nanotube Transisors as Quantum Cavity for Terahertz Plasmons — •Diego Kienle — Theoretische Physik I, Universität Bayreuth, 95440 Bayreuth

Since their discovery in 1990, carbon nanotubes (NTs) are believed to be one potential candidate to replace silicon- based electronics due to their exceptional electronic properties. Much effort has been invested in understanding electronic transport at DC, whereas their high-frequency (AC) properties are less explored. In this talk, we employ a newly developed theory for self-consistent AC quantum transport using Non-Equilibrium Green functions and study the AC response of NT transistors in terms of their dynamic conductance with the AC signal applied at the gate terminal. In the ON state, the conductance exhibits pronounced divergent peaks at terahertz frequencies, which are attributed to plasmon excitations. In the OFF-state such collective excitations are suppressed, since the dynamic coherence between the single-particle states is destroyed due to the reflection of electrons at the gate controlled potential barriers. In this case, the AC conductance is oscillatory - a signature of the single-particle excitation spectrum. Importantly, the plasmonic excitations are only captured if the self-consistent charge-potential feedback is an integral part of the AC theory. Higher-order plasmon modes can be excited by varying the length of the NT and thus allows to tune the plasmonic excitation spectrum. [1] D. Kienle and F. Leonard, Phys. Rev. Lett. **103**, 026601 (2009). [2] D. Kienle, M. Vaidyanathan, and F. Leonard, Phys. Rev. B **81** 115455 (2010).

HL 28.4 Mon 18:15 POT 51

Microscopic model of two-dimensional THz spectroscopy: Quantum well intersubband dynamics — •Thi Uyen-Khanh Dang[1], Sebastian Eiser[2], Andreas Knorr[1], Marten Richter[3], Wilhelm Kühn[4], Michael Wörner[4], and Carsten Weber[1] — [1]Institut für Theoretische Physik, Technische Universität Berlin, Germany — [2]European Space Research Institute, Frascati, Italy — [3]Department of Chemistry, University of California Irvine, USA — [4]Max Born Institut, Berlin, Germany

Time resolved two-dimensional spectroscopy combined with field-resolved detection allow important insights into the nonlinear optical response of a sample [1]: A variation of the time delay between the collinear pump and probe pulses enables the simultaneous detection of all orders of n-wave mixing, which can be separated in the frequency domain. Here, a theoretical model is presented to describe the corresponding experimental setup, performed on a GaAs/AlGaAs multiple quantum well sample. Within a density-matrix approach, the equations of motions for the electron density and the intersubband coherence are derived. Focusing on the electron-phonon interaction [2], its influence on the two-dimensional intersubband absorption spectrum is investigated. Experimentally observed signatures are reproduced in the theoretical simulations.

[1] W. Kühn et al., J. Chem. Phys. 130, (2009)
[2] S. Butscher et al., Phys. Rev. B. 72, (2005)

HL 28.5 Mon 18:30 POT 51

Generation of tuneable narrow-band terahertz pulses using large-area photoconductive antennas — Johannes Krause, •Martin Wagner, Manfred Helm, and Dominik Stehr — Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf (HZDR), P.O. Box 510119, 01314 Dresden, Germany

Photoconductive antennas, driven by ultrafast optical pulses, are frequently used as broadband terahertz sources. Due to water vapour absorption in ambient air, these sources are less suitable for free space imaging or addressing small spectral regions. Amongst other techniques, narrow-band THz generation via difference frequency generation in ZnTe crystals [1] and photoconductive antennas [2] were demonstrated, the latter reaching frequencies of only 900 GHz. In this work we generate tuneable narrow-band terahertz pulses from a large-area photoconductive antenna by means of difference frequency generation with two up to 3.3 ps long time-delayed chirped optical pulses. The source is a 250 kHz regenerative Ti:sapphire amplifier. It's output is split into three beams, where one is compressed for field resolved detection. The other two pulses are sent to a Michelson interferometer and get - with an adjustable time delay - recombined and are focussed on the antenna. By using this technique we generated THz pulses tuneable from 0.35 to 2.5 THz with adjustable spectral widths (FWHM) of 200 to 500 GHz.

[1] J.R. Danielson et al., J. Appl. Phys. 104, 033111 (2008).
[2] A.S. Weling and D.H. Auston, J. Opt. Soc. Am. B 13, 2783 (1996).