HL 41: Graphene: Optics (Joint session of HL and TT, organized by HL)

Time: Tuesday 14:45–15:45 Location: H17

Invited Talk HL 41.1 Tue 14:45 H17

Ultrafast carrier dynamics in monolayer graphene — •Daniele Brida — Department of Physics and Center for Applied Photonics, University of Konstanz, Universitätsstr. 10, D-78464 Konstanz, Germany

The impulsive optical excitation of carriers in graphene creates an nonequilibrium distribution, which thermalizes on an ultrafast timescale. The hot Fermi-Dirac distribution subsequently cools via phonon emission within few hundreds of femtoseconds. We investigated the initial stages of the thermalization process that are dominated by electron-electron scattering events. By comparing the two-color pump-probe experimental data with different models, that solve the quantum Boltzmann equation by implementing three different screening methods, we can visualize the importance of Auger recombination processes, such as carrier multiplication, in the ultrafast relaxation of the electronic distribution along the Dirac cone in graphene. Recent theoretical and experimental work also emphasizes the role of the polarization state of the light pulses used for the excitation. When carriers are excited with linearly polarized light, the resulting occupation in momentum space is not isotropic due to the pseudospin selection rules. To observe this anisotropy we compare the transient absorption signal arising for probe pulses with polarizations parallel and perpendicular to the pump pulse. We identify electron-phonon scattering as main driving mechanism of isotropization of the electronic distribution across the Dirac cone since it occurs in approximately 100 fs.

HL 41.2 Tue 15:15 H17

Noncollinear Coulomb scattering in graphene — •Jacob C. König-Otto[1,2], Martin Mittendorff[3], Torben Winzer[4], Ermin Malic[5], Andreas Knorr[4], Alexej Pashkin[1], Harald Schneider[1], Manfred Helm[1,2], and Stephan Winnerl[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [2]Technische Universität Dresden, Germany — [3]University of Maryland, USA — [4]Technische Universität Berlin, Germany — [5]Chalmers University of Technology, Sweden

Utilizing the anisotropy of the optical excitation in graphene, we reveal the twofold nature of Coulomb scattering in graphene. The initial nonequilibrium charge carrier distribution in graphene created by linearly polarized light possesses a pronounced anisotropy, which has been observed in our recent experiment [1]. In the present study we perform polarization-dependent pump-probe measurements using a photon energy of 88 meV to suppress efficiently the optical phonon scattering. In this case the relaxation dynamics leading to an isotropic distribution is dominated by noncollinear Coulomb scattering. By varying the pump fluence over a range of several orders of magnitudes we are able to successfully control the efficiency of this process. This reveals a surprising twofold nature of Coulomb scattering in graphene: Whereas collinear Coulomb scattering is known to be a very fast process on the fs timescale, noncollinear scattering is remarkably slow, resulting in a thermalization time of several ps in our experiment. Our experimental findings are complemented by the results of microscopic modelling.
[1] M. Mittendorff et al., Nano Lett. **14**, 1504 (2014).

HL 41.3 Tue 15:30 H17

Gate-Voltage Dependency of Förster Transfer in Graphene - Quantum Dot Photo Detection — •Lorenz Maximilian Schneider[1], Ruifeng Li[2], Huizhen Wu[2], Martin Koch[1], and Arash Rahimi-Iman[1] — [1]Faculty of Physics and Materials Sciences Center, Philipps-Universität Marburg, 35032 Marburg, Germany — [2]Department of Physics and the State Key Laboratory of Silicon Materials, Zhejiang University, Hangzhou, 310058, P.R. China

Graphene photodetectors functionalized by colloidal Quantum dots (cQDs) have been recently demonstrated for effective photo detection. Nevertheless, the transfer of the energy or charge carriers from cQDs to graphene is not sufficiently understood. Here, we present a respective study of a graphene field-effect transistor, which is functionalized with CdSe/ZnS Core-Shell QDs covering it's conductive channel. In order to investigate energy transfer dynamics in this system, we have investigated the time-resolved photo-luminescence from the cQDs as function of the applied gate voltage. A clear change in the photo-luminescence lifetime has been observed, indicating a change of the decay channels. In support of our findings, we provide data for a Förster-like energy transfer model as a function of the gate voltage. The model shows that by applying a backgate voltage to the photo detector, absorbance can be tuned with respect to the photo-luminescence of the cQDs, changing the energy transfer rate of the photo-detector.