TECHNISCHE UNIVERSITÄT CHEMNITZ

PHYSIKALISCHES KOLLOQUIUM

Mittwoch, den 25.05.2011, um **17:15 Uhr**

Ort: Reichenhainer Str. 90; Neues Hörsaalgebäude, Raum: 2/N013

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Ultrafast relaxation dynamics in graphene and carbon

We present microscopic calculations of the coupled population and coherence dynamics describing the relaxation of photo-excited carriers in graphene and carbon nanotubes. The strength of our approach is the possibility to access the time-, momentum-, and angle-resolved relaxation dynamics. We take all relevant Coulomb- and phonon-induced relaxation channels into account focusing in particular on Augen-type processes. As a zero-bandgap semi-conductor graphene is an ideal model structure to study the carrier relaxation channels, which are inefficient in conventional semiconductors, cp. Fig.1. In particular, it is of fundamental interest to address the question whether Auger-type processes significantly influence the carrier dynamics in graphene. These scattering channels bridge the valence and conduction band allowing carrier multiplication - a process that generates multiple charge carriers from the absorption of a single photon.

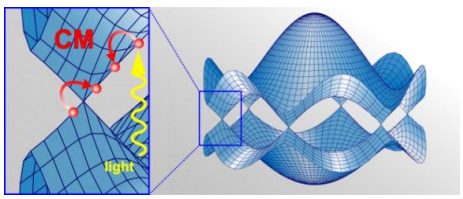

Fig.1: Bandstructure of graphene.

We observe a redistribution of optically excited carriers to energetically lower states resulting in a hot Fermi distribution within the first hundred femtoseconds followed by a slower phonon-induced energy dissipation. The two decay components are in good agreement with recent high-resolution pump-probe experiments. Our investigations further reveal the importance of Auger-type processes, cp. Fig.2. Due to the Pauli blocking, we find a strong asymmetry between the Auger recombination (AR) and impact ionization (II) in favor of the latter. As a result, a significant multiplication of charge carriers (CM) is obtained confirming the potential of graphene as a new material for photodevices, such as high-efficiency solar cells and high-sensitivity photodetectors.

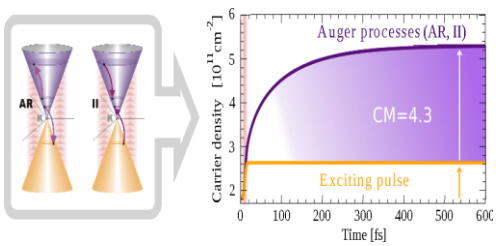

Fig.2: Influence of Auger recombination (AR) and impact ionization (II) on the dynamics of the charge carrier density illustrating the significant carrier multiplication (CM) in graphene.

Our studies on carbon nanotubes focus on the Coulomb-induced relaxation dynamics of optically excited charge carrier. We go beyond the Markov description treating the Coulomb interaction up to the second order Born approximation. We observe a relaxation towards the Fermi distribution on the femtosecond timescale. The appearing oscillations in the temporal evolution of the charge density reflect the importance of memery effects. Furthermore, we have performed calculations on phonon-induced intra- and intersubband scattering processes investigating the chirality and diameterdependence of the relaxation time.

Alle Zuhörer sind ab 17:00 Uhr zum Kaffee vor dem Hörsaal eingeladen

Informationen zum Vortrag erteilt Prof. Dr. Rudolf Bratschitsch, Tel. 0371/531-39182