TECHNISCHE UNIVERSITÄT
IN DER KULTURHAUPTSTADT EUROPAS
CHEMNITZ

Institut für Physik
Physikalisches Kolloquium

Donnerstag, 26.10.2023, 15:30 Uhr

Ort: Reichenhainer Str. 90;
Zentrales Hörsaal- und Seminargebäude,
Raum C10.013

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Justus-Liebig-Universität Gießen

How ultrafast spectroscopy reveals excitation dynamics in model 2D charge-carrier systems

Low-dimensional semiconductor structures are at the heat of virtually all optoelectronic devices. Understanding their charge-carrier dynamics is thus crucial in developing for improved performance concepts or accessing new functionalities. Photon based spectroscopic techniques offer contactless probes. Choosing the appropriate energy and time regimes allows disentangling and even controlling such quantum system. The optical response of such low-dimensional semiconductor structures is governed by exciton resonances, Coulomb-correlated electron-hole-pair excitations which, in the case of the discussed Wannier excitons feature a Rydberg-like series of excited states. This colloquium reviews the concepts of ultrafast optical and THz Spectroscopy for the case of model, high-quality GaAs-based quantum well systems and discusses in how far these observations apply to more fashionable materials like 2D materials or perovskites. These include conventional type-I quantum wells as well as type-II heterostructures and their charge transfer excitons which feature a permanent dipole moment.

Specifically, the nonlinear optical responses are investigated experimentally using polarization resolved four-wave mixing, optical-pump optical-probe, and optical-pump Terahertz-probe spectroscopy. The four-wave mixing data reveal clear signatures which obey the suitable polarization selection rules indicating higher correlated states like coherent charge-transfer biexcitons. The intricate differences between type-I quantum wells and type-II heterostructures are further investigated in the coherent regime (optical Stark shift and Rabi flopping), and incoherent gain from population inversion. Furthermore, the corresponding THz absorption following comparable optical excitation are discussed. The THz probe directly monitors the exciton populations. It reveals several time scales for the formation and the decay indicating several different contributing mechanisms. Below-resonance excitation invokes signatures of a coherent THz gain following an excitation into a Floquet-like state. Furthermore, the scattering and ionization of excitons is discussed for several excitation geometries yielding control rules for elastic and inelastic quasiparticle collisions.

Alle Zuhörer sind ab 15:15 Uhr zum Kaffee vor dem Hörsaal eingeladen.

Informationen zum Vortrag erteilt:
Prof. Dr. Ulrich T. Schwarz, Tel. 0371 531 30001

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