Eugene Wigner Colloquium

event of SFB 910

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Frank Lengers

Westfälische Wilhelms-Universität Münster

"Ultrafast Spatio-Temporal Carrier Dynamics in Low-Dimensional Semiconductors"

Low-dimensional semiconductors like two-dimensional (2D) monolayers of transition metal dichalcogenides (TMDCs) or one-dimensional (1D) quantum wires are at the heart of modern day semiconductor physics. To use such systems in nanoscale electronic or optoelectronic devices a fundamental understanding of the carrier dynamics on these small length scales is required. In this talk I will give an overview of our theoretical investigations of the inhomogeneous carrier transport using two examples: In the first part I will focus on carrier dynamics in a 2D TMDC monolayer with an embedded localized confinement potential forming a quantum dot (QD) in the 2D layer. Due to carrier-phonon interaction, electrons can be captured into the QD resulting in a non-trivial dynamics determined by spatial selection rules for the carrier capture. The capture process can further be used to monitor electron diffraction patterns to resolve carrier dynamics on a nanometer scale. In the second part I will address the effects of the Coulomb interaction on the spatial carrier dynamics in a 1D quantum wire. Here, the Coulomb correlations can result in strong modifications of the ultrafast spatio-temporal dynamics for elevated densities. These examples illustrate that spatially inhomogeneous transport shows fascinating effects in low dimensional semiconductors due to the combination of ultrashort time and length scales.

Thursday, 04.07.19 · 16:15h · EW 202

Technische Universität Berlin · Institut für Theoretische Physik · Hardenbergstraße 36 · 10623 Berlin

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