SFB - Colloquium

“Many-body Effects and Optical Excitations in Semiconductors”

Tuesday 7th May, 14:00, Room PHY 9.2.01

Program

14:00 - 14:05 Welcome and Opening
David Egger (U Regensburg)

14:05 - 14:30 Introductory Tutorial Lecture
Alexey Chernikov (U Regensburg)

14:30 - 15:15
Excitons in Flatland: Exploring and Manipulating Many-body Effects on the Optical Excitations in Quasi-2D Materials
Diana Y. Qiu (UC Berkeley)

Since the isolation of graphene in 2004, atomically-thin quasi-two-dimensional (quasi-2D) materials have proven to be an exciting platform for both applications in novel devices and exploring fundamental phenomena arising in low dimensions. This interesting low-dimensional behavior is a consequence of the combined effects of quantum confinement and stronger electron-electron correlations due to reduced screening. In this talk, I will discuss how the optical excitations (excitons) in quasi-2D materials, such as monolayer transition metal dichalcogenides and few-layer black phosphorus, differ from typical bulk materials. In particular, quasi-2D materials are host to a wide-variety of strongly-bound excitons with unusual excitation spectra and massless dispersion. The presence of these excitons can greatly enhance both linear and nonlinear response compared to bulk materials, making them ideal candidates for optoelectronics and energy applications. Moreover, due to enhanced correlations and environmental sensitivity, the electronic and optical properties of these materials can be easily tuned. I will discuss how substrate engineering, stacking of different layers, and the introduction or removal of defects can be used to tune the band gaps and optical selection rules in quasi-2D materials.

15:15 - 16:00
Excitons and Symmetry: Studying Structural Effects on Complex Excited-State Phenomena in 2D and Molecular Crystals
Sivan Refaely-Abramson (Weizmann Institute)

New developments in the theory of excited-state phenomena can lead to better understanding of the involved nanoscale mechanisms and to predictions of new materials hosting such phenomena. In this talk, I will present recent studies using first-principles computational methods to model and understand such mechanisms in extended materials. Specifically, I will discuss the effect of point defects on excited-state properties and selection rules in monolayer transition metal dichalcogenides. These impurities can give rise to localized states, introduce strongly-bound excitons below the absorption edge, and reduce the valley-selective circular dichroism, suggesting a novel pathway to tune spin-valley polarization and other optical properties through defect engineering. Additionally, I will present a new approach to explore multi-exciton generation in solids from first principles and describe an application of this approach to singlet fission, a multi-exciton generation process in organic crystals. Focusing on crystalline acenes, I will discuss a newly discovered exciton—bi-exciton coupling channel, revealing selection rules for singlet fission that are associated with the crystal symmetry and structure.

16:00 – Coffee and discussion

Organizers: Egger, Chernikov