Newsletter Physics 12/21

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News from the Department

CRC/TRR 135 extended for another 4 years!

The German Research Foundation has approved the third funding period of the Collaborative Research Center CRC/TRR 135 "Cardinal mechanisms of perception", starting in January 2022 for four years, and with a budget of roughly 10.5 Million Euros. This truly interdisciplinary research on physics brings together psychologists, physicists, psychiatrists and computer scientists to study the brain functions that underly visual perception. The CRC/TRR-135 is composed of 19 scientific projects and three central projects, with participating groups at the universities of Marburg, Giessen, Chemnitz and Frankfurt. Frank Bremmer is member of the steering committee of the CRC/TRR-135.

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Physics on Saturday on 18 December!

We are happy to announce the first presentation of our series "Physik am Samstagmorgen", where physical concepts are presented to a broader audience. The first presentation is entitled "Alles Schall und Rauch, oder: "Wie die Physik den Ton angibt " and will take place on Saturday, December 18th, starting at 11 am. In their talk Maximilian Dreher and Josefine Neuhaus aim to visualise what a note is from a physical point of view, why tones sound differently on different instruments and much more. The presentation will be supported by live music from the guitar duo "Apocalyptic Sebastian Anhäuser (master students at our department) and his duo-partner will enrich the presentation with their jazztunes.
Due to the pandemic, the presentation will be online. Further details and infos on how to join the presentation are provided below.

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Felix Widdascheck: new doctor at our department!

We congratulate Felix Widdascheck from the Molecular Solids group (AG Witte) who has just finished his PhD on "Preparation and characterization of molecular contact layers to modify the work function of noble metal surfaces." In his work, he demonstrated that molecular monolayer films enable a controlled tailoring of the work function of metal electrodes and thereby reduce barriers for charge carrier injection from metal electrodes into organic semiconductors, which is a central aspect in the successful realization of organic electronics. In particular, he compared this approach for single crystalline surfaces and polycrystalline electrodes, some of which are even printed using metal inks. This enables a validation of model concepts for real devices for the first time.

Research Highlights

Valley-exchange coupling probed by angle-resolved photoluminescence (AG Malic)

Optical properties of monolayer transition metal dichalcogenides are dominated by tightly bound excitons. They form at distinct valleys in reciprocal space, and can interact via the valley-exchange coupling, modifying their dispersion considerably. In collaboration with experimental groups of Christian Schneider (University of Oldenburg) and Witlef Wieczorek (Chalmers University of Technology), AG Malic published that angle-resolved photoluminescence can be used to probe the changes of the excitonic dispersion. The exchange-coupling leads to a unique angle dependence of the emission intensity that can be strongly tuned by an external magnetic field. The work has been published in Nanoscale Horizons.

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Accelerated diffusion of hot dark excitons (AG Malic)

While dark excitons are known to dominate the relaxation dynamics and low-temperature photoluminescence in atomically thin semiconductors, their impact on the spatial propagation of excitons has remained elusive. In a joint theory-experiment study together with Alexey Chernikov (TU Dresden), AG Malic addressed this intriguing regime of dark state transport. We found clear evidence of an unconventional, time-dependent diffusion during the first tens of picoseconds, exhibiting strong deviation from the steady-state propagation. Dark exciton states are initially populated by phonon emission from the bright states, resulting in creation of hot excitons whose rapid expansion leads to a transient increase of the diffusion coefficient by more than one order of magnitude. The work was published in Nanoscale.

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Events

Due to the pandemic, our colloquium presentations are hybrid events. They take place in Rentho f 5 (grosser Hörsaal) and simultaneously digitally on big blue button.

BBB link

Colloquium Inaugural lecture Jens Güdde 2 Dec, 5.15 pm

Jens Güdde (FB Physik, Philipps-Universität Marburg)

Ultrafast photocurrents at interfaces

In his inaugural lecture, Jens Güdde, who was appointed adjunct professor at the physics department in 2020, will give an overview of his research on ultrafast photocurrents at interfaces. He will show how a combination of optical generation of ultrafast electrical currents by different methods with a direct observation by time- and angle-resolved photoelectron spectroscopy in momentum space makes it possible to study electron transport at interfaces of conventional materials and topological insulators in unprecedented detail. These experiments demonstrate that it is in fact possible to generate inertia in electron currents in three-dimensional topological insulators with huge ballistic mean free paths and therefore low dissipation. Owing to spin-momentum locking, the ballistic currents carry a spin current, which should enable spintronics up to optical clock rates. The lecture will be held in German.

Colloquium Leo Gross 9 Dec, 5.15 pm

Leo Gross (IBM Research - Zurich Laboratory, Switzerland)

Molecular reactions, charge transitions and excited states investigated by AFM

Atomic force microscopy (AFM) with functionalized tips achieves atomic and bond-resolved resolution providing insights into the structure, aromaticity, charge states and bond-order relations of individual molecules. Importantly for on-surface synthesis, the products and intermediates of chemical reactions can be identified and characterized. Recently, we generated by atom manipulation the elusive carbon allotrope cyclo carbon and resolved its debated structure.

Colloquium Florian Peißker 16 Dec, 5.15 pm

Florian Peißker (Physikalisches Institut, Universität Köln)

The Turbulent and Dynamical Environment of the Supermassive Black Hole Sgr A* in the Center of our Galaxy

The technological evolution of ground-based observatories and infrared instruments results in sub-parsec observations that reveal the direct vicinity of Sgr A*, the supermassive black hole in the center of our Galaxy. Since the first finding of fast moving S-stars in the related S-cluster, observations resulted in unexpected discoveries. Surprisingly, the 40-pc wide cluster contains young O/B stars that raise the question of where they have formed. This unresolved and fundamental question is translated into the "Paradox of youth". With advanced and sophisticated high-pass filter, we are able to push the imaging results to the detection limit. On these scales, the influence of General Relativity is eminent. In addition, black-hole physics on AU scales becomes important to categorize the fruitful and various observational outcomes.
Here, I want to provide an overview of the recent results of me and my team and give an outlook on upcoming projects.

Colloquium Bernd Engels 13 Jan, 5.15 pm

Bernd Engels (Institute for Phys. & Theor. Chem., Universität Würzburg)

Are cluster approaches usefull for describing thin films of organic semiconductors?

Organic semiconductors have been intensively studied for decades. However, short comings in the theoretical descrip-
tion of the photo physics of the thin films of organic semiconductors still prevent a precise understanding of the complex interplay of the various processes that determine the photophysical properties of these thin films. So far, cluster approaches which have been able to explain many very different photophysical phenomena appearing in various organic semiconductors, have failed to reproduce the absorption spectra of thin films of pentacene. In the present work we describe our recent approach combining cluster approaches with optimal-tuned functionals. In a first step we investigate the pentacene monomer to benchmark various DFT approaches. In the second step we show that our approach achieves very accurate results (errors < 0.1 eV) if some rules are obeyed. We discuss the rules and the underlying reasoning using pentacene, tetracene and perfluoropentacene as examples.

Colloquium Rudolf Bratschitsch 20 Jan, 5.15 pm

Rudolf Bratschitsch (Institute of Physics and Center for Nanotechnology, University of Münster)

Single-photon emitters in 2D materials

Atomically thin materials serve as a promising new material class for optoelectronics. Monolayer semiconductors such as MoS2 or MoSe2 exhibit prominent
photoluminescence. Recently, we have discovered bright and stable single-photon emitters in single layers of W Se2, which renders atomically thin semiconductors also interesting for quantum optics and quantum technologies. In my talk, I will show that these quantum light sources can be controlled by mechanical strain and demonstrate deterministic positioning of the emitters on the nanoscale. Furthermore, I will present single-photon emission from GaSe, and demonstrate that the photons can be routed in dielectric waveguides on a photonic chip. Finally, I will discuss the nature and prospects of single-photon emitters in the van der Waals insulator hexagonal boron nitride (hBN) by focusing on the role of phonons and how large emitter arrays can be created with commercially available hBN nanocrystals.

Colloquium Inaugural lecture Marina Gerhard 27 Jan, 5.15 pm

Marina Gerhard (FB Physik, Philipps-Universität Marburg)

On the trail of excitons: What luminescence tells us about (not entirely perfect) semiconductors

Solution-processed semiconductors such as polymers or hybrid perovskites are promising material classes for the fabrication of low-cost and flexible solar cells or light emitters. However, their photophysical processes are not well understood in many aspects. Spatially and temporally resolved photoluminescence spectroscopy employing short laser pulses provides insights into processes occurring on time scales below a nanosecond. Employing this technique allows us to understand how light-generated charge carriers and electron-hole pairs, so-called excitons, behave. In particular, we obtain insight into mechanisms that affect the efficiency of semiconductors, such as the localization of photoexcited species and non-radiative processes. Overall, I will present how conclusions about loss mechanisms can be drawn from quantitative analysis of spatially and temporally resolved photoluminescence data for a few selected model systems, and I will discuss the important role of temperature, as well as micro- and nanostructure. The lecture will be held in German.

New Colleagues

Dominik Muth (AG Gerhard)

I recently finished my master's thesis and started working as a PhD- student for the semiconductor-spectroscopy group of Marina Gerhard. I am interested in all aspects of experimental physics with a special fascination for everything having to do with lasers. My work deals with time resolved measurements of charge carrier and excitons in organic semiconductors and heterostructures. Outside of work I love boardgames, reading and fitness.

Christmas break

We are back in February 2022 and wish everybody
Marry Christmas and a Happy New Year 2022!

Share your good news

Your newsletter team: Carina Hawaty, Maya Strobel, and Ermin Malic

Send us an e-mail with a short text and a nice foto to newsf63@physik.uni-marburg.de

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