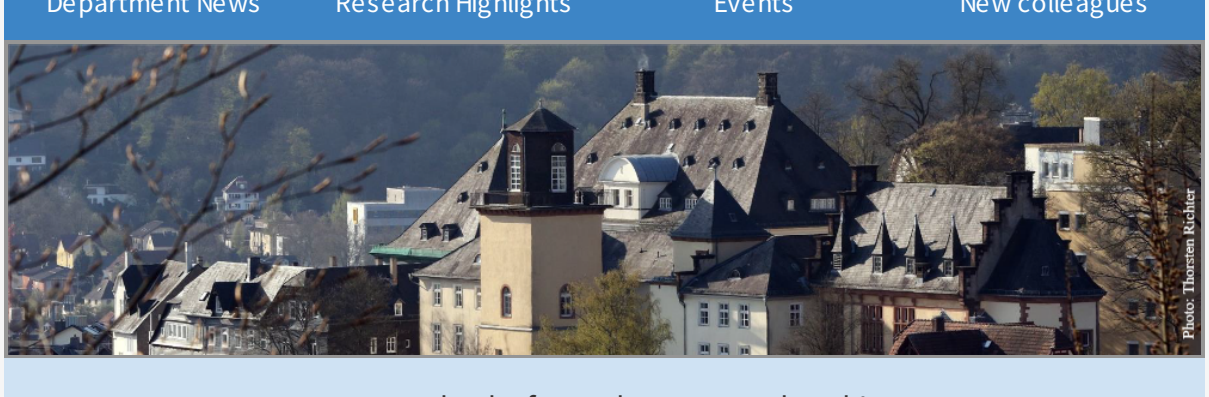
Newsletter Physics 06/22

Department News | Research Highlights | Events | New colleagues



We are back after a short Easter break!

If you have difficulties reading the newsletter, you can download it by clicking the "download pdf" button or on the department homepage (under events).

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News from the Department

Interview with Tobias Breuer

We start a new series of interviews with key people in our department. You can read our first inteview with Tobias Breuer, head of physics lab courses. "Teaching has always been fun for me". "I would like to meet Mai Thi Nguyen-Kim ... she can certainly be described as a source of inspiration." "I have a project for this year: I want to learn juggling." Read below the full interview (in German) that has been done by Josefine Neuhaus.

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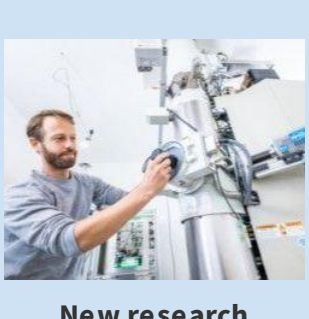

New research building with a modern electron microscope (AG Volz)

The German Science and Humanities Council (Wissenschaftsrat) gave its recommendation for a project of groups in Marburg and Giessen working on materials. The project is called ATEMMA (Advanced Transmission Electron Microscopy, Marburg). ATEMMA comprises a volume of 10 Mio € and is led by Prof. Dr. Kerstin Volz. The money is divided into 4 Mio € for a new building on the Lahnberge campus and 6 Mio € for a new electron microscope. ATEMMA strengthens the focus on material sciences and especially on interfaces and paves the way for further research, e.g., on new materials used for communication and energy technologies, as these represent extremely important topics in our today's society.

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Alfred-Wegener-Prize goes to Felix Widdascheck (AG Witte)

Dr. Felix Widdascheck, who has worked in the group of Prof. Dr. Gregor Witte receives the Alfred-Wegener doctoral thesis award for the best dissertation of the year 2021 in the department of physics. The award honors his outstanding dissertation "Preparation and characterization of molecular contact layers to modify the work function of noble metal surfaces", in which he studied the energy level alignment at the interface between metal electrodes and organic semiconductor films, which leads to the formation of energy barriers for the injection of charge carriers. His work contributes to closing the gap between model studies of molecular contact primer layers on idealized surfaces (single crystalline substrates, precise coverage control under UHV conditions) and contact layers in real devices (polycrystalline electrodes, real process conditions in mass production) and allows to improve future organic electronic devices. The prize will be awarded in July in an academic ceremony at the department.

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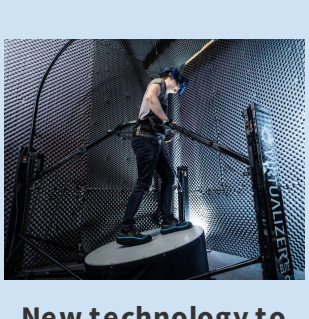

New technology to enhance research on self-motion perception (AG Bremmer)

The addition of a new virtual reality (VR) motion platform (Virtualizer Elite 2, Cyberith) to the already existing VR Lab of the Neurophysics group will enable a multitude of new methods to investigate psychophysical correlates during self-mo. The Virtualizer allows subjects to move freely and naturally in a virtual environment while actually staying in place. This is made possible by a special walking surface with extremely low friction. A unique feature of the Virtualizer is that the platform recognizes the intended walking direction and automatically tilts the surface to always make the user walk slightly uphill, which creates the necessary counterforce to keep them in one spot. In this way, the setup allows for complete control over the visual scenery while also providing a naturalistic way of locomotion. Alexander Kreß (doctoral candidate) and Dr. David Engel run the VR experiments in the Neurophysics group.

Girls' Day 2022

A successful Girls' Day in Physics: this year finally after the long Corona-break, 12 girls (age 11 - 14 years) were happy to get to know the world of physics. They enjoyed a bit of science, research and experiments, got a glimpse of the workshops, labs and lecture halls - and even started to consider an academic career.

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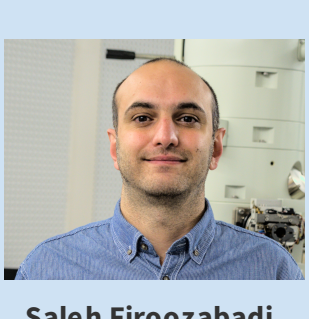
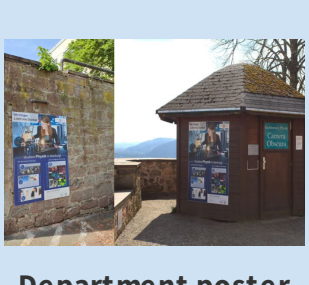


Saleh Firoozabadi, new doctor at our department! (AG Volz)

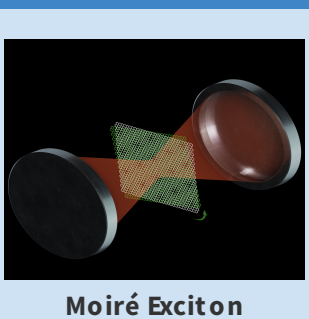
I completed my master of Functional Materials in Marburg in the group of Prof. Volz and started my Ph. D. in the same research group in February 2018. My research was focused on quantitative scanning transmission microscopy (STEM) by comparing annular dark filed micrographs and complementary image simulations. I used a combination of different electron microscopy techniques, such as energy-filtered STEM and four-dimensional STEM, for the atomic scale composition determination of material containing heavy or light elements. This project was funded by the Collaborative Research Center SFB 1083. Morever, I was involved in the uSPIRE project funded by European Union's Horizon 2020 research and innovation program. Here, I investigated the dislocations and morphology of vertical heterostructures aiming for single-photon detectors. I am also happy to announce the birth of my daughter in the third year of my Ph.D.



Department poster at the Camera Obscura!

As already reported in the previous newsletter, the PR team has created a poster for the Physics Department. The poster is now placed in one of the most exposed positions in Marburg, the Camera Obscura directly at the castle. It can be also found at the entrance gate of the Renthof and will be also placed at the Chemikum.

Research Highlights



Moiré Exciton Polaritons in twisted materials (AG Malic)

Twisted atomically thin semiconductors are characterized by moiré excitons. Their hybridization with photons in the strong coupling regime for heterostructures integrated in an optical cavity has not been well understood yet. In this work, AG Malic combined an excitonic density matrix formalism with a Hopfield approach to provide microscopic insights into moiré exciton polaritons. In particular, they show that exciton-light coupling, polariton energy, and even the number of polariton branches can be controlled via the twist angle. These new hybrid light-exciton states become delocalized relative to the constituent excitons due to the mixing with light and higher-energy excitons. The system can be interpreted as a natural quantum metamaterial with a periodicity that can be engineered via the twist angle. The work has been published in Nano Letters.

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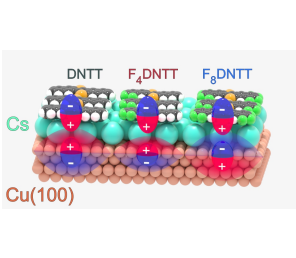

Buried Interface Dipoles (AG Witte)

The use of contact layers to reduce injection barriers for charge carriers between metals and active organic layers can face the problem of electronic level pinning effects. While chemical functionalization of organic molecules enable a specific tailoring of their energetic levels in the isolated states, this can be wiped out in their condensed phase on the metal surface, leading to quite similar energetic levels. Gregor Witte and his group demonstrated that this HOMO, resp. LUMO pinning effect can be avoided by incorporating an additional 2D layer of cesium between metal and organic adlayer. This yields the formation of two interface dipoles: (i) an outer one between the 2D cesium layer and the organic adlayer and (ii) an inner, buried interface dipole between the 2D cesium layer and the bulk metal, which can be modulated by the organic layer on top. This work has been published in Advanced Materials Interfaces.

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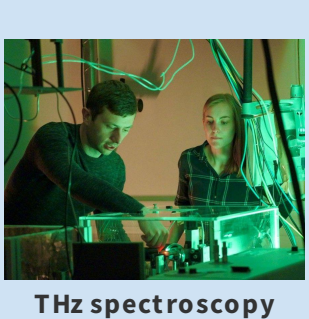

THz spectroscopy probes the state of crystallinity of pharmaceuticals (AG Koch)

Since THz radiation interacts with crystal vibrations, THz spectroscopy is well suited for determining the crystallinity of active pharmaceutical ingredients. Many crystalline pharmaceutical ingredients dissolve only poorly in water and thus cannot be completely absorbed by the human body. Increasing solubility is therefore one of the key challenges in current pharmaceutical research.
The AG Keck from the Department of Pharmacy at the Philipps-Universität Marburg has developed a solution to this problem, the so-called smartFilms® or paper tablets which help to keep the drug amorphous, at least up to a certain paper-to-active ingredient ratio. Jan Ornik and Lara Heidrich from AG Koch used THz spectroscopy to confirm that the drug indomethacin stays amorphous up to a loading of 15 % in the paper. The work was published in Scientific Reports.

Press release

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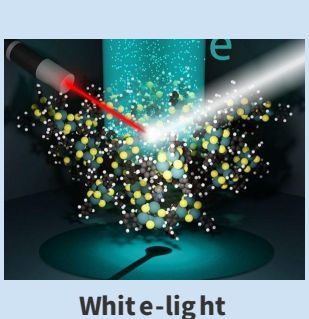

White-light generating molecular materials (AG Volz)

Amorphous materials are integral part of today´s technology, they commonly are performant and versatile in integration. Establishing their structure-property relationship, however, is inherently challenging using diffraction- based techniques yet is extremely desirable for developing advanced functionalities. In this article, AG Volz and co-workers introduced a set of transmission electron microscopy-based techniques to locally quantify the structure of an ensemble of well-defined, functionalized adamantane-type cluster molecules exhibiting exceptionally promising nonlinear optical properties of unclear origin. The nanoscopic structure for three model compounds ([(PhSn)4S6], [(NpSn)4S6], [(CpSn)4S6]) correlates with their characteristic optical responses. The work was published in ChemPhotoChem.

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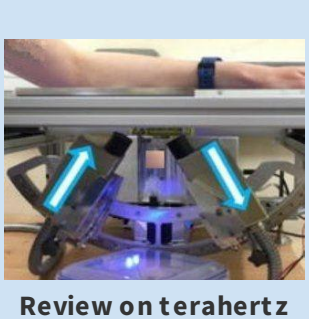

Review on terahertz biophotonics technology (AG Koch)

A plethora of interdisciplinary applications of terahertz radiation are emerging. One of the most promising fields of impact for this technology is biomedicine. THz biophotonics involves studies applying THz photonic technology in biomedicine, which has attracted attention due to the unique features of THz waves, such as the high sensitivity to water, resonance with biomolecules, capacity to probe the water–biomolecule interactions, among others. Despite the great potential, THz biophotonics is still at an early stage of development. In this article, Enrique Castro-Camus, Guest Professor at AG Koch and co-workers from the University of Warwick (UK), CUHK (Hong Kong) and Aalto University (Finland) give an overview of basic biomedical research as well as pre-clinical and clinical applications under investigation. The work was published in Chemical Physics Reviews.

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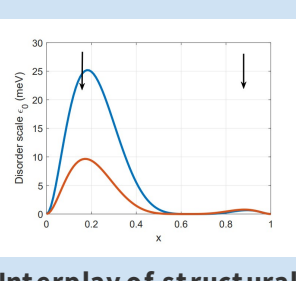

Interplay of structural and optoelectronic properties in perovskites (AG Gebhard / AG Koch)

Perovskite semiconductors are currently in the focus of intensive research due to various device applications, particularly in photovoltaics. Alloyed perovskites exhibit variable bandgaps, making alloys promising for applications in tandem solar cells. The price for the tunable bandgaps is a disorder potential caused by alloying. The disorder potential localizes photo-excited electrons and reduces the cell efficiency. The technological challenge is to reduce the disorder by optimizing the material preparation conditions. A collaboration headed by the many-particle theory group (F. Gebhard) and the semiconductor photonics group (M. Koch) in Marburg succeeded to estimate the limit of the statistical alloy disorder that cannot be improved any further by technological optimization. This was erroneously claimed to be possible in previous communications where the significant dependence of the disorder scale $\varepsilon_0(x)$ on the alloy concentration x was overlooked. The work was published in Advanced Functional Materials.

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Events

Antrittsvorlesung Marina Gerhard
2 Jun, 5.15 pm
Big lecture hall, Renthof 5

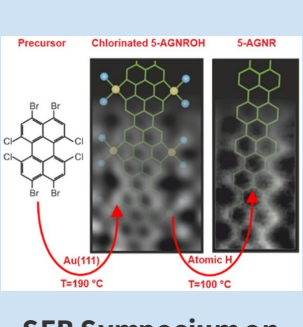
Prof. Dr. Marina Gerhard

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 properties 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. This inaugural lecture will be given in German.

"Tischlein deck dich"
800 years anniversary
5th of June, 11am - 6pm, table number 377

The 800-year Marburg anniversary event "Tischlein deck dich" will take place on Sunday, 5th June on the motorway. The Department of Physics will be represented at this event - you can find us at the table 377. Prof. Heinz Jänsch has prepared some exciting experiments around the topic sustainability. The PR team has prepared a giveaway from the physics department including nice looking pencils with a logo of our department. We are looking forward to meeting you there.



SFB Symposium on organic interfaces
8 Jun, 10 am
Lecture Hall E, D in the Chemistry Department

The symposium focuses on the structure, dynamics and reactivity of organic interfaces. Particular highlights of this symposium include the invited lecture by Dr. habil. Szymon Godlewski from the Jagellonian University Krakow about "*On-surface synthesis of long acenes and nanographenes*" and the talk by Prof. Stefan Tautz about "*The Jülich Quantum Microscope*". Further talks will cover time-resolved photoemission orbital tomography, reactions of organic molecules on different surfaces, or the ab initio theory of semiconductor/organic interfaces. Moreover, electronic properties of organic/metal heterolayers as analyzed by a wide variety of different techniques will be discussed.
Everyone is welcome to join this symposium. In case you want to participate, please register by sending an email to Dr. Stefan Kachel (sfb@internal-interfaces.de).

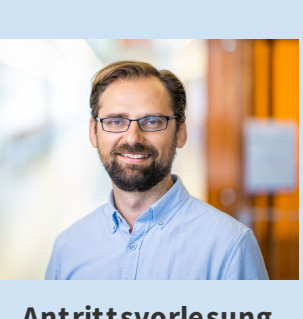
program

Colloquium Steven Schofield
9 Jun, 5.15 pm
Big lecture hall

Prof. Dr. Steven Schofield (Centre for Nanotechnology,University College London)

New routes to donor-based quantum devices: structures and processes on semiconductor surfaces

Laboratory-scale electronic devices can now be fabricated with atomic-scale precision via the deterministic placement of individual donor atoms in silicon, and electron spins localized on donor atoms in semiconductors form excellent two-level quantum systems (qubits) for quantum technological devices. The creation of such devices is achieved by a combination of conventional and scanning tunnelling microscopy-based fabrication, and critically, relies on a detailed understanding and control of the chemical reactions of dopant precursor molecules with atomically clean semiconductor surfaces in vacuum. In this talk, I will present recent work in our group investigating alternatives to the phosphine/silicon system for the fabrication of atomic-scale dopant devices in semiconductors. I will present atomic-resolution scanning tunnelling microscopy and spectroscopy data complimented by density functional theory calculations and photoemission spectroscopy. Our new results offer exciting opportunities for the fabrication of donor-based devices and their scale-up to the large numbers of qubits required for the fabrication of technological quantum devices.



Antrittsvorlesung Ermin Malic
23 Jun, 5.15 pm
Big lecture hall

Prof. Dr. Ermin Malic

Atomically thin nanomaterials - fascinating properties and technological application potential

Materials with tailored properties for technological applications have always been a dream in materials science. With atomically thin nanomaterials, there has recently been a class of materials that comes very close to this dream. The most prominent examples are graphene consisting of a single layer of carbon atoms and monolayers of transition metal dichalcogenides. These atomically thin materials exhibit a number of unique properties, such as being bendable, largely transparent, excellent conductors of electricity and heat, efficient emitters of light. They are considered promising candidates for novel technologies, especially in the field of optoelectronics (e.g. light emitting, light detecting and light harvesting devices). In the newly established Ultrafast Quantum Dynamics Group, we develop fully quantum-mechanic and material-specific models to understand the properties of these materials on a microscopic level. In joint theory-experiment studies, we shed light on many-particle phenomena governing their optics, dynamics and transport properties, which are the key processes for the operation of many optoelectronic devices.

Nacht der Kunst
24th of June

Visit the Gerling Observatory and the Scientific Instrument Collection at the "Nacht der Kunst" on June 24, 2022!
On October 12, 1841, Christian Ludwig Gerling looked up at the night sky with a telescope for the first time in his newly built observatory. The observatory was in operation for astronomical research until the 1930s. Immerse yourself in the astronomical history of the 19th century at a historic site!

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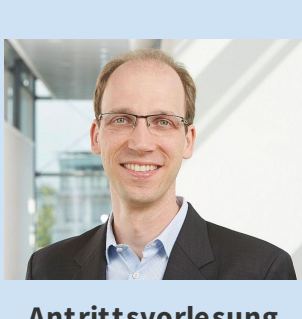


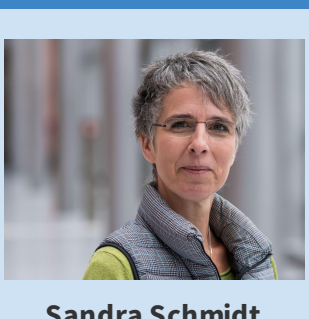
Antrittsvorlesung Jan Christoph Goldschmidt
30 Jun, 5.15 pm
Big lecture hall

Prof. Dr. Jan Christoph Goldschmidt

Photovoltaic solar energy conversion – Great potentials, new concepts and open questions

Photovoltaics is the most important energy conversion technology for cost-effective climate protection. In order to realize the necessary rapid expansion of photovoltaics on the terawatt scale in a resource- and cost-efficient manner, efficiency must be further increased in the long term. At the moment, tandem solar cells, where solar cells from different materials are stacked on top of each other, are the most promising way to achieve efficiencies beyond the fundamental limits of silicon technology. This requires a better understanding of the physical phenomena that occur, especially at the numerous interfaces and the interaction of electrical and optical effects. Based on these findings, ever-improved solar cells can then be realised.

New Colleagues



Sandra Schmidt (secretary, AG Goldschmidt)

In April 22, I started as secretary of Prof. Dr. Jan Christoph Goldschmidt in the Solar Energy Conversion Group. In the past I held secretarial positions in a variety of commercial businesses and I have a technical working background in the garment production industry also. Apart from Germany I have worked and/or lived in England, China, Korea and India. In 2008, I joined an institution for environmental research in Berlin which has broadened my horizon in many ways. For family reasons I returned to my hometown near Marburg a few years ago and shortly after I started working for the Philipps University. Everyone at the Department of Physics who I met so far made me feel very welcome and I am looking forward to supporting the research of the Solar Energy Conversion Group with my work.

Lukas Wagner (postdoc, AG Goldschmidt)

I joined the Physics for Solar Energy Conversion group (Prof. Goldschmidt) in May 2022. Before that, I was with the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg, where I also carried out research for my PhD on perovskite photovoltaics. I studied at Karlsruhe Institute of Technology (KIT) and have spent one year in the USA (Oregon State, Corvallis, OR, and Georgia Tech, Atlanta, GA) as well as one year in France (CEA-INES, Chambery) for studies and research.
My research interests are perovskite solar cell development, sustainability assessments, and advanced characterization techniques such as photoluminescence-based methods. I am looking forward to exploring the unique research environment at Uni Marburg to delve deeper into the fascinating physics of perovskite photovoltaic devices. In my spare time, I already enjoyed to explore the picturesque city of Marburg and to roam around in the beautiful hinterland of Mittelhessen with my partner and our two dogs.

Share your good news

Your newsletter team: Carina Hlawaty and Ermin Malic

Send us an e-mail with a short text and a nice foto to newsfb13@physik.uni-marburg.de

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