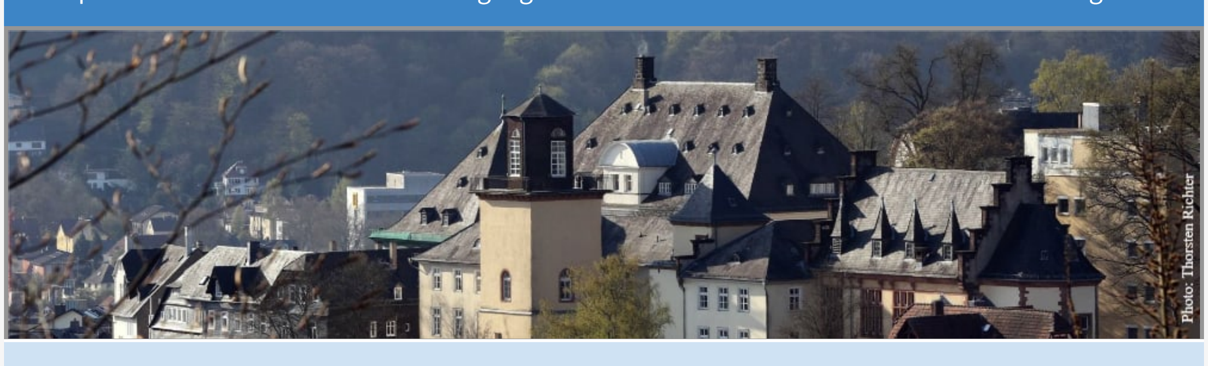
Philipps Universität Marburg

Newsletter Physics 02/23

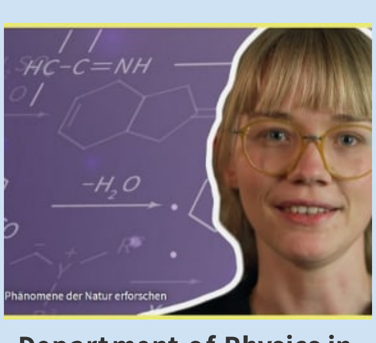


Welcome back after our short Christmas break.

Auf Wunsch von einigen Lesern werden wir die Bereiche "News" und "Neue Kolleg*innen" sowohl auf englisch als auch auf deutsch zeigen.

By request of some readers, the sections "Department News" and "New Colleagues" will be shown in English as well as in German.

News from the Department



Department of Physics in ARD Alpha Uni

The ARD Alpha Uni filmed a report about studying physics at the University of Marburg. They followed our student Lea Obermüller during a regular day in her studies and interviewed her about the challenges of studying physics. This report has been clicked over 100.000 times so far and increases the visibility of our Department.

Die ARD Alpha Uni drehte eine Reportage über das Physikstudium an der Universität Marburg. Sie haben unsere Studentin Lea Obermüller an einem ganz normalen Tag in ihrem Studium begleitet und sie zu den Herausforderungen des Physikstudiums befragt. Dieser Bericht wurde bisher über 100.000 Mal angeklickt und erhöht die Sichtbarkeit unseres Fachbereichs.

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Physik am Samstagmorgen

In January, Ermin Malic and Robert Wallauer, gave a popular science talk on atomically thin nanomaterials in the lecture series “Physik am Samstagmorgen”. Next talk will be given by Marina Gerhard on 11 February in the lecture hall in Biegenstr. 12. She will explain the significance of fluorescence as a tool in modern materials research. The lecture will cover examples from everyday life, fluorescence-based methods in biology and environmental research, as well as a brief introduction to fluorescence studies of semiconductor micro- and nanocrystals.

Im Januar hielten Ermin Malic und Robert Wallauer einen populärwissenschaftlichen Vortrag über atomar dünne Nanomaterialien im Rahmen der Vortragsreihe "Physik am Samstagmorgen". Den nächsten Vortrag hält Marina Gerhard am 11. Februar im Hörsaal in der Biegenstr. 12. Sie wird die Bedeutung der Fluoreszenz als Werkzeug in der modernen Materialforschung erläutern. Der Vortrag umfasst Beispiele aus dem Alltag, fluoreszenzbasierte Methoden in der Biologie und Umweltforschung sowie eine kurze Einführung in Fluoreszenzuntersuchungen an Halbleiter-Mikro- und Nanokristallen.

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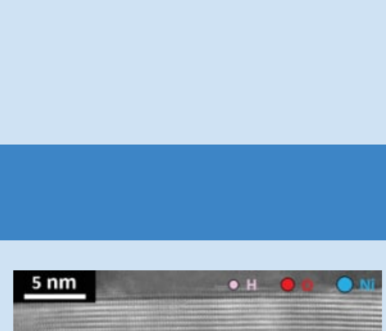
German Conference of Women in Physics

A group of students from our department attended the German Conference of Women in Physics (Deutsche Physikerinnentagung, DPT) which took place at KIT in Karlsruhe in November. For the participants, being surrounded by so many female scientists not only was an unfamiliar sight but also influenced the interactions and discussions. We congratulate Marleen Axt from the AG Höfer for winning the poster award. In a creative way she managed to fascinate for the exciting physics of Van der Waals heterostructures that she investigated in the context of our SFB 1083. Besides the scientific contributions, one very important aspect of the event is to offer a platform for discussions on various carrier paths for women. We encourage all students to look out for the next DPT.

Eine Gruppe von Studentinnen unseres Fachbereichs besuchte die Deutsche Physikerinnentagung (DPT), die im November am KIT in Karlsruhe stattfand. Für die Teilnehmerinnen war es nicht nur ein ungewohnter Anblick, von so vielen Wissenschaftlerinnen umgeben zu sein, sondern es beeinflusste auch die Interaktionen und Diskussionen. Wir gratulieren Marleen Axt aus der AG Höfer zum Gewinn des Posterpreises. Sie hat es auf kreative Art und Weise geschafft, die Menschen für die spannende Physik von Van-der-Waals-Heterostrukturen zu begeistern, die sie im Rahmen unseres SFB 1083 untersucht hat. Neben den wissenschaftlichen Beiträgen ist ein wichtiger Aspekt der Tagung eine Plattform für Diskussionen über verschiedene Karrierewege für Frauen. Wir ermutigen alle Studierenden, nach dem nächsten DPT Ausschau zu halten.

Contact



New characterization equipment (AG Goldschmidt)

The Physics of Solar Energy Conversion Group has received its first characterization equipment. A hyperspectral imaging tool, a UV-Vis Spectrometer, a Hall measurement station and an ellipsometer are now available. A time resolved photoluminescence tool is currently under construction. In January hopefully the last remaining parts for the current voltage, external quantum efficiency and aging solar cell measurement tools will be delivered.

AG Solar-Energiekonversion hat Ende 2022 die erste Charakterisierungsausrüstung erhalten. Ein hyperspektrales Bildgebungsinstrument, ein UV-Vis-Spektrometer, ein Hall-Messplatz und ein Ellipsometer sind jetzt verfügbar. Ein zeitaufgelöstes Photolumineszenz-Tool befindet sich derzeit im Aufbau. Im Januar werden hoffentlich die letzten verbleibenden Teile für die Instrumente zur Messung der Stromspannung, der externen Quanteneffizienz und der Alterung von Solarzellen geliefert.

Research Highlights

Structural Defects in a Layered Cathode Material (AG Volz)

In lithium ion batteries, layered cathode active materials having the composition $LiNi_{1-x-y}Co_xMn_yO_2$ are critical for achieving high energy densities. However, adjusting the perfect stoichiometry is a challenge and results in various structural issues, which in turn result in the capacity fade of the batteries. To better understand defect formation in $LiNi_{1-x-y}Co_xMn_yO_2$, the role of the $Ni(OH)_2$ precursor morphology in the synthesis requires in-depth investigation. By employing aberration-corrected scanning transmission electron microscopy, electron energy loss spectroscopy, and precession electron diffraction, AG Volz demonstrates a direct observation of defects in the $Ni(OH)_2$ precursor and monitors the structural evolution from the precursor to the end product. This study showcases the necessary routes to be taken to minimize defects in cathode active materials and hence improve their performance. The work is published in Small.

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Exciton optics and dynamics in molecular crystals (AG Malic/Witte/Gerhard)

Organic semiconductor crystals stand out as an efficient, cheap and diverse platform for realising optoelectronic applications. So far, little is known on the phonon-driven singlet exciton dynamics in this class of materials. In this joint theory-experiment work, AG Malic, AG Witte and AG Gerhard combine the fabrication of a high-quality oligoacene semiconductor crystal and characterization via photoluminescence measurements with a sophisticated approach to the microscopic modeling in these crystals. This allows us to investigate singlet exciton optics and dynamics. We predict phonon-bottleneck effects in pentacene crystals, where we find dark excitons acting as crucial phonon-mediated relaxation scattering channels. We reveal both in theory and experiment a distinct polarisation- and temperature-dependence in absorption and photoluminescence spectra of tetracene crystals, including microscopic origin of exciton linewidths, the activation of the higher Davydov states at large temperatures, and polarisation-dependent quenching of specific exciton resonances. The work is published in Natural Sciences.

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Electrical tuning of moiré excitons in $MoSe_2$ bilayers (AG Malic)

Recent advances in the field of vertically stacked 2D materials have revealed a rich exciton landscape. In particular, it has been demonstrated that out-of-plane electrical fields can be used to tune the spectral position of spatially separated interlayer excitons. Other studies have shown that there is a strong hybridization of exciton states, resulting from the mixing of electronic states in both layers. However, the connection between the twist-angle dependent hybridization and field-induced energy shifts has remained in the dark. Here, AG Malic investigates on a microscopic footing the interplay of electrical and twist-angle tuning of moiré excitons in $MoSe_2$ homobilayers. We reveal distinct energy regions in PL spectra that are clearly dominated by either intralayer or interlayer excitons, or even dark excitons. Consequently, we predict twist-angle-dependent critical electrical fields at which the material is being transformed from a direct into an indirect semiconductor. Our work provides new microscopic insights into experimentally accessible knobs to significantly tune the moiré exciton physics in atomically thin nanomaterials. The work is published in a focus issue of 2D Materials.

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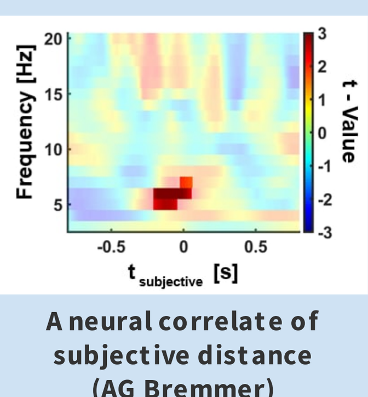

Layer separation mapping of paintings using terahertz time-domain imaging (AG Koch)

Old paintings often experience peeling of paint layers and air holes in their internal structure due to storage conditions. It is difficult for art conservators to determine the exact location and extent of layer detachment on a work of art in a non-invasive manner. Still more difficult is to evaluate the success of a consolidation procedure. AG Koch analyzed a fifteenth-century panel painting using terahertz time-domain imaging before and after consolidation. Using the terahertz data, it was possible to determine the areas of the artwork that needed consolidation and to support the intervention. The work is published in Scientific Reports.

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A neural correlate of subjective distance (AG Bremmer)

Navigating through an environment requires knowledge about one’s direction of self-motion and traveled distance. Behavioral studies showed that human participants can actively reproduce a previously observed travel distance purely based on visual information. In this study, AG Bremmer employed EEG to investigate the underlying neural processes. We measured in human observers event-related potentials (ERPs) during visually simulated straight-forward self-motion across a ground plane. The participants’ task was to reproduce (active condition) double the distance of a previously seen self-displacement (passive condition) using a gamepad. We recorded the trajectories of self-motion during the active condition and played it back to the participants in a third set of trials (replay condition). When aligned to self-motion on- or offset, response modulation of the ERPs was stronger, and several ERP-components had different latencies in the passive as compared to the active condition. This result is in line with the concept of *predictive coding*. The work is published in eNeuro.

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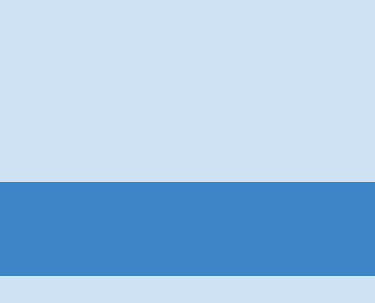

Exciton transport in a moiré potential (AG Malic)

The propagation of excitons in TMD monolayers has been intensively studied revealing interesting many-particle effects, such as halo formation and non-classical diffusion. Initial studies have investigated how exciton transport changes in twisted TMD bilayers, including Coulomb repulsion and Hubbard-like exciton hopping. In this work, AG Malic investigated the twist-angle-dependent transition of the hopping regime to the dispersive regime of effectively free excitons. Based on a microscopic approach for excitons in the presence of a moiré potential, we show that the hopping regime occurs up to an angle of approx. 2° and is well described by the Hubbard model. At large angles, however, the Hubbard model fails due to increasingly delocalized exciton states. Here, the quantum mechanical dispersion of free particles with an effective mass determines the propagation of excitons. Overall, our work provides microscopic insights into the character of exciton propagation in twisted TMD heterostructures. The work is published in Phys. Rev. Materials.

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Events

Dr. Cyril Poriel
SFB Colloquium jointly with FB Chemie (Lahnberge)
09.02.23 at 5.15 pm
HS C Chemie

Dr. Cyril Poriel
(CNRS University Rennes, Frankreich)

Pure Hydrocarbon Hosts for High Performance Phosphorescent OLEDs

In the Organic Electronic technologies, Phosphorescent Organic Light-Emitting Diodes are the second generation of OLEDs and have encountered a fantastic development. During the past two decades, intense research has been focused on developing high-efficiency host materials. The most efficient are the bipolar hosts constructed on a ‘Donor/Acceptor’ molecular design. However, the complicated structure of these molecules increases the synthetic complexity, the environmental footprint and production costs. Thus, as the instability of OLEDs is one of the most important problem to address at the current stage of development, developing new generations of host materials, without heteroatoms has appeared as an important challenge in the field. In this talk, our recent advances in the field of PHC host materials for PhOLEDs will be presented. The molecular design strategies developed will be shown and analysed to demonstrate their impact on electronic and physical properties and the final device performance.

New colleagues

Maryam Raouph
PhD student
AG Schrimpf

I was born in Iran, Rasht in 1993. I studied BSc in Solid-State Physics at Payame - Noor University. Then I started my master's degree in astrophysics major at the university of Zanjan. I have worked on Testing the "standard model of cosmology using dwarf galaxies rotation curve as the master's thesis under the supervision of Dr. Hossein Haghi from the Institute for Advanced Studies in Basic Sciences. In December 2022 I joined the group of Prof. Andreas Schrimpf as a Ph.D. student and am working on the photometry of variable stars using astronomical photographic plates. The main idea of this project is to show the usefulness of photo plate observations in stellar astrophysics. I like to use my leisure time to do sports. I do roller skating and go running regularly, and particularly enjoy dancing.

Ich wurde 1993 in Iran, Rasht, geboren. Ich habe einen Bachelor-Abschluss in Festkörperphysik an der Payame-Noor-Universität. Dann begann ich mein Masterstudium im Hauptfach Astrophysik an der Universität Zanjan. Ich habe an der Überprüfung des "Standardmodells der Kosmologie anhand der Rotationskurve von Zwerggalaxien als Masterarbeit unter der Leitung von Dr. Hossein Haghi vom Institute for Advanced Studies in Basic Sciences gearbeitet. Seit Dezember 2022 bin ich Doktorand in der Gruppe von Prof. Andreas Schrimpf und arbeite an der Photometrie von veränderlichen Sternen mit Hilfe von astronomischen Fotoplatten. Die Hauptidee dieses Projekts ist es, die Nützlichkeit von Fotoplattenbeobachtungen in der stellaren Astrophysik zu zeigen. Meine Freizeit nutze ich gerne für Sport. Ich gehe regelmäßig Rollschuhlaufen und Joggen und tanze besonders gern.

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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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