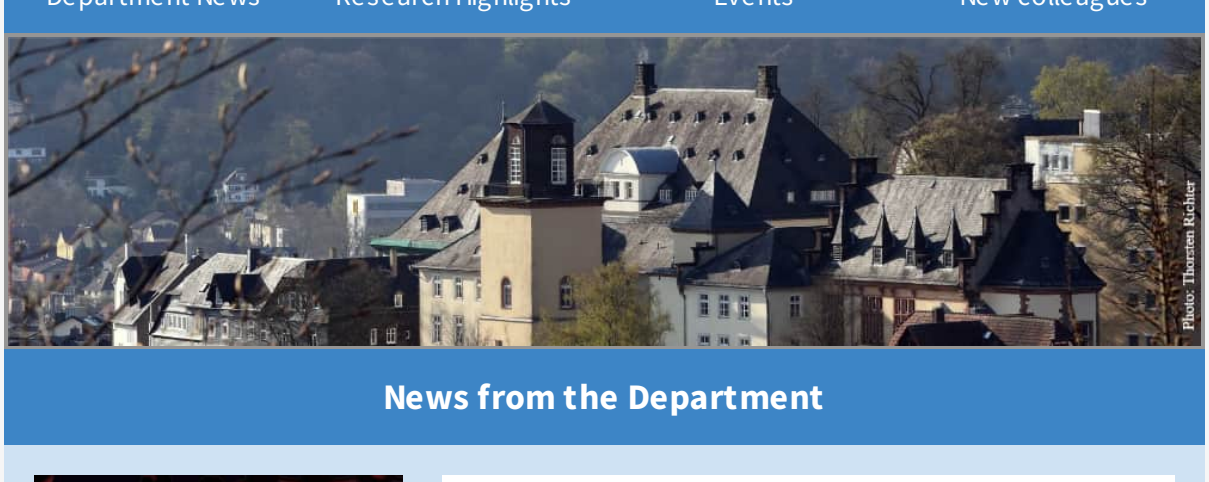
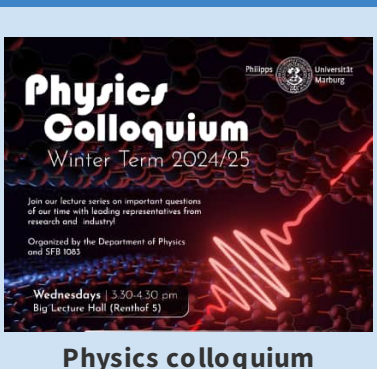
Philipps Universität Marburg

Newsletter Physics 10/24

Department News | Research Highlights | Events | New colleagues



News from the Department



Physics colloquium in the winter term

The program for the physics colloquium in the winter term is fixed! The talks will have a general character and will be given by leading representatives in research and industry. The first speaker will be Prof. Vincenzo Palermo, Direktor am National Research Council of Italy in Bologna, and he will give a presentation on "Graphene history - from lab weirdo to breakthrough in industry". We would like to welcome everybody, in particular students and non-scientific employees of the department. The colloquium will take place on Wednesdays 3.30-4.30pm in the big lecture hall in Renthof 5. After the colloquium, we will offer coffee and cake giving you the opportunity to meet our speakers. The students will again have the opportunity to get credit points for a key qualification.

Das Programm für das Physik-Kolloquium im Wintersemester steht fest! Die Vorträge werden wieder einen allgemeinen Charakter haben und werden von führenden Vertretern aus Forschung und Industrie gehalten. Der erste Sprecher ist Prof. Vincenzo Palermo, Direktor am Nationalen Forschungsrat Italiens in Bologna, und er wird einen Vortrag zum Thema „Graphene history - from lab weirdo to breakthrough in industry“ halten. Alle sind herzlich willkommen, insbesondere aber Studierenden und auch nicht-wissenschaftliche Mitarbeiter des Fachbereichs. Das Kolloquium findet mittwochs von 15.30-16.30 Uhr im großen Hörsaal im Renthof 5 statt. Im Anschluss an das Kolloquium wird es bei Kaffee und Kuchen die Möglichkeit geben, unsere Sprecher auch persönlich kennenzulernen. Die Studenten haben wieder die Möglichkeit eine Schlüsselqualifikation zu erhalten.

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Meet-the-prof interview with Frank Bremmer

There is a new “Meet the Prof” video! This time with Prof. Frank Bremmer from the neurophysics research group. The crucial question that has driven Frank Bremmer since the beginning of his career is how the brain works or more precisely how vision works? Can machine learning methods help in our search for the answer? His hobbies and of course the new “Physics and AI” Master course are also addressed in the video. The interview was conducted by Sarah Zajusch with OliverRehn behind the camera

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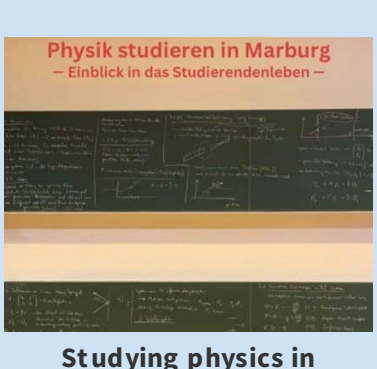
Es gibt ein neues „Meet the Prof“-Video! Diesmal mit Prof. Frank Bremmer von der Forschungsgruppe Neurophysik. Die entscheidende Frage, die Frank Bremmer seit Beginn seiner Karriere umtreibt, lautet: Wie funktioniert das Gehirn oder genauer gesagt, wie funktioniert das Sehen? Können Methoden des maschinellen Lernens uns bei der Suche nach der Antwort helfen? Auch seine Hobbys und natürlich der neue Masterstudiengang „Physik und KI“ kommen in dem Video zur Sprache. Geführt wurde das Interview vonSarah Zajusch mit Oliver Rehn hinter der Kamera.

Interview



Studying physics in Marburg from a student perspective

What is the everyday life like for physics students at our department? In addition to lectures, exercise sheets and experimental labs, Marburg offers a wide range of leisure activities. In this video you can see what makes Marburg, its diversity and student life so special and what characterizes studying physics here. The video was made by Christien Off from the PR group and will be used in social media to attract students to come to Marburg.

Wie sieht der Alltag von Physikstudierenden an unserem Fachbereich aus? Neben Vorlesungen, Übungszettel und Praktika bietet Marburg eine große Auswahl an Freizeitaktivitäten. Was Marburg, dessen Vielfalt, und Studentenleben so besonders machen und was ein dortiges Physikstudium auszeichnet, ist in diesem Video zu sehen. Das Video wurde von Christien Off von der PR-Gruppe gedreht und wird in den sozialen Medien eingesetzt, um Studierende für Marburg zu gewinnen.

Video

SFB 1083 organized the third International Conference on Internal Interfaces (ICII-24)

The international conferences ICII-24 organized by the SFB 1083 brought together more than 100 scientists from across the world in the new library building of the Philipps-Universität Marburg. From those, over 25 national and international speakers were invited to present their most recent progress in interface-research. Oral and poster sessions set the framework for intensive discussions on the newest developments in a fast-changing research field. Prizes for the best posters were also awarded. The first price went to Klaus Zollner from the University of Regensburg (“*Proximity-induced spin interactions in twisted van der Waals heterostructures*”). The second price was shared between Dr. Sabine Wenzel (“*Selective on-surface synthesis of isokekulene through strong molecule-metal interaction*”) and Dr. Roberto Rosati (“*Engineering the charge-transfer excitons in 2D lateral heterostructures*”) both from Marburg. The attractive setting for the event provided by the Philipps-Universität Marburg and the city contributed to making it a memorable meeting.

Die internationale Tagung ICII-24 organisiert vom SFB 1083 brachte mehr als 100 Wissenschaftler aus der ganzen Welt im neuen Bibliotheksgebäude der Philipps-Universität Marburg zusammen. Von diesen wurden über 25 nationale und internationale Referenten eingeladen, um ihre neuesten Fortschritte in der Schnittstellenforschung zu präsentieren. Vortrags- und Postersitzungen bildeten den Rahmen für intensive Diskussionen über die neuesten Entwicklungen in einem sich schnell verändernden Forschungsfeld. Es wurden auch Preise für die besten Poster verliehen. Der erste Preis ging an Klaus Zollner von der Universität Regensburg ("Proximity-induced spin interactions in twisted van der Waals heterostructures"). Den zweiten Preis teilten sich Dr. Sabine Wenzel ("Selective on-surface synthesis of isokekulene through strong molecule-metal interaction") und Dr. Roberto Rosati ("Engineering the charge-transfer excitons in 2D lateral heterostructures"), beide aus Marburg. Der attraktive Rahmen, den die Philipps-Universität Marburg und die Stadt für die Veranstaltung zur Verfügung stellten, trug dazu bei, dass es ein unvergessliches Treffen wurde.

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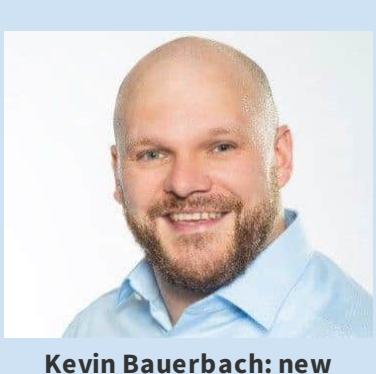
Long Night of Science

On November 15th (starting at 5:30 pm), the "Long Night of Science", an event organised by the Biology, Chemistry and Physics students, will take place in the Chemistry Department's lecture building. The Long Night of Science is an event at which professors or guest lecturers report on interesting scientific topics. The physics department is represented with lectures by Lukas Stock and Professor Ermin Malic. The evening will be complemented by an experimental chemistry lecture and the game "Real or Fake", which will liven up the evening alongside the lectures and provide plenty to talk about.

Am 15.11.2024 (ab 17:30 Uhr) findet die „Lange Nacht der Wissenschaft“, eine Veranstaltung der Fachschaften Biologie, Chemie und Physik im Hörsaalgebäude des Fachbereichs Chemie statt. Die Lange Nacht der Wissenschaft ist eine von den Studierenden organisierte Veranstaltung, bei der ProfessorInnen oder GastdozentInnen über interessante wissenschaftliche Themen berichten. Die Physik ist dieses Jahr mit Vorträgen von Lukas Stock und Professor Ermin Malic vertreten. Natürlich darf auch etwas Spaß nicht fehlen. Ergänzt wird der Abend durch einen Experimentalvortrag aus der Chemie und das Spiel "Echt oder Fake", die den Abend neben den Vorträgen auflockern und für Gesprächsstoff sorgen.



Kevin Bauerbach: new doctor at the department

Kevin Bauerbach successfully completed his Ph.D. in July 2024. In his dissertation written under the supervision of Prof. Florian Gebhard, Many-Particle Theory Group, Kevin focused on correlated fermions in low dimensions. He investigated the extended *1/r*-Hubbard model, which features no Umklapp scattering and thus shows metal-to-insulator quantum-phase transitions at finite interactions. The competition between the nearest-neighbor and Hubbard interactions, as well as the fermion’s kinetic energy, leads to a complex quantum-phase diagram, which he quantitatively investigated together with Florian Gebhard and Örs Legeza using the Density Matrix Renormalization Group. These results deepen the understanding of metal-to-insulator quantum-phase transitions in correlated electron systems.

Kevin Bauerbach hat im Juli 2024 seine Promotion erfolgreich abgeschlossen. In seiner Dissertation, die er in der AG Vielteilchentheorie unter Prof. Florian Gebhard anfertigte, beschäftigte er sich mit korrelierten Fermionen in niedrigen Dimensionen. Er untersuchte das erweiterte *1/r*-Hubbard-Modell, das keine Umklapp-Streuprozesse aufweist und daher Metall-Isolator-Übergänge bei endlichen Wechselwirkungen zeigt. Die Konkurrenz zwischen der Nächst-Nachbar- und der Hubbard-Wechselwirkung sowie der kinetischen Energie der Fermionen führt zu einem komplexen Quantenphasendiagramm, das er gemeinsam mit Florian Gebhard und Örs Legeza mithilfe der Dichtematrix-Renormierungsgruppe quantitativ untersuchte. Diese Ergebnisse vertiefen das Verständnis von Metall-Isolator Quantenphasenübergängen in korrelierten Elektronen-systemen.

City cycling event

12 researchers from the Volz and Gottfried reesarch groups took part in the city cycling event as a WZMW team. Our team was organized and led by Franzi Hüppe from AG Volz. The aim of this 3-week campaign, city cycling, is to cover as many everyday routes as possible by bike instead of by car. Together, the team cycled 2146 km in 21 days. Half a week before the start of the city cycling event (15 June to 5 July), a team from the Volz group traveled to Giessen by bike for the Materials Research Day as a training tour. The researchers want to make a contribution to sustainable development not only by researching new, sustainable functional materials, but also through personal behavior in everyday life.

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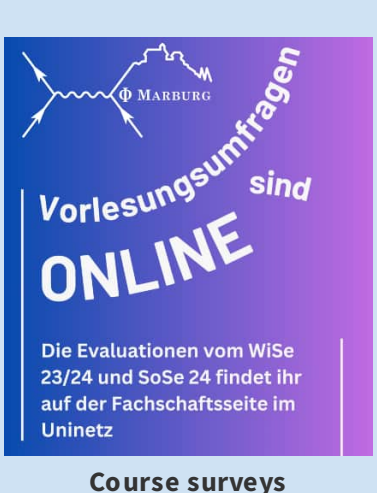
12 Forscherinnen und Forscher aus den AG Volz und AG Gottfried haben gemeinsam als WZMW Team am Stadtradeln teilgenommen. Organisiert und geleitet hat unser Team Franzi Hüppe aus der AG Volz. Bei dieser 3-wöchigen Aktion, dem Stadtradeln, geht es darum, möglichst viele Wege des Alltags mit dem Rad anstelle des Autos zurückzulegen. Das Team hat gemeinsam 2146 km in 21 Tagen mit dem Fahrrad zurückgelegt. Schon eine halbe Woche vor dem Start des Stadtradelns (15. Juni bis 5. Juli) ist ein Team aus der AG Volz zum Materialforschungstag nach Gießen via Fahrrad als Trainingstour angereist. Die Forscher und Forscherinnen wollen nicht nur mit dem Erforschen neuer, nachhaltiger Funktionsmaterialien, sondern auch mit dem persönlichen Verhalten im Alltag einen Beitrag für eine nachhaltige Entwicklung leisten.



Course surveys

The evaluation of the courses offered in our department has been carried out by the student council and is ready to be viewed by all members of our university.

Die Evaluation der an unserem Fachbereich angebotenen Kurse wurde von der Fachschaft ausgeführt und ist nun online und für alle Unimitglieder einsehbar.

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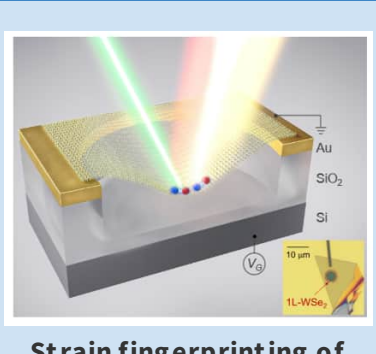
Research Highlights



Strain fingerprinting of excitons in 2D materialss (AG Malic)

Intervalley excitons with electron and hole wavefunctions residing in different valleys determine the long-range transport and dynamics observed in many semiconductors. However, these excitons with vanishing oscillator strength do not directly couple to light and, hence, remain largely unstudied. In this joint experiment-theory work between the groups of Prof. Bolotin (FU Berlin) and Prof. Malic, we developed a nanomechanical technique to control the energy hierarchy of valleys via their contrasting response to mechanical strain. We use our technique to discover previously inaccessible intervalley excitons associated with K, Γ, or Q valleys in prototypical 2D semiconductors WSe2 and WS2. We also demonstrate a new brightening mechanism, rendering an otherwise “dark” intervalley exciton visible via strain-controlled hybridization with an intravalley exciton. Overall, our valley engineering approach establishes a new way to identify intervalley excitons and control their interactions in a diverse class of 2D systems. This work is published in **Nature Communications.**

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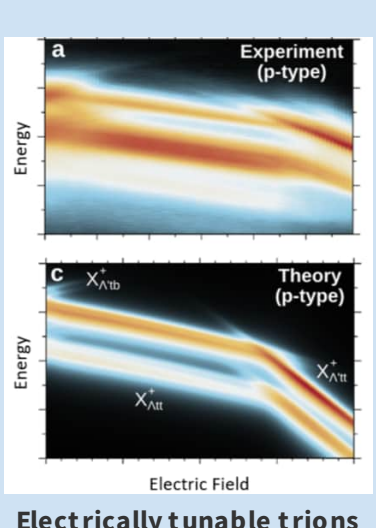

Electrically tunable trions in doped WSe2 bilayers (AG Malic)

Doped van der Waals heterostructures host layer-hybridized trions, i.e. charged excitons with layer-delocalized constituents holding promise for highly controllable optoelectronics. Combining a microscopic theory perforemd in the Malic group with photoluminescence experiments performed in the group of Kaiqiang Lin (Xiamen University, China), we demonstrate the electrical tunability of the trion energy landscape in naturally stacked WSe2 bilayers. We show that an out-of-plane electric field modifies the energetic ordering of the lowest lying trion states. At small fields, intralayer-like trions yield distinct PL signatures in opposite doping regimes characterized by weak Stark shifts in both cases. Above a doping-asymmetric critical field, interlayer-like species are energetically favored and produce PL peaks with a pronounced Stark red-shift and a counter-intuitively large intensity arising from efficient phonon-assisted recombination. Our work presents an important step forward in the microscopic understanding of layer-hybridized trions in van der Waals heterostructures. This work is published in **Nature Communications.**

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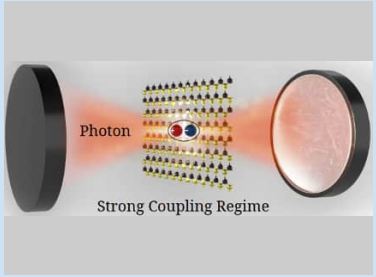

Circumventing the polariton bottleneck in 2D materials (AG Malic)

Efficient scattering into the exciton polariton ground state is a key prerequisite for generating Bose-Einstein condensates and low-threshold polariton lasing. However, this can be challenging to achieve at low densities due to the polariton bottleneck effect that impedes phonon-driven scattering into low-momentum polariton states. The rich exciton landscape of transition metal dichalcogenides provides potential intervalley scattering pathways via dark excitons to rapidly populate these polaritons. In this joint theory-experiment work between the Malic gropu and the the group of Prof. Schneider (University of Oldenburg), we explore the time- and momentum-resolved relaxation of exciton polaritons supported by a MoSe2 monolayer integrated within a Fabry-Perot cavity. By exploiting phonon-assisted transitions between momentum-dark excitons and the lower polariton branch, we demonstrate that it is possible to circumvent the bottleneck region and efficiently populate the polariton ground state. This represents a distinctive experimental signature for efficient phonon-mediated polariton-dark-exciton interactions. The work was published in **Optica.**

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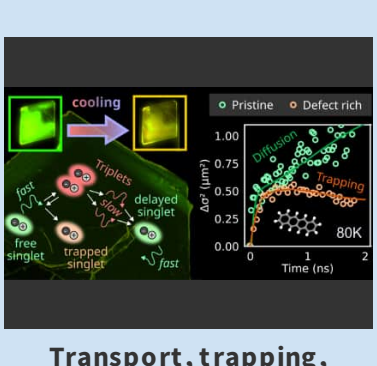

Transport, trapping, triplet fusion in tetracene crystals (AG Gerhard/AG Witte)

The dynamics of exciton migration in the organic semiconductor tetracene (TET) was recently studied by AG Gerhard and AG Witte. They observed a "cooperative transport" mechanism, in which the interconversion of fast moving singlet and long lived triplet excitons facilitates efficient transport. Using time-resolved photo-luminescence micro-spectroscopy on TET crystals of intentionally varied quality, they found that exciton dynamics are highly temperature-dependent and significantly influenced by sample quality, which was also rationalized by a kinetic model. Their findings underscore the critical importance of material purity and the interplay between singlet and triplet excitons in optimizing exciton transport, especially in materials like TET where singlet fission is slightly endothermic. The employed research framework, which integrates spectral, spatial, and temporal data, sets a robust standard for future studies and paves the way for improving the efficiency of organic semiconductors in practical applications, highlighting the need for further experimental efforts to understand and enhance exciton transport in other materials with endothermic singlet fission. The work was published in **Nanoscale.**

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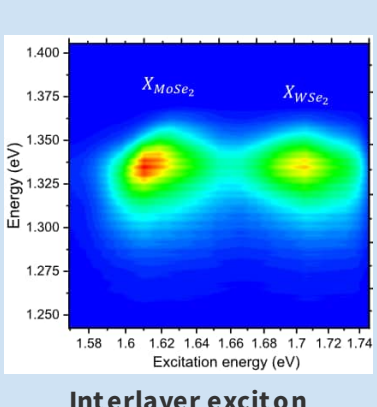

Interlayer exciton emission in TMD heterostructures (AG Malic)

Van der Waals heterostructures utilizing semiconducting transition metal dichalcogenide monolayers have surfaced as compelling candidates due to their intriguing optical characteristics, which can be effectively controlled by the manipulation of the stacking twist angle. This joint study between the groups of Prof. Reitzenstein (TU Berlin) and AG Malic investigates the intricate correlation between twist angle, band offset, and interlayer exciton emission within twisted WSe2/MoSe2 heterostructures. Our findings suggest a crucial influence of monolayer stacking order on the band offset and the dipole orientation in twisted heterostructures that leads to either blueshift or redshift in emission energy. Our fundamental study of exciton resonances provides comprehensive insights into the nuanced interplay between twist angle, dipole orientation, and dielectric asymmetry, providing a deeper understanding of the factors governing the optical properties of layered TMDC heterostructures. This work is published in **2D Materials.**

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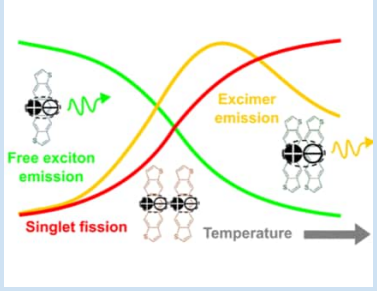

Singlet Fission in a Binary System (AG Gerhard)

Organic semiconductors are promising candidates for opto-electronic applications because their optical properties can be tuned over a broad range, either chemically or via the packing of the molecular building blocks. However, it is not easy to understand the dynamics of optically excited populations and the effect of nanomorphology. The present study performed in the group of Prof. Gerhard systematically explores the excited state dynamics by combining structural and time-resolved optical studies of molecular mixtures comprised of anthradithiophene and different concentrations of neutral spacer molecules. It is found that both the mesostructure, as well as temperature have a strong influence on competing singlet exciton fission and the formation of self-trapped excimers, both relevant kinetic processes for device applications. The study is a joint work of AG Gerhard and AG Schreiber (Tübingen). This work is published in the **Journal of Physical Chemistry C.**

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Events

Physics Colloquium
16 October, 3.30 pm
Big lecture hall, Renthof 5

Vincenzo Palermo, ISOF National Research Council of Italy, Bologna

Graphene History - from Lab Weirdo to Breakthrough in Industrial Innovation

Physics Colloquium
30 October, 3.30 pm
Big lecture hall, Renthof 5

Heidi Ottevaere, Vrije Universiteit Brussel

Environmental Sensing with Spectroscopy

Physics Colloquium
13 November, 3.30 pm
Big lecture hall, Renthof 5

Junsheng Chen, University of Copenhagen

Ultrabright Fluorescent Organic Nanoparticles via Molecular Self-Assembly: A Journey from Photophysics to Bioimaging Applications

Physics Colloquium
27 November, 3.30 pm
Big lecture hall, Renthof 5

Tobias Brixner, Universität Würzburg

Ultrafast Science from Sudoku to Many-Body Physics

New Colleagues

Katharina Brandl (Wirtschaftsverwaltung)

Since the beginning of June 2024, I have been working as an administrative assistant in the area of business administration and in the Cluster Project - The Adaptive Mind "TAM". My tasks range from personnel administration, especially student assistants, to procurement processes including equipment orders and third-party funding management, advising employees and HR managers on issues relating to the above-mentioned areas and working with the Dean's Office. Most recently, I worked for about seven years in financial accounting at the University of Marburg in the accounts payable and accounts receivable department. There I processed incoming invoices, credit notes and incoming payments. From 2013 to 2016, I trained as an office communications specialist at the University of Marburg. This was followed by further training as an administrative specialist from 2021 to 2023. Outside of the office, I enjoy reading, doing sports and spending time with friends and family.

Dr. Daniel Erkensten (AG Malic)

I am a postdoc in Prof. Ermin Malic's Ultrafast Quantum Dynamics Group. I am Swedish and did my PhD studies at Chalmers University of Technnology in Gothenburg focusing on modeling exciton-exciton interactions in atomically thin semiconductors. My current theoretical research concerns correlated phases such as Wigner crystals in 2D materials. During my time off I much enjoy reading, watching good movies, hiking or pub quizzing. I am happy to be in the beautiful Marburg!

Ali Reza Nazari Pour (AG Goldschmidt)

I have started my activity as a PhD student in Solar Energy Conversion Group led by Prof. Jan Christoph Goldschmidt since February 2024. I have graduated with a master’s degree in Electrical Engineering with a focus on Semiconductor devices from Iran University of Science and Technology in Tehran which partly was conducted at the Sharif University of Technology, in the field of Fabrication and Characterization of Perovskite Solar Cells. The focus of my PhD dissertation is on Fabrication and Characterization of Carbon-based Perovskite Solar Cells. This research aims to improve the efficiency and the stability of these devices.

Share your good news

Your newsletter team: Carina Hlawaty, Ermin Malic and Oliver Rehn

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

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