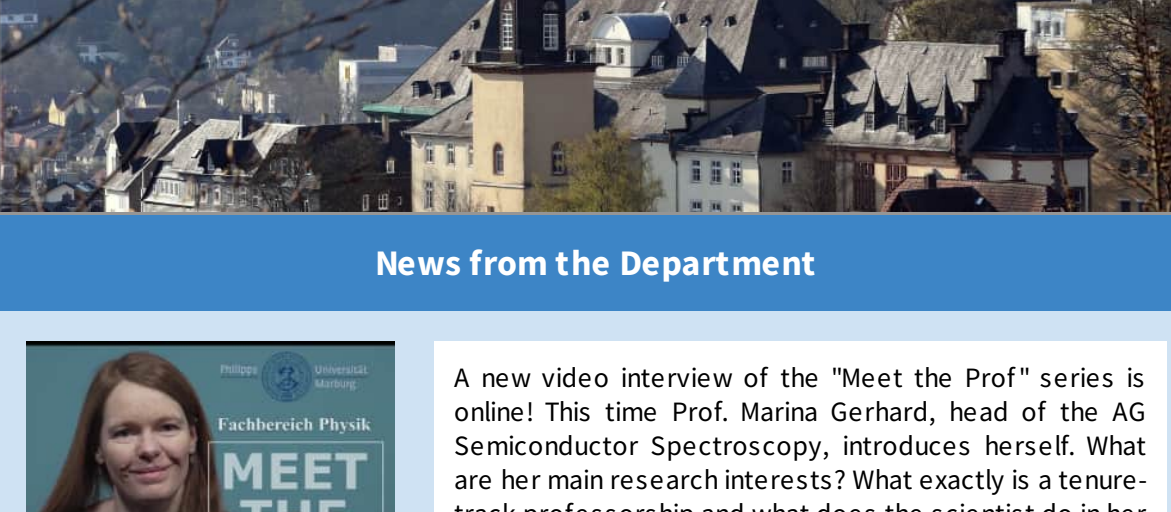


Newsletter Physics 05/24

Department News Research Highlights Events New colleagues



News from the Department



Meet the Prof with Marina Gerhard

A new video interview of the "Meet the Prof" series is online! This time Prof. Marina Gerhard, head of the AG Semiconductor Spectroscopy, introduces herself. What are her main research interests? What exactly is a tenure-track professorship and what does the scientist do in her free time? These and many other questions are answered in the video. If you don't want to miss anything, subscribe to the youtube channel of the department that has been created by the PR group. The interview was conducted by Sarah Zajusch with Oliver Rehn behind the camera.

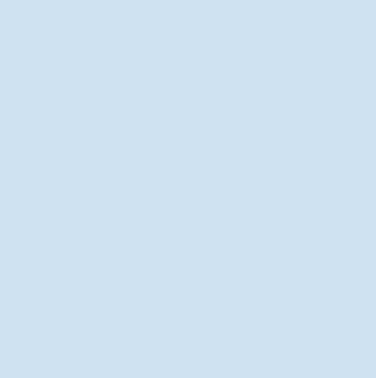
[Interview](#)



Interview with Carmen Schwee

We continue our series of interviews with key people in our department, this time with Carmen Schwee, our safety officer. Actually already retired, but not quite. She has now been at the department for 30 years and tells us how it came about and what the "yes-man" actually wanted to be. Read below the full interview (in German) that has been conducted by Sarah Zajusch from the PR team.

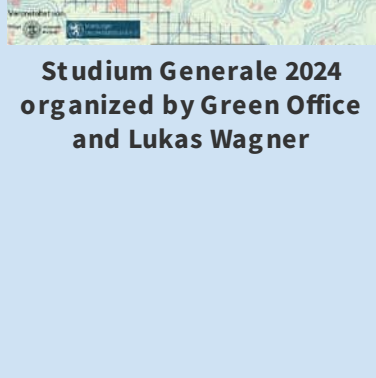
[Interview](#)



OTST-2024 Conference at Marburg Castle

The 10th Optical Terahertz Science and Technology conference (OTST-2024) was hosted by our department in April 2024. It gathered 197 scientists from around the world to discuss the most recent advances in the terahertz field. The conference was co-chaired by Martin Koch and Enrique Castro Camus and showcased the department, the University and the City of Marburg to the leaders of the international community in this field. The conference included a 1-day student workshop, and 4 days of oral and poster presentations. The opening ceremony and plenary took place at the Alte Aula and the conference banquet was served in the Fürstensaal in the Marburg Castle.

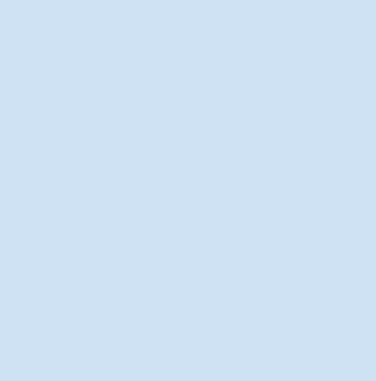
Die 10. Optical Terahertz Science and Technology Konferenz (OTST-2024) veranstaltet vom Fachbereich Physik im April 2024. Sie versammelte 197 Wissenschaftler aus der ganzen Welt, um die neuesten Fortschritte auf dem Gebiet der Terahertz-Technologie zu diskutieren. Die Konferenz wurde gemeinsam von Martin Koch und Enrique Castro Camus geleitet und präsentierte den Fachbereich, die Universität und die Stadt Marburg den führenden internationalen Wissenschaftlern auf diesem Gebiet. Die Konferenz umfasste einen eintägigen Workshop für Studierende und 4 Tage mit Vorträgen und Posterpräsentationen. Die Eröffnungszereimonie und die Plenarsitzung fanden in der Alten Aula statt, das Konferenzbankett wurde im Fürstensaal des Marburger Schlosses serviert.



Studium Generale 2024 organized by Green Office and Lukas Wagner

The Studium Generale of the University of Marburg is organized by the Department of Physics and the Green Office this semester. Every Wednesday, 18:00-20:00 c.t. at the university library, the university's central lecture series addresses the question "How do we want to live? In conversation with science and practice about shaping a more sustainable future". The event continues the tradition of the Marburg Sustainability Talks and is co-organized by Lukas Wagner (AG Goldschmidt).

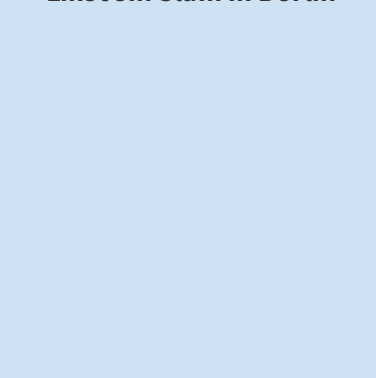
Das Studium Generale der Universität Marburg wird in diesem Semester vom Fachbereich Physik und dem Green Office organisiert. Jeden Mittwoch 18:00-20:00 Uhr c.t. in der Universitätsbibliothek widmet sich die zentrale Vorlesungsreihe der Universität der Frage "Wie wollen wir leben? Im Gespräch mit Wissenschaft und Praxis über die Gestaltung einer nachhaltigeren Zukunft". Die Veranstaltung setzt die Tradition der Marburg Sustainability Talks fort und wird mitorganisiert von Lukas Wagner (AG Goldschmidt).



Alexander Gerst and Prof. Ralph Ernstorf at the DFG spring meeting in Berlin

From March 17th to 22nd the spring meeting of the condensed matter section of the German Physical Society took place at the Technical University in Berlin. More than 6,000 physicists came together, making it the largest physics event in Europe. In addition to numerous specialist lectures and poster sessions in the various subdivisions, there were also several public plenary lectures, including from astronaut Alexander Gerst on space exploration and Robert Schlägl (President of the Alexander von Humboldt Foundation) on the energy transformation. The Physics Department of the Philipps University Marburg was represented by numerous talks and poster contributions from the research groups Gerhard, Höfer, Jakob, Malic, Volz and Witte.

Vom 17.–22. März fand die Frühjahrstagung der Sektion kondensierte Materie der Deutschen Physikalischen Gesellschaft an der Technischen Universität in Berlin statt. Dabei kamen mehr als 6.000 Physikerinnen und Physiker zusammen womit es die größte Fachveranstaltung in Europa ist. Neben zahlreichen Fachvorträgen und Postersitzungen in den verschiedenen Fachverbänden gab es auch mehrere öffentliche Plenarvorträge unter anderem vom Astronaut Alexander Gerst zur Erforschung des Weltraums oder Robert Schlägl (Präsident der Alexander-von-Humboldt-Stiftung) zur Energieumwandlung. Der Fachbereich Physik der Philipps-Universität Marburg war durch zahlreiche Vortrags- und Posterbeiträge der AGs Gerhard, Höfer, Jakob, Malic, Volz und Witte vertreten.



Einstein Slam in Berlin

The Einstein Slam has become a well-established and popular part of the DFG Spring Conference, which took place this year in Berlin. Five slammers from all over Germany competed for "the Golden Albert" with knowledge, wit and charm in the packed Audimax at TU Berlin. Among them: Sarah Zajusch from the AG Höfer with the title "The dark valley", which was about the formation of dark excitons. The slam was not only open to conference participants, but also to the general public. If you would like to see the slam (in German), you can drop by the KFZ Marburg on May 14 at 8 pm. Damien Heimes from the AG Volz will also be performing there. But beware: Tickets are always in high demand!

Der Einstein-Slam ist inzwischen ein fest etablierter und beliebter Programmpunkt der DFG Frühjahrstagung geworden, welche dieses Jahr in Berlin stattfand. Im vollbesetzten Audimax der TU Berlin konkurrierten fünf Slammers aus ganz Deutschland mit Wissen, Witz und Charme um den Goldenen Albert. Mit dabei Sarah Zajusch aus der AG Höfer mit dem Titel „The dark valley“, wo es um die Bildung von dunklen Exzitonen ging. Der Slam war nicht nur für die Teilnehmenden der Konferenz, sondern auch für die breite Öffentlichkeit zugänglich. Wer den Slam gerne einmal sehen würde, kann am 14. Mai um 20 Uhr im KFZ Marburg vorbeischauen. Dort wird unter anderem auch Damien Heimes aus der AG Volz auftreten. Aber Achtung: Die Tickets sind immer heiß begehrt!



YAS membership for Lukas Wagner (AG Goldschmidt)

Lukas Wagner has been awarded a three-year membership at the Young Academy for Sustainability Research (YAS) of the Freie Universität für Advanced Studies at the University of Friburg. The YAS seeks to foster cross-disciplinary cooperation between distinguished early-career postdoctoral researchers in the field of sustainability research.

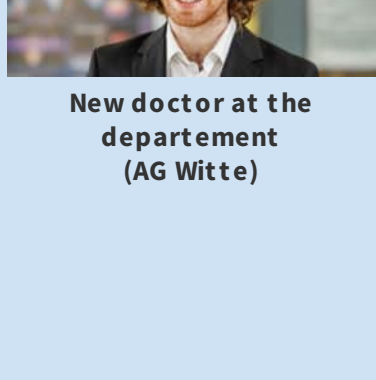
Lukas Wagner hat eine dreijährige Mitgliedschaft in der Young Academy for Sustainability Research (YAS) des Freieburg Institute for Advanced Studies an der Universität Fribourg erhalten. Die YAS soll die interdisziplinäre Zusammenarbeit zwischen herausragenden Postdoktoranden im Bereich der Nachhaltigkeitsforschung fördern.



New Humboldt fellow at the department (AG Malic)

Kabyashree Sonawal has received a scholarship from the Alexander von Humboldt foundation. She will start in October 2024 in the AG Malic Ultrafast Quantum Dynamics and will stay for two years as postdoc. Her topic is "Microscopic study of charge-transfer excitons in 2D lateral superlattices".

Kabyashree Sonawal erhält von der Alexander von Humboldt Stiftung ein Stipendium und wird ab Oktober 2024 für 2 Jahre in unserem Fachbereich arbeiten. In der AG Ultraschnelle Quantendynamik von Herrn Malic forscht sie als Postdok zum Thema "Microscopic study of charge-transfer excitons in 2D lateral superlattices".



New doctor at the department (AG Witte)

Maximilian Dreher successfully completed his PhD. in April 2024. In his dissertation, conducted in the Molecular Solids Group of Prof. Gregor Witte, he demonstrated how self-organizing molecular thin film structures can be controlled and even adjusted within the same material combination. By combining structural characterization techniques with computational methods, he could predict the epitaxial alignments as well as the morphologies of various weakly interacting Organic/TMD heterostructures. The identification of the relevant growth mechanisms further allowed him to adjust these structural properties by tuning simple growth parameters. His work leads to new insights into the self-organization processes within the class of van-der-Waals heterostructures.

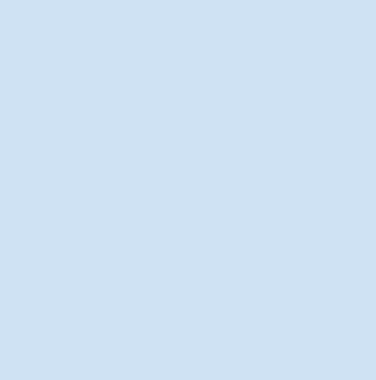
Maximilian Dreher hat im April 2024 seine Promotion erfolgreich abgeschlossen. In seiner Dissertation, die er in der AG Molekulare Festkörperphysik von Prof. Gregor Witte durchführte, zeigte er, wie sich selbstorganisierende molekulare Dünnschichten innerhalb der gleichen Materialkombination kontrollieren und sogar anpassen lassen. Durch die Kombination verschiedenster Analysetechniken mit theoretischen Methoden konnte er die epitaktischen Ausrichtungen sowie die Morphologien verschiedener schwach wechselwirkender Organik/TMD-Heterostrukturen vorhersagen. Die Identifizierung der relevanten Wachstumsmechanismen ermöglichte es ihm außerdem, diese strukturellen Eigenschaften gezielt anzupassen. Seine Arbeit führt zu neuen Erkenntnissen über die Selbstorganisationsprozesse innerhalb der Klasse der van-der-Waals-Heterostrukturen.



New doctor at the department (AG Malic)

Giuseppe Meneghini successfully completed his PhD. in April 2024. In his dissertation, performed in the Ultrafast Quantum Dynamics Group of Prof. Malic, he focused on studying exciton dynamics in atomically thin heterostructures. Using a microscopic and material specific theoretical model, he investigated the ultrafast phonon-mediated charge transfer dynamics in twisted TMD heterostructures. By including a twist angle dependence in the model, he investigated the effect of the moiré superlattice on exciton thermalization. Revealing the appearance of a relaxation bottleneck at low twist angles and temperatures, he could explain the experimentally observed unexpected bright-to-photoluminescence response of excited moiré states. His studies have contributed to a thorough microscopic understanding of exciton thermalization processes in van der Waals heterostructures.

Giuseppe Meneghini hat seine Promotion im April 2024 erfolgreich abgeschlossen. In seiner Dissertation, die in der AG Ultraschnelle Quantendynamik von Prof. Malic durchgeführt wurde, konzentrierte er sich auf die Untersuchung der Exzitondynamik in atomar dünnen Heterostrukturen. Unter Verwendung eines mikroskopischen und materialspezifischen theoretischen Modells untersuchte er die ultraschnelle phononvermittelte Ladungstransferdynamik in verdrehten TMD-Heterostrukturen. Durch die Einbeziehung einer Drehwinkelabhängigkeit in das Modell untersuchte er die Auswirkung des Moiré-Potentials auf die Thermalisierung von Exzitonen. Indem er das Auftreten eines Relaxations-Bottlenecks bei niedrigen Verdrehungswinkeln und Temperaturen aufdeckte, konnte er die experimentell beobachtete unerwartete hellere Photolumineszenz von angeregten Moiré-Zuständen erklären. Seine Studien haben zu einem tieferen mikroskopischen Verständnis der Exziton-Thermalisierungsprozesse in Van der Waals-Heterostrukturen beigetragen.



New doctor at the department (AG Malic)

Willy Knorr successfully completed his doctoral studies in March 2024. His dissertation, performed in the Ultrafast Quantum Dynamics Group of Prof. Malic, focused on exploring exciton transport within twisted Van der Waals heterostructures. Through his research, he identified distinct transport phenomena associated with varying twist angles. Additionally, he conducted an in-depth analysis of the impact of polaron effects on transport properties of moiré excitons.

Im März 2024 schloss Willy Knorr seine Promotion erfolgreich ab. In seiner Dissertation, die in der Gruppe Ultraschnelle Quantendynamik von Prof. Malic durchgeführt wurde, untersuchte er den Exziton-Transport in verdrehten Van-der-Waals-Heterostrukturen. Durch seine Forschung identifizierte er verschiedene Transport-Phänomene, die stark vom Twist-Winkel abhängen. Darüber hinaus untersuchte er die Auswirkungen von Polaron-Effekten auf die Transporteigenschaften von Moiré-Exzitonen.

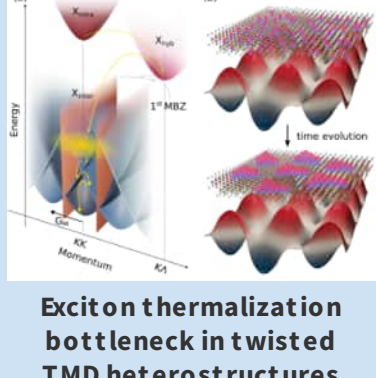
Research Highlights



Exciton thermalization bottleneck in twisted TMD heterostructures (AG Malic)

Twisted van der Waals heterostructures show intriguing interface exciton physics, including hybridization effects and emergence of moiré potentials. Recent experiments have revealed that moiré-trapped excitons exhibit remarkable dynamics, where excited states show lifetimes that are several orders of magnitude longer than in monolayers. The origin of this behavior is still under debate. Based on a microscopic many-particle approach, AG Malic investigated the phonon-driven relaxation cascade of nonequilibrium moiré excitons in the exemplary MoSe₂-WSe₂ heterostructure. Exciton relaxation pathways across different moiré mini-bands were tracked and the phonon-scattering channels assisting the spatial redistribution of excitons into low-energy pockets of the moiré potential were identified. We unravel a phonon bottleneck in the flat band structure at low twist angles preventing excitons from fully thermalizing into the lowest state, explaining the measured enhanced emission intensity and lifetime of excited moiré excitons. Overall, our work provides important insights into exciton relaxation dynamics in flat-band exciton materials. This work is published in **Nano Letters**.

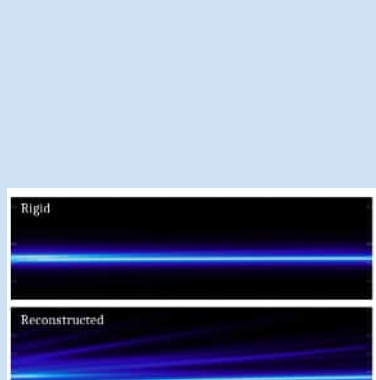
[read more](#)



Impact of atomic reconstruction on optics in twisted TMD homobilayers (AG Malic)

Twisted bilayers of transition metal dichalcogenides have revealed a rich "exciton" landscape including hybrid excitons and spatially trapped moiré excitons that dominate the optical response of the material. Recent studies have shown that in the low-twist-angle regime, the lattice undergoes a significant relaxation in order to minimize local stacking energies. Here, large domains of low energy stacking configurations emerge, deforming the crystal lattices via strain and consequently impacting the electronic band structure. However, so far the direct impact of atomic reconstruction on the exciton energy landscape and the optical properties has not been well understood. Here, AG Malic applied a microscopic and material-specific approach and predict a significant change in the potential depth for moiré excitons in a reconstructed lattice, with the most drastic change occurring in naturally stacked TMD homobilayers. We show the appearance of multiple flat bands and a significant change in the position of trapping sites compared to the rigid lattice. Most importantly, we predict that a multiplex structure emerging in optical absorption of WSe₂ homobilayers—in contrast to the single peak that dominates the rigid lattice—this finding can be exploited as an unambiguous signature of atomic reconstruction in optical spectra of moiré excitons in naturally stacked twisted homobilayers. This work is published in **Phys. Rev. Materials**.

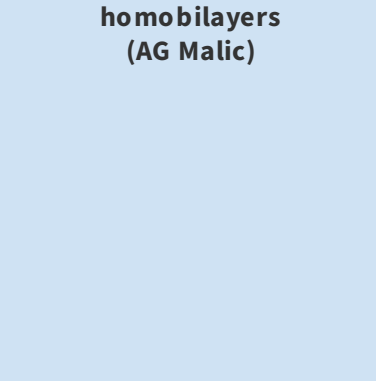
[read more](#)



Polaron-induced changes in moiré exciton propagation (AG Malic)

Twisted transition metal dichalcogenides present an intriguing platform for exploring excitons and their transport properties. By introducing a twist angle, a moiré superlattice forms, providing a spatially dependent exciton energy landscape. Based on a microscopic many-particle theory, AG Malic investigated polaron-induced changes in exciton transport properties in the MoSe₂/WSe₂ heterostructure. We demonstrate that polaron formation and the associated enhancement of moiré excitonic mass lead to a significant band flattening. As a result, the hopping rate and the propagation velocity undergo noticeable temperature and twist-angle dependent changes. The provided microscopic insights into the spatio-temporal exciton dynamics in presence of a moiré potential further deepens our understanding of the intriguing moiré exciton physics. This work is published in **Nanoscale**.

[read more](#)



Optical signatures of moiré trapped bixcitons (AG Malic)

Atomically thin heterostructures formed by twisted transition metal dichalcogenides can be used to create periodic moiré patterns. The emerging moiré potential can trap interlayer excitons into arrays of strongly interacting bosons, which form a unique platform to study strongly correlated many-body states. In order to create and manipulate these exotic phases of matter, a microscopic understanding of exciton-exciton interactions and their manifestation in these systems becomes indispensable. Recent density-dependent PL measurements have revealed novel spectral features indicating the formation of trapped multi-exciton states providing important information about the interaction strength. In this work, AG Malic developed a microscopic theory to model the PL spectrum of trapped multi-exciton complexes focusing on the emission from moiré trapped single- and bixcitons. Based on an excitonic Hamiltonian we determine the properties of trapped bixcitons as function of twist angle and use these insights to predict the luminescence spectrum of moiré excitons for different densities. We demonstrate how side peaks resulting from transitions to excited states and a life time analysis can be utilized as indicators for moiré trapped bixcitons and provide crucial information about the excitonic interaction strength. This work is published in **2D Materials**.

[read more](#)

Events

Physics Colloquium
8 May, 3:30pm
Big lecture hall, Renthof 5

Ian Marius Peters, Helmholtz-Institut Erlangen Nürnberg
High-Throughput Analysis of PV Installations

Physics Colloquium
15 May, 3:30pm
Big lecture hall, Renthof 5

Roberto Rosati, Philipps-Universität Marburg
Exciton Transport in Atomically Thin Semiconductors (Habilitationsskizzen)

Physics Colloquium
22 May, 3:30pm
Big lecture hall, Renthof 5

Thomas Hannappel, TU Ilmenau
Integration of Semiconductor Tandem Structures

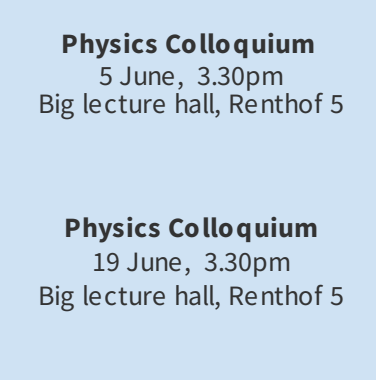
Physics Colloquium
5 June, 3:30pm
Big lecture hall, Renthof 5

John Lupton, Universität Regensburg
OLEDs - a Model for Avian Magnetoreception?

Physics Colloquium
19 June, 3:30pm
Big lecture hall, Renthof 5

Matthias Hirtzsch, d-fine Consulting
Physics Meets Consulting: Blockchain in the Financial Industry

New Colleagues



Dr. Uta Hamers Fachbereichsreferentin

Since the beginning of April 2024, I have been working as a departmental officer in the Dean's Office of the Department of Physics. My tasks range from financial management and supporting the Dean of Studies to being the contact person and safety officer. From today, I worked for almost four years in the Dean's Office of the Department of Physics at Goethe University Frankfurt. As deputy to the managing director of the Dean's Office, I was involved in all processes there. I studied agricultural sciences, then did my doctorate in the field of promoter studies and was a postdoc at LMU Munich for several years. I live with my family in Gießen.



Dr. Maha Habibi (AG Bremner)

I recently started a postdoc position in the Neurophysiology Group led by Prof. Frank Bremner. I began my academic journey by earning a Bachelor of Computer Science at the University of Bojnord, followed by a Master of Computer Science from the University of Shahid Rajayee in Tehran, Iran. My master's project in Computational Neuroscience, which partly was conducted at the Institute for Research in Fundamental Sciences (IPM) in Tehran, was instrumental in shaping my journey into the field of neuroscience. I received my PhD at the University of Marburg in the framework of the Brain-HE-Brain connection, under the supervision of Prof. Wolfgang Oertel (former director of the neurological hospital of UKMG) and Doug Mowz, Queens University, Canada. Here, I was focusing on eye movements in neurodegenerative diseases, aiming to identify biomarkers. Afterward, I continued in Prof. Oertel's lab as a Postdoc, aiming to identify progression and diagnostic markers and to develop a disease classifier. Moreover, I continued my collaboration with the lab of Prof. Munoz in Kingston, Canada, where I spent nine months as a visiting researcher. In my PostDoc work with Prof. Bremner in the framework of the Brain-HE-Brain connection project Oculobuffs, I am developing an AI-based method to classify eye movements - and sub-components thereof - during everyday activities. This research aims to establish a new description of eye movements and new biomarkers for healthy aging and to improve our understanding of neurological and psychiatric diseases. Outside of the lab, I enjoy reading, sports, and traveling, and I am happy to be in the beautiful Marburg.

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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