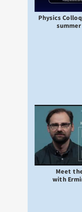
Newsletter Physics 03/24

News from the Department

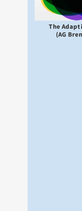


Physics Colloquium in the summer term

The program for the physics colloquium in the next summer term is fixed! The talks will have a general character and will be given by leading representatives in research and industry. 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 kommenden Sommersemester steht fest! Die Vorträge haben einen allgemeinen Charakter und werden von führenden Vertretern aus Forschung und Industrie gehalten. Das Kolloquium findet jeweils mittwochs von 15.30-16.30 Uhr im großen Hörsaal im Renthof 5 statt. Im Anschluss an das Kolloquium bieten wir bei Kaffee und Kuchen die Möglichkeit an, unsere Vortragenden kennen zu lernen. Die Studierenden haben wieder die Möglichkeit, Leistungspunkte für eine Schlüsselqualifikation zu erwerben.

Poster



Meet the Prof with Ermin Malic

The PR group continues the serie of video interviews "meet-the-prof" mit Professoren unseres Fachbereichs fort. Die Idee ist, neuen (und älteren) Studierenden die Möglichkeit zu geben, die Professoren aus einer anderen Perspektive kennenzulernen. Diesmal wurde Prof. Ermin Malic interviewt, der seit drei Jahren am Fachbereich ist und die AG Ultrafast Quantum Dynamics leitet. Das Interview wurde von Sarah Zajusch geführt mit Unterstützung von Oliver Rehn.

Interview

The Adaptive Mind (AG Bremmer)

The German Research Foundation (DFG) has announced the results of the evaluation of the draft proposals for a Cluster of Excellence in the framework of the German Excellence Strategy. From 143 submitted draft proposals, 41 were invited to submit a full proposal. Among these 41 was the consortium The Adaptive Mind – TAM. Applicant universities of TAM are Justus-Liebig-University Giessen, Philipps-Universität Marburg, and Technische Universität Darmstadt. Further participating institutions are Goethe-Universität Frankfurt and the Frankfurt Institute of Advanced Studies. The consortium brings together researchers from Psychology, Medicine, Physics and Artificial Intelligence to understand how the human mind successfully adapts to changing conditions, and what happens when these adaptive processes fail. Designated directors are Roland Fleming and Katja Fiehler (JLU), Frank Bremmer (UMR) and Constantin Rothkopf (TUD), who are currently also the speakers of the predecessor cluster project TAM, funded by the state ministry HMWK.

Die Deutsche Forschungsgemeinschaft (DFG) die Ergebnisse der Begutachtung der Antragsskizzen für einen Exzellenzcluster im Rahmen der deutschen Exzellenzstrategie bekannt gegeben. Von 143 eingereichten Antragsskizzen wurden 41 aufgefordert, einen Vollantrag zu stellen. Unter diesen 41 war auch das Konsortium The Adaptive Mind - TAM. Antragsteller Universitäten von TAM sind die Justus-Liebig-Universität Gießen, die Philipps-Universität Marburg und die Technische Universität Darmstadt. Weitere beteiligte Institutionen sind die Goethe-Universität Frankfurt und das Frankfurt Institute of Advanced Studies. Das Konsortium bringt Forscher aus Psychologie, Medizin, Physik und Künstlicher Intelligenz zusammen, um zu verstehen, wie sich der menschliche Geist erfolgreich an veränderte Bedingungen anpasst und was passiert, wenn diese Anpassungsprozesse versagen. Designierte Direktoren sind Roland Fleming und Katja Fiehler (JLU), Frank Bremmer (UMR) und Constantin Rothkopf (TUD), die derzeit auch die Sprecher des vom HMWK geförderten Vorgängerclusterprojekts TAM sind.

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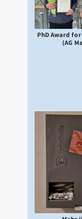

DFG grant on trions (AG Malic)

Atomically-thin layers of transition-metal dichalcogenides emerged as an excellent platform to study interacting electronic many-particle states. A particularly interesting scenario, relevant from both fundamental physics and applications perspectives, it the simultaneous presence of bound electron-hole complexes, known as excitons, and free charge carriers. The properties of these composite bosons in Fermi mixtures are a topic of intense research in these systems due to their strong impact on the optical response. However, while the physics of the resulting trion and Fermi polaron complexes are well understood in the static limit, little is known about the propagation dynamics of these states, with respect to both linear and non-linear phenomena. This is the topic of the DFG project "Propagation dynamics of exciton-electron complexes in atomically-thin semiconductors" by Ermin Malic in collaboration with Alexey Chernikov (TU Dresden). The grant has been approved by the DFG, it runs over 3 years and will be carried out by two PhD students.

Atomdünne Schichten von Übergangsmetall-Dichalkogeniden haben sich als eine hervorragende Plattform zur Untersuchung wechselwirkender elektronischer Vielteilchenzustände erwiesen. Ein besonders interessantes Szenario, das sowohl für die Grundlagenphysik als auch für technologische Anwendungen von Bedeutung ist, ist das gleichzeitige Vorhandensein von gebundenen Elektron-Loch-Komplexen, so genannten Exzitonen, und freien Ladungsträgern. Die Eigenschaften dieser zusammengesetzten Bose-Fermi-Mischungen sind wegen ihres starken Einflusses auf das optische Verhalten ein Thema intensiver Forschung in diesen Systemen. Während jedoch die Physik der resultierenden Trion- und Fermi-Polaron-Komplexen im statischen Bereich gut verstanden ist, ist über die Ausbreitungsdynamik dieser Zustände sowohl im Hinblick auf lineare als auch nichtlineare Phänomene wenig bekannt. Dies ist das Thema des DFG-Projekts "Ausbreitungsdynamik von Exziton-Elektron-Komplexen in atomar dünnen Halbleitern" von Ermin Malic in Zusammenarbeit mit Alexey Chernikov (TU Dresden). Das Projekt wurde von der DFG bewilligt, läuft über 3 Jahre und wird von zwei Doktoranden durchgeführt.

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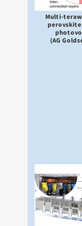

PhD Award for Raul Cauvin (AG Malic)

We congratulate Raul Perea-Causin, PhD student from the Ultrafast Quantum Dynamics group, for obtaining the Best Thesis Award from the Department of Physics at the Chalmers University of Technology. He was awarded for his doctoral thesis entitled "Microscopic Theory of Charge Complexes in Atomically-Thin Materials".

Wir gratulieren Raul Perea-Causin, Doktorand in der AG Ultraschnelle Quantendynamik, zum Preis für die beste Dissertation des Fachbereichs Physik an der Chalmers University of Technology. Er wurde für seine Doktorarbeit mit dem Titel "Microscopic Theory of Charge Complexes in Atomically-Thin Materials" ausgezeichnet.

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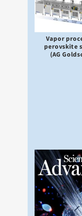

Mehr (für) Physikstudentinnen

The project "more (for) female physics students" managed to get us our very own "Period-dispenser" at the department! You can find it in RHL in the small room between the bathrooms underneath the lecture hall. Please feel free to take a tampon or a pad if you need one, the products are free of charge. Financing and procurement are carried out by the Equal Opportunities Office as part of the project "PERIOD." The project's main goals are making menstruation visible as a topic and contribute to its social normalization and "de-tabooization" as well as supporting those who cannot afford or have no access to those products.

Das „Mehr (für) Physikstudentinnen" Projekt beschaffte dem Fachbereich einen eigenen Period-Spender! Dieser hängt seit November im RHL in dem Zwischenraum von den Toiletten unter dem Hörsaal. In Notfällen könnt ihr euch hier kostenfrei an Binden und Tampons bedienen. Beschafft und finanziert wird der Spender, im Rahmen des „PERIOD." Projekts, vom Gleichstellungsbüro. Ziel dieses Projekts ist die Enttabuisierung der Menstruation, aber auch das Unterstützen derer, die aus finanziellen oder privaten Gründen einen erschwerten Zugang zu diesen Produkten haben.

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Research Highlights

Multi-terawatt scale perovskite tandem photovoltaics (AG Goldschmidt)

Cost efficient climate change mitigation mandates the rapid expansion of photovoltaic (PV) module production to multi-TW scale. Such an expansion requires enormous material- and energy-streams. Perovskite-based tandem solar cells are widely regarded to help solving these issues as they promise higher efficiencies and overall lower materials demands. The Solar Energy Conversion Group investigated the resource demand of the emerging tandem PV technology, considering two factors of supply criticality, namely mining capacity for minerals, as well as production capacity for synthetic materials. Severe supply risks were identified for a range of materials that are widely used in high-performing perovskite PV devices: Cesium used in perovskite alloys, indium employed in transparent electrodes, gold used in back-electrodes, as well as most organic contact layers. These results can be regarded as wake-up call for the perovskite PV research community to re-assess current research directions and align them with long-term sustainability considerations. As promising alternative exists, the expansion of perovskite PV to a multi-terawatt scale may not be limited by material supply. The work was published in **Joule**.

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Vapor processing of perovskite solar cells (AG Goldschmidt)

Vapour deposition of the perovskite absorber instead of the widely used wet-chemical processing could have decisive advantages for upscaling the industrial production of perovskite solar cells. Advantages would be high reproducibility and the absence of solvents, as well as experience from the processing of other thin-film photovoltaic technologies. In contrast, research is carried out almost exclusively on the basis of wet-chemical processes, as these are easier to realise - particularly in a university context. Hence, it is important to broaden the focus of research. Accordingly, the working group has now also initiated the acquisition of a vapour deposition system that is suitable for perovskite deposition. This was the conclusion reached by researchers from the Physics of Solar Energy Conversion working group as part of an international collaboration, the results of which have now been published in **Energy & Environmental Science**.

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Probing electron-hole Coulomb correlations in twisted TMD bilayers (AG Malic)

Excitons are two-particle correlated bound states that are formed due to Coulomb interaction between single-particle holes and electrons. In the solid-state, cooperative interactions with surrounding quasiparticles can strongly tailor the exciton properties and potentially even create new correlated states of matter. It is thus highly desirable to access such cooperative and correlated exciton behavior on a fundamental level. In this joint experiment-theory study involving the experimental group of Stefan Mathias (Göttingen) and AG Malic, we find that the ultrafast transfer of an excited-state hole across a type-II band-aligned moiré heterostructure leads to a surprising sub-200-fs upshift of the single-particle energy of the electron being photoemitted from the two-particle exciton ground state. While energy relaxation usually leads to an energetic downshift of the spectroscopic signature, we show that this unusual upshift is a clear fingerprint of the correlated interactions of the electron and hole parts of the exciton quasiparticle. In this way, time-resolved photoelectron spectroscopy is straightforwardly established as a powerful method to access exciton correlations and cooperative behavior in two-dimensional quantum materials. Our work highlights this new capability and motivates the future study of optically inaccessible correlated excitonic and electronic states in moiré heterostructures. This work is published in **Science Advances** and was selected for the **cover of the journal.**

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Share your good news

Your newsletter team: Carina Hawaty and Ermin Malic

Send us an e-mail with a short text and a nice foto to news1fb13@physik.uni-marburg.de

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