Newsletter Physics 03/22

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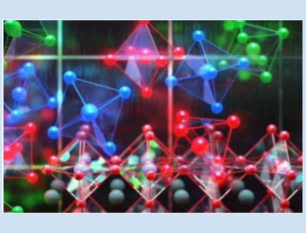
News from the Department

Department Poster

The PR group has created a department poster! The aim of the poster is to display the advantages of studying physics in Marburg and this way attract more students to our department. The poster will be placed on camera obscura close-by the castle.

The PR group consisting of Josefine Neuhaus, Samuel Brem, Eike Pohlenz and Ermin Malic has the goal to increase the visibility of the Physics Department to the public, to other research institutions and in particular to school students. The poster was designed with a great commitment of Samuel Brem.

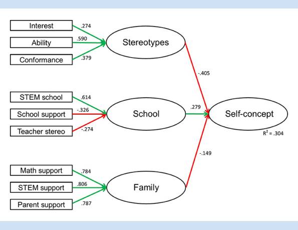
poster



Digital School Event

The PR group is organising a digital school event on 14/15 March. The focus lies on presenting the broad spectrum of cutting-edge research performed in our Department. For this event, we have included neurophysics (Frank Bremmer), microplastics (Marina Gerhard), solar cells (Jan-Christoph Goldschmidt), organic electronics (Gregor Witte), and nanophysics (Ermin Malic). So far, eleven schools in Marburg and surroundings plan to attend the event. If you are interested in learning more about the research performed in our Department, write an email to: pr-physics@physik.uni-marburg.de and we will provide you with login details. The event will be held in German.

program

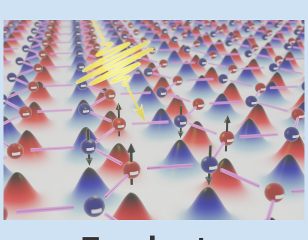


Gender project "More (for) female physics students"

Have you already heard of "More (for) female physics students"? This new programme wants to raise the awareness of gender equality in our Department. Together, we want to support and enlarge the number of female students in physics. The project includes events for networking and a higher visibility of women in physics, as well as smaller get together's, funding and workshops for lecturers to raise the Department's awareness of gender equality and diversity in teaching. In March, we will start with an online party exclusively for all female Bachelor and Master students as well as teachers.
If you are studying physics as a Bachelor's student and would like to work for more equal rights and for female students in your discipline, please get in touch with us (stefanie.wittich@ or jana.iljenkarevic@verwaltung.uni-marburg.de). We look forward hearing from you!

read more

Research Highlights



Terahertz Fingerprint of Wigner Crystals (AG Malic)

The strong Coulomb interaction in monolayer semiconductors represents a unique opportunity for the realization of Wigner crystals without external magnetic fields. In this work, Samuel Brem and Ermin Malic predict that the formation of monolayer Wigner crystals can be detected by their terahertz response spectrum, which exhibits a characteristic sequence of internal optical transitions. We apply the density matrix formalism to derive the internal quantum structure and the optical conductivity of the Wigner crystal and to microscopically analyze the multi-peak shape of the obtained terahertz spectrum. Moreover, we predict a characteristic shift of the peak position as function of charge density for different atomically thin materials and show how our results can be generalized to other 2D systems. The work was published in **Nano Letters**.

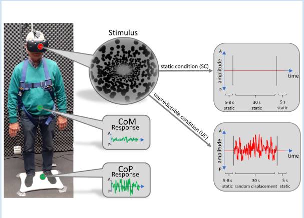
paper

press release

Reliability of power measurements in the terahertz band (AG Koch)

While terahertz technology has experienced enormous progress over the last three decades, this technology is comparatively immature with respect to its spectral neighbors, the microwaves and the infrared. In order for terahertz devices to reach technological maturity, robust characterization methods and reliable metrics for comparison between studies must be defined. In this comment, authored by members of AG Koch in collaboration with metrologists from PTB we describe the challenges faced in obtaining robust power measurements in the terahertz regime, and summarize recent efforts to establish standards for this field.
The work was published in **Communication Physics**.

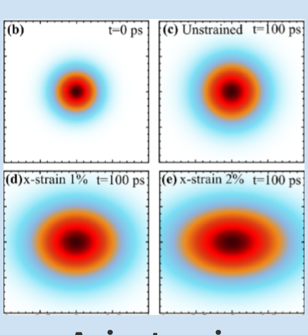
paper



Parkinson's disease and the effect of age (AG Bremmer)

In a collaboration with the neurological hospital of the UKGM Justus Student (Neurology) and David Engel (AG Bremmer), we found that specific aspects of balance impairments associated with Parkinson's disease seem to be an effect of natural aging, rather than the disease itself. Using a recently established portable setup, participants wore a virtual reality headset and were simulated to be standing in a tunnel, which then moved back and forth unpredictably. Participants' foot center of pressure (COP) and their entire body motion were tracked with a force plate and a video-based motion tracking system, respectively. From the full-body motion data, the trajectory of participants' center of mass was derived. Three groups were tested: A cohort of Parkinson patients, an age-matched control group, and a group of young healthy adults. COP trajectories revealed that the patients and age-matched controls alike – in contrast to the young - needed an increased effort to achieve this task, reflected in their significantly higher COP velocity. These results suggest COP velocity to be a useful quantitative measure to objectify clinical findings of balance control. The work was published in the
Journal of Neurophysiology.

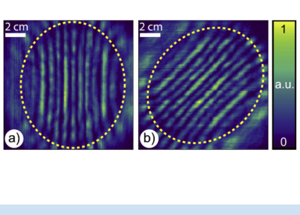
paper



Anisotropic diffusion in atomically thin semiconductors (AG Malic)

The energy transport in technologically promising transition metal dichalcogenides is determined by exciton diffusion, which strongly depends on the underlying excitonic and phononic dispersion. Based on a fully microscopic theory, AG Malic demonstrated that the valley-exchange interaction leads to an enhanced exciton diffusion due to the emergence of a linear excitonic dispersion and the resulting decreased exciton-phonon scattering. Interestingly, we find that the application of an uniaxial strain can drastically boost the diffusion speed and even give rise to a pronounced anisotropic diffusion, which persists up to room temperature. We reveal that this behaviour originates from the highly anisotropic exciton dispersion in presence of strain, displaying parabolic and linear behaviour perpendicular and parallel to the strain direction, respectively. Our work demonstrates the possibility to control the speed and direction of exciton diffusion via strain and dielectric engineering.
The work was published in **2D Materials**.

paper



Terahertz referenceless wavefront sensing (AG Koch)

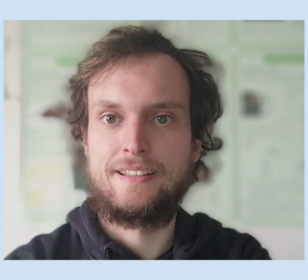
The most powerful technique available to access the terahertz band is known as time-domain spectroscopy. Such technique differs fundamentally from the traditional UV-vis-IR spectroscopies, since it is based on sensing the time-resolved waveform of the electric field, which provides access to both the amplitude and the phase of the electromagnetic wave. However, terahertz time-domain spectroscopy is a relatively expensive technique, since it requires the use of ultrafast lasers, and it is complicated to implement. In this article a collaboration between AG Koch and the Bremer Institut für angewandte Strahltechnik (BIAS) demonstrate the first referenceless measurement of a THz wavefront by means of shear-interferometry in combination with a gradient-based iterative algorithm to reconstruct the wavefront from a set of shear interferograms. This result is the first step towards wavefield sensing in the terahertz band without using a reference wave.
The work was published in **Optica**.

paper

New Colleagues

Prof. Dr. Alexey Nenashev (Guest professor)

We welcome Prof. Dr. Alexey Nenashev as our guest professor, who joined the Many Particle Physics group of Florian Gebhard and Reinhard Noack. He will stay for the whole year 2022. Currently, Alexey Nenashev has a joint position as a senior researcher at the Institute of Semiconductor Physics of the Russian Academy of Sciences in Novosibirsk and as an associate professor at the Novosibirsk State University. His research interests focus on semiconductor physics, particularly on the opto-electronic properties of disordered organic and inorganic materials. Over the past decade, Alexey Nenashev visited our Department several times. The results of his fruitful collaboration with theoretical and experimental research groups in Marburg are documented in 28 joint publications in highly ranked scientific journals, such as Nature Communications. On Alexey Nenashev's agenda for 2022 are the continuing development of versatile theories for charge distributions and electric-field dependent hopping transport in disordered media, and the compilation of a review article on the subject. As in his previous visits, he will be happy to discuss physics with the colleagues in Marburg!



Tobias Hofman, PhD student (AG Koch)

I am about to finish my master thesis in the group of Prof. Stöckmann and started working as a Ph.D. student for the semiconductor photonics group of Prof. Martin Koch. I am interested in microwave physics and will work on the detection of dissolved organic carbon and microwave-related topics in various projects. Besides work, I love spending time with my family and am involved in local politics.

Share your good news

Your newsletter team: Carina Hlawaty, Maya Strobel, 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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