Universität Münster

Allgemeines Physikalisches Kolloquium

Donnerstag, 29.10.26 – 16 Uhr c.t.

IG1 – HS 2 | Wilhelm-Klemm-Str. 10

Kolloquiums-Kaffee ab 16 Uhr vor dem Hörsaal

Antrittsvorlesungen

PD Dr. Jörg Imbrock

Institut für Angewandte Physik, Universität Münster

Light-Structured Photonics: From Nonlinear Beam Shaping to Optofluidics



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PD Dr. Daniel Laumann

Institut für Didaktik der Physik / Physikalisches Institut, Universität Münster

Interest and instruction: Two sides of learning physics



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Apl. Prof. Dr. Harry Mönig

Physikalisches Institut, Universität Münster

Dynamic Force Microscopy with Atomically Defined Probe Tips



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wissen.leben

Fachbereich Physik

Universität Münster

Allgemeines Physikalisches Kolloquium

Light-Structured Photonics: From Nonlinear Beam Shaping to Optofluidics

PD Dr. Jörg Imbrock, Institut für Angewandte Physik

How can light be used to structure matter, and how can these structures, in turn, control light and microscopic objects? These questions provide a starting point for exploring the physical principles of light-induced material structuring and their applications in nonlinear optics and optoelectronics.

Ferroelectric crystals, particularly lithium niobate, provide a versatile platform for studying these interactions due to their nonlinear optical, pyroelectric, and photovoltaic properties. Starting from the fundamentals of second-harmonic generation, we will explore how spatial modulation of the second-order nonlinear susceptibility enables quasi-phase matching and the shaping of newly generated optical fields. Different approaches to modifying the quadratic nonlinearity will be introduced, including femtosecond laser writing and light-assisted ferroelectric domain inversion, while second-harmonic generation microscopy provides a means to visualize the resulting structures.

Beyond nonlinear optics, light-induced photovoltaic charge distributions can generate spatially structured electric fields that act as virtual electrodes. These fields enable the controlled manipulation of particles and liquid droplets, opening possibilities for optofluidic applications.

Together, these examples illustrate how light can be used to engineer nonlinear optical structures and spatially controlled electric fields, enabling the manipulation of both optical waves and microscopic objects. The interplay between optical, electrical, and ferroelectric properties provides a common framework connecting nonlinear photonics with optoelectronic applications.

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Interest and instruction: Two sides of learning physics

PD Dr. Daniel Laumann, Institut für Didaktik der Physik / Physikalisches Institut

Imagine two students encountering the same physics topic. One is fascinated and keeps asking questions, the other sees little point. Now imagine the topic is taught in two different ways: as a carefully designed animation with narration, or as a real experiment supplemented by digital visualizations. The same two students may react very differently to each version. Teaching physics pursues two goals at once: Building subject-specific competencies and fostering interest in physics. The latter is a goal in its own right, but also a prerequisite for the former, since interested learners engage more deeply and persistently. Both goals depend on who is learning and on how instruction is designed.

Who is interested in physics, and why? Drawing on Krapp's person – object theory of interest, I will show that research has focused almost exclusively on gender, although interventions aimed at girls have shown only modest success. I will present studies on the importance of systemizing thinking and further personal characteristics as predictors of students' interest.

Interest alone does not produce knowledge, however. The second perspective therefore turns to the design of (digital) media, grounded in the cognitive theory of multimedia learning. Its principles were established mainly for seeing and hearing, although other modalities are central to physics. I will show how we extended the theory, tested whether its principles hold beyond these two channels, and why complexity turns out to be a decisive boundary condition.

This suggests a broader lesson: To understand and promote learning in physics, we need to look beyond simple group differences, at the individual learner and the learning environment alike.

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Dynamic Force Microscopy with Atomically Defined Probe Tips

PD. Dr. Harry Mönig, Physikalisches Institut

The implementation of atomically defined probe tips in non-contact atomic force microscopy (nc-AFM) not only provides increased resolution and reproducibility, but also enables precise control over chemical interactions. In conjunction with ultra-sensitive qPlus force sensors, this allows imaging organic nano-structures with sub-molecular resolution, which has led to a new era in surface chemistry. Highlighting their potential for elemental and chemical discrimination, presented examples include the use of oxygen-terminated copper tips in imaging the sublattices and defect structures of heterogeneous surfaces.

Beyond imaging, the atomic-scale control of probe tips allows for tailored force spectroscopy and tip manipulation experiments with picometer and piconewton resolution. Controlling nc-AFM probe tips on an atomic level constitutes a powerful opportunity to standardize such experiments, which greatly improves the fundamental understanding of surfaces and interfaces toward applications ranging from heterogeneous catalysis to electronics, and energy conversion where the local atomic structure largely determines the performance of the material systems and devices.