Eröffnungsvortrag

Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Robert Feidenhans‘l

European XFEL, Managing Director

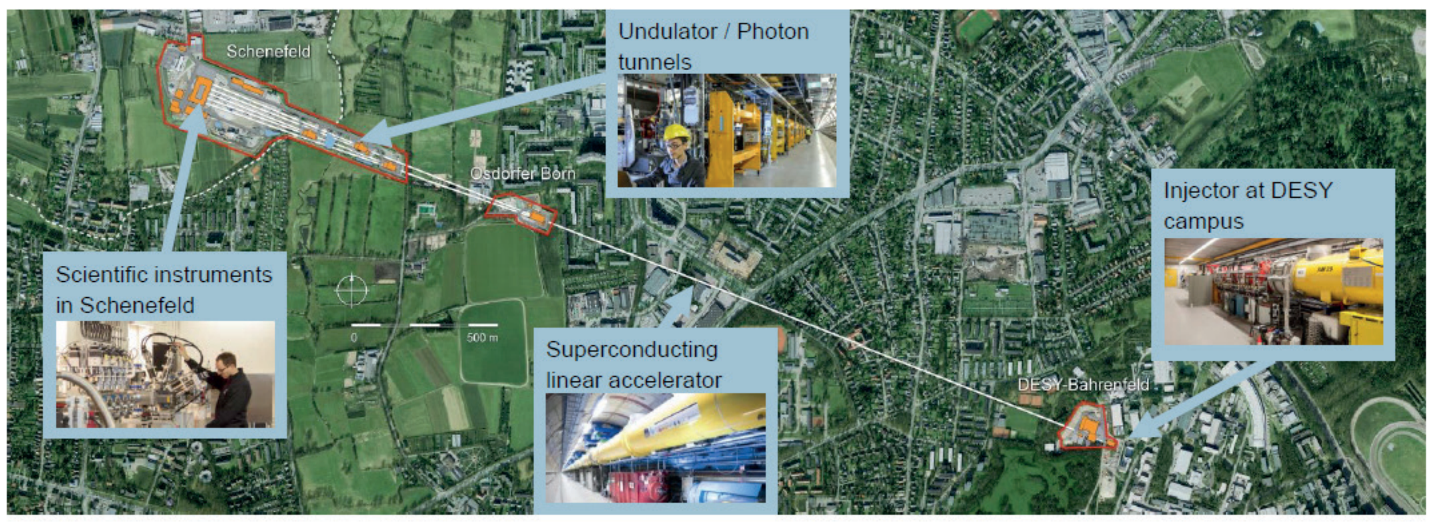
09.04.2019

16^{45} Uhr / HS III

A New Facility for Fundamental Science

Hard X-ray Free Electron (XFEL) lasers provide extremely and intense and ultra-short X-ray pulses that are ideal to investigate structural and dynamics of matter at very short time scales. X-ray free electron lasers have been in operation for 10 years now and have had wide range of areas of applications in physics, chemistry, materials and structural biology.

European XFEL is the most recent large scale research infra structure in Europe and was taken into user operation in September 2017. It is a hard X-ray free electron laser and provides a very powerful X-ray beam for research. European XFEL is an intergovernmental organization with 12 member states and is a facility that serves the European user community by providing the possibility for performing new classes of experiments to investigate the structure and dynamics of matter on the atomic length and time scales. The facility encompasses a 3.5 km long tunnel from DESY in Hamburg/Bahrenfeld to Schenefeld in Schleswig-Holstein where the experimental hall is placed. The tunnel encloses a 2 km long superconducting accelerator operated by DESY and undulator radiation sources. The first two experimental stations have been in operation doing user experiments for about one and a half years, one of them the SPB/SFX instruments for structural biology. Two more experimental stations were taken into operation end of last year. In total six instrumental stations will be in user operation by mid-2019. In the talk the basic principles of European X-FEL will be discussed and results of some of the first experiments will be shown.



Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Greg Boebinger
Florida State University

30.04.2019
16^{45} Uhr / HS III

Exploring the heart of Quantum Matter with extreme magnetic fields

In "Quantum Matter" intrinsic electronic charges and spins conspire in strange and weird ways to create new materials properties. High magnetic fields are uniquely positioned to probe the mysteries that remain at the heart of Quantum Matter, where Nature creates 1/3 fractional electric charges, "spin liquids" of fixed charges but mobile spins, and high-temperature superconductivity in which even the existence of electrons as particles becomes uncertain.

Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Ulrich Schwarz

Institute for Theoretical Physics,
Heidelberg University

21.05.2019

16[45] Uhr / HS III

Active Cell Mechanics

Biological cells use non-equilibrium processes to actively generate forces, movement and growth. Some of these processes can be reconstituted in biomimetic experiments with active soft matter, nurturing the vision of a synthetic cell built from the bottom-up. In this talk, I will first discuss how and why contractile forces are generated by cells, and how they can be measured. I will also explain how cell forces sometimes can be inferred from a model-based shape analysis, thus rendering a direct measurement unnecessary. For many situations of interest, we find that continuum mechanics can describe well the mechanical properties of cells and cell monolayers, if extended by an active tension in the force balance. We finally discuss how elasticity can emerge on cellular scales despite the fact that the underlying molecular processes are highly dynamic.

Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Ruslan Temirov

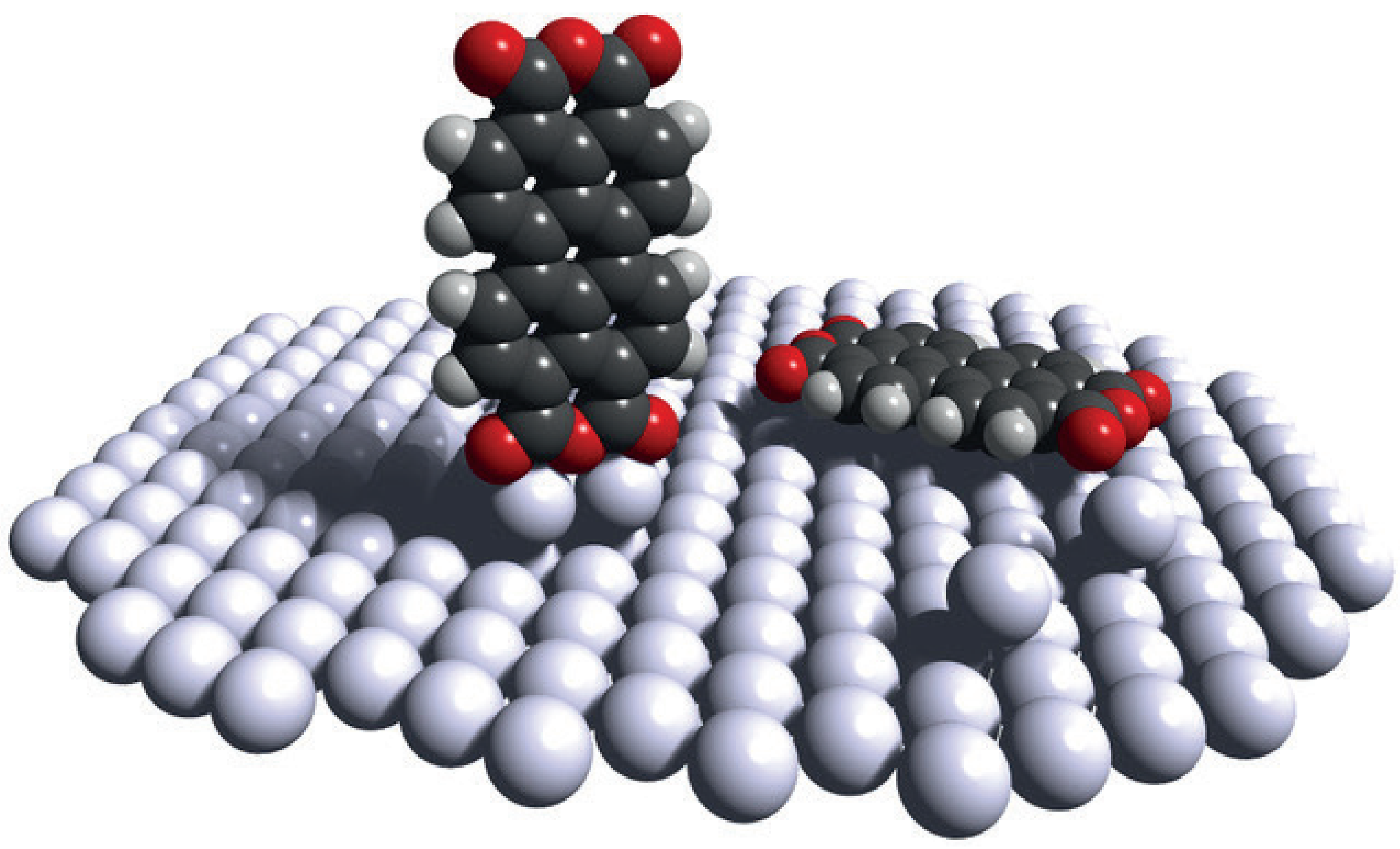
Peter Grünberg Institute 3, Forschungszentrum Jülich and Institute of Physics II, University of Cologne

04.06.2019

16^{45} Uhr / HS III

Practicing quantum nanoscience with a scanning probe microscope

Interest in quantum technology is rising swiftly. When implemented in computing it may fundamentally change the way we store and process information. What makes quantum phenomena so interesting and why are their studies challenging? These questions will be discussed from the perspective of the scanning probe microscopy - the experimental technique which enables a direct view into the world of single atoms and molecules adsorbed on a surface. Studies of single atoms and molecules are the main subject of nanoscience primarily because it is in these nanoscale objects the quantum phenomena manifest themselves in the most clear way. Operating a scanning probe microscope at the temperature of liquid helium, today it is routinely possible not only to image complex molecular and atomic structures but also access their electronic vibrational and spin excitations spectra. The recent progress in molecular and atomic manipulation performed with a scanning probe microscope opens a new scene for controlled fabrication of artificial nanoscale structures, the well defined quantum excitations spectra of which may offer a chance of coherent control of their quantum states thus opening a possibility of their future use for quantum information processing.



Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Andreas Wallraff

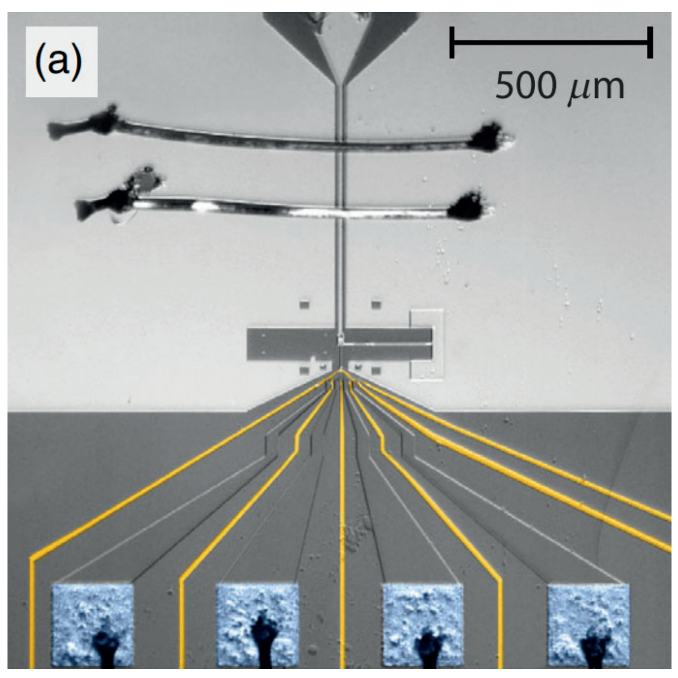
Solid State Physics in the Department of Physics at ETH Zurich

25.06.2019

16^{45} Uhr / HS III

Quantum Information Science with Superconducting Circuits

Superconducting circuits are a prime contender for realizing universal quantum computation in fault-tolerant processors and for solving noisy intermediate-scale quantum (NISQ) problems with non-error-corrected ones. Superconducting circuits also play an important role in state of the art quantum optics experiments and provide interfaces in hybrid systems when combined with semiconductor quantum dots, color centers or mechanical oscillators. In this talk, I will introduce the operation of superconducting circuits in the quantum regime and put quantum information processing with superconducting circuits into perspective with other solid state and atomic physics approaches. As one of two examples of our own research work in the area of fault tolerant quantum computing, which relies on the ability to detect and correct errors, I will present an experiment in which we stabilize the entanglement of a pair of superconducting qubits using parity detection and real-time feedback [1]. In quantum-error-correction codes, measuring multi-qubit parity operators projectively and subsequently conditioning operations on the observed error syndrome is quintessential. We perform experiments in a multiplexed device architecture [2], which enables fast, high-fidelity, single-shot qubit read-out [3], unconditional reset [4], and high fidelity single and two-qubit gates. As a second example, I will present the realization of a deterministic state transfer and entanglement generation protocol aimed at extending monolithic chip-based architectures for quantum information processing. Our all-microwave protocol exchanges time-symmetric itinerant single photons between individually packaged chips connected by transmission lines to achieve on demand state transfer and remote entanglement fidelities of about 80 % at rates of 50 kHz [5]. We believe that sharing information coherently between physically separated chips in a network of quantum computing modules is essential for realizing a viable extensible quantum information processing system.



References

[1] C. Kraglund Andersen et al., arXiv:1902.06946 (2019)
[2] T. Walter et al., Phys. Rev. Applied 7, 054020 (2017)
[3] P. Magnard et al., Phys. Rev. Lett. 121, 060502 (2018)
[4] J. Heinsoo et al., Phys. Rev. Applied 10, 034040 (2018)
[5] P. Kurpiers et al., Nature 558, 264-267 (2018)