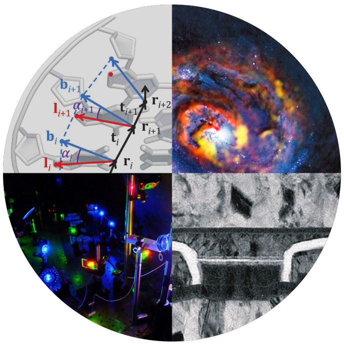

Münchner Physik-Kolloquium

Winter 2014/15

Vortragsprogramm mit Abstracts

Beginn der Veranstaltungen ist um 17:15 Uhr. Sämtliche Vorträge sind öffentlich bei freiem Eintritt. Die Art der Nachsitzung wird in der Veranstaltung bekannt gegeben.

LMU bezeichnet Vorträge im *Hörsaal H 030 der Fakultät für Physik / LMU* in der Schellingstraße 4.

TUM bezeichnet Vorträge im *Hörsaal 2 des Physik-Departments / TUM* am Forschungsgelände in Garching. Das Forschungsgelände kann mit der U6 (bis Garching-Forschungszentrum) erreicht werden.

Friction and adhesion in the nanoworld

Prof. Dr. Thorsten Hugel TUM **2014-10-13**

Institut für Physikalische Chemie, Albert-Ludwigs-Universität Freiburg

Macroscopic observations have led to a couple of phenomenological friction laws, such as Amontons' law, the Rouse model, or Stokes' law. Our atomic force microscopy (AFM) based nanoscale measurements with various single polymers as probes necessitate an additional friction mechanism, which we term desorption stick. We discuss how nanoscale friction is related to normal force, polymer length, velocity and adhesion.

In addition, we investigate friction mechanisms for articular cartilage, including lubrication and wear, by a combination of AFM and fluorescence based experiments.

The puzzling Higgs: physics beyond the standard model after the first LHC phase

Dr. David M. Straub LMU **2014-10-20**

Excellence Cluster Universe und Physik-Department, Technische Universität München

The first three-year run of the LHC with up to 8 TeV center-of-mass energy concluded in 2012. The greatest achievement was the discovery of the Higgs boson which, so far, is perfectly compatible with the properties predicted by the Standard Model. Although strong theoretical arguments imply that the Higgs boson should not exist in isolation, no sign of physics beyond the Standard Model has been discovered. This talk will review the theoretical motivation for and the status of two of the most well-motivated models for a ''natural'' Higgs boson, supersymmetry and Higgs compositeness, and their prospects for the upcoming 13 TeV LHC run.

Structurally disordered materials: from fundamental physics to applications

Prof. Dr. Alessio Zaccone TUM **2014-10-27**

Physik-Department, Technische Universität München

The 20th century saw a major revolution in our understanding of materials, whereby perfect crystals have played a key role for both theory and applications of solid-state science. There is no doubt that the 21st century revolution in materials physics will be centred on disordered (non-crystalline) materials. First of all, their natural abundance and industrial processing make them economically attractive. Further, they offer properties and mechanical performances that are unattainable with their crystalline counterparts. I will focus on the lattice dynamics and deformation behaviour of amorphous materials, where recent progress led to the possibility of handling structural disorder at the atomic-scale in a non-perturbative way. This means that the physics of strongly disordered solids like glasses can be captured. This framework allows us to understand the complex atomic-scale deformation behaviour and plastic instabilities of bulk metallic glasses for advanced applications (e.g. airspace engineering). Future challenges include the electronic properties of these and other amorphous materials (e.g. polymers) for energy applications, and a bottom-up understanding of biological materials.

Ultracold atomic Fermi gases

Prof. Dr. Michael Köhl LMU **2014-11-03**

Alexander-von-Humboldt Professor, Physikalisches Institut, Universität Bonn

Pairing of fermions is ubiquitous in nature and it is responsible for a large variety of fascinating phenomena like superconductivity, superfluidity of ^{3}He, the anomalous rotation of neutron stars, and the BEC-BCS crossover in strongly interacting Fermi gases. When confined to two dimensions, interacting many-body systems bear even more subtle effects, many of which lack understanding at a fundamental level. In particular, the questions how (Cooper-) pairing is established in strongly interacting systems and whether it precedes superconductivity are crucial to be answered. Atomic quantum gases at nanokelvin temperature have emerged as a highly controlled and competitive system to investigate this physics from first principles. We will present an overview over recent experiments, including the observation of a pseudo pairing gap above the superfluid transition temperature, the discovery of polaron quasiparticles, and spin-transport measurements.

Spin-orbitronics, a new direction for spintronics

Prof. Dr. Albert Fert TUM **2014-11-10**

Nobelpreis für Physik 2007, Unité Mixte de Physique CNRS-Thales, Palaiseau and Université Paris-Sud, France

Classical spintronic devices use the exchange interaction between conduction electron spins and local spins in magnetic materials to create spin-polarized currents or to manipulate nanomagnets by spin transfer from spin-polarized currents. A novel direction of spintronics – that can be called spin-orbitronics - exploits the Spin-Orbit Coupling (SOC) in nonmagnetic materials instead of the exchange interaction in magnetic materials to generate, detect or exploit spin-polarized currents. This opens the way to spin devices made of only nonmagnetic materials and operated without magnetic fields. Spin-orbit coupling can also be used to create new types of topological magnetic objects as the magnetic skyrmions or the Dzyaloshinskii-Moriya domain walls. After a general and simple introduction on spintronics, I will review recent advances in two directions of spin-orbitronics.

a. Nucleation, current-induced motion and pinning of individual skyrmions or trains of skyrmions in films or multilayers: I will focus on skyrmions induced by Dzyaloshinsky-Moriya Interactions (DMI) at interfaces of ferromagnetic layers with materials of large spin-orbit coupling and I will discuss their potential for applications. It will include calculations of DMI, micromagnetic simulations ans preliminary experimental results on multilayers.

b. Conversion between charge and spin current by SOC (Spin Hall Effect and Edelstein Effect): I will describe recent experiments and applications to the current-induced motion of magnetic domain walls and the switching of nanomagnets.

Is the wave function in one-to-one correspondence with reality?

Prof. Dr. Renato Renner LMU **2014-11-17**

ETH Zürich, Switzerland

The old question (considered already by Einstein) whether the quantum-mechanical wave function represents ''reality'' has recently attracted renewed interest. Amazingly, modern approaches inspired by Quantum Information Theory can provide answers. In my talk, I will provide an overview on them, focusing on a recent result that establishes a one-to-one correspondence between the wave function and the ''elements of reality''.

Non-relativistic effective field theories of QCD and QED

Prof. Dr. Joan Soto TUM **2014-11-24**

University of Barcelona, Spain

The Standard Model of Particle Physics is described by a relativistic quantum field theory. However many phenomena in particle, nuclear and atomic physics are of non-relativistic nature. Non-relativistic effective field theories are instrumental for understanding these systems from the Standard Model under well controlled approximations.

I will explain the basic ideas behind their contruction, focusing on Non-relativistic QCD and Non-relativistic QED, and discuss a number of applications, including the precision determination of the strong coupling constant and the heavy quark masses, the suppression of charmonium and bottomonium states in a quark gluon plasma, and the light quark mass dependence of nuclear forces.

Dark matter and galaxy formation

Prof. Dr. Francoise Combes LMU **2014-12-01**

Observatoire de Paris, LERMA, France

The ''standard'' model of cold dark matter LCDM is today the best to account for the formation of large-scale structures of the universe. However, there remain unsolved problems at the scale of galaxies. The distribution of baryons and dark matter in galaxies predicted by numerical simulations is far from what is observed. The model predicts a large excess of dark matter in galaxies, and a large number of satellites, with orders of magnitude discrepancy with observations. I will discuss how baryonic physics (Star Formation and AGN feedback) confronted to observations can constrain the nature of dark matter. Alternative models with modified gravity will also be discussed.

Probing the mechanical properties, interactions, and processing of DNA and RNA using single molecule torque and twist measurements

Prof. Dr. Jan Lipfert TUM **2014-12-08**

Faculty of Physics, Ludwig-Maximilians-Universität München

Single-molecule manipulation techniques have provided unprecedented insights into the structure, function, interactions, and mechanical properties of biological macromolecules. While many single-molecule manipulation techniques naturally operate in the space of (linear) extension and force, recently a number of techniques have been developed that enable measurements of rotation angle and torque.These new methods provide exciting opportunities to probe biological important macromolecules. In particular, the helical nature of double-stranded DNA and RNA intrinsically links key processes such as replication, transcription, and genome repair to rotational motion and the accumulation of torsional strain.

In my talk, I will briefly review novel magnetic tweezers assays that enable direct measurements of single molecule torque and twist, notably magnetic torque tweezers and freely-orbiting magnetic tweezers. Using these techniques, we have for the first time mapped out the complete force-torque phase diagram for double-stranded RNA, discovering some similarities but also striking differences to its better-studied cousin, DNA. In addition, I will briefly describe results on Rad51-DNA filaments, a key intermediate in DNA repair, and applications of novel magnetic tweezers techniques to probe nucleosome dynamics.

Quantum optomechanics – a road to gravity?

Prof. Dr. Markus Aspelmeyer LMU **2014-12-15**

Universität Wien, Austria

Massive mechanical objects are now becoming available as new systems for quantum science. Devices currently under investigation cover a mass range of more than 17 orders of magnitude – from nanomechanical waveguides of some picogram to macroscopic, kilogram-weight mirrors of gravitational wave detectors. This has fascinating perspectives for quantum foundations: the mass of available mechanical resonators provides access to a hitherto untested parameter regime of macroscopic quantum physics, eventually enabling novel table-top tests at the interface between quantum physics and gravity.

The spin on electronics!

Prof. Dr. Stuart S.P. Parkin TUM **2015-01-12**

Max-Planck-Institut für Mikrostrukturphysik, Halle / IBM Research – Almaden, California, USA

Recent advances in manipulating spin-polarized electron currents in atomically engineered magnetic heterostructures make possible entirely new classes of sensor, memory and logic devices - a research field generally referred to as spintronics. A magnetic recording read head, initially formed from a spin-valve, and more recently by a magnetic tunnel junction, has enabled a 1,000-fold increase in the storage capacity of hard disk drives since 1997. The very low cost of disk drives and the high performance and reliability of solid-state memories, may be combined in the Racetrack Memory. The Racetrack Memory is a novel three dimensional technology which stores information as a series of magnetic domain walls in nanowires, manipulated by spin polarized current. Spintronic devices may even allow for ''plastic'' devices that mimic synaptic switches in the brain, thereby allowing for the possibility of very low power computing devices.

Materials properties controlled by microstructure and external fields

Prof. Dr. Horst Hahn LMU **2015-01-19**

Institute for Nanotechnology and Helmholtz-Institut Ulm / Karlsruhe Institute of Technology (KIT)

Modern materials science uses the complex interplay of defects, such as impurities, phases, point and line defects and interfaces, to tailor properties and obtain high-performance metallic alloys and ceramics. In this approach of materials design, properties can only be changed by modifying their microstructure, for example by initiating grain growth during annealing at elevated temperatures. Such a behavior is advantageous for many applications of materials, where long-term stability of the properties is required.

Metallic glasses offer interesting properties due to their disordered atomic structure. As an example for materials that exhibit novel effects by tailoring the microstructure, nanoglasses will be discussed. Nanoglasses consist of two distinct structural components, which differ in their free volume and elemental constitution, and have been shown to exhibit drastic property changes. In contrast, tuning using external fields, i.e., electric, offers completely new opportunities for the fully reversible control of materials properties. Such tuning of physical properties will be demonstrated for several nanostructures. Tuning can be either achieved using dielectric/ferroelectric gating, or by electrolyte gating using liquid or solid electrolytes. Furthermore, using electrochemical ion intercalation, fully reversible properties can be achieved.

Finally, the concepts employed for tuning properties of nanostructures will be described for field-effect transistors based on inorganic nanoparticles as the channel material and solid electrolyte for the gating.

Allgemeine Informationen

Das Münchner Physik-Kolloquium ist das Podium der physikalischen Forschung im Münchner Raum. Es wird gemeinsam von den beiden Universitäten und den entsprechenden Max-Planck-Instituten veranstaltet. Die Vorträge berichten über aktuelle Themen der Physik und angrenzender Gebiete und spiegeln den interdisziplinären Charakter moderner Physik wider.

Die Darstellung wird möglichst allgemeinverständlich gehalten, um auch physikalisch interessierte Zuhörer aus dem industriellen oder schulischen Bereich anzusprechen. Die Vortragenden sind ausgewiesene Fachleute auf dem jeweiligen Gebiet, zum Teil auch neu nach München berufene Wissenschaftler, die sich in diesem Rahmen einer breiteren Öffentlichkeit vorstellen wollen. Das Kolloquium stellt insbesondere für die Studenten der Physik eine einfache Möglichkeit dar, im Laufe eines Jahres alle wichtigen Arbeitsgebiete der gegenwärtigen physikalischen Forschung kennen zu lernen.

Es ist erklärtes Anliegen des Münchner Physik-Kolloquiums, die räumliche Trennung der Physik in die verschiedenen Forschungsstandorte in München und Garching durch eine gemeinsame Veranstaltung zu überbrücken. Dazu soll auch der alternierende Wechsel des Veranstaltungsorts beitragen.

Veranstaltende Einrichtungen

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Ludwig-Maximilians-Universität München
Fakultät für Physik, Schellingstraße 4, 80799 München
LMU-Koordinatoren:
Prof. L. Pollet, Prof. B. Ercolano

Aktuelles Programm: http://www.ph.tum.de/kolloquium

Technische Universität München