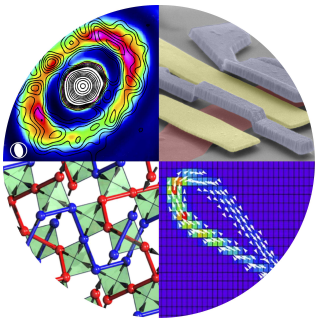

Münchner Physik-Kolloquium

Winter 2016/17

Vortragsprogramm mit Abstracts

Beginn der Veranstaltungen ist um 17:15 Uhr, sofern keine besondere Anfangszeit vermerkt ist. 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, München.

TUM bezeichnet Vorträge im *Hörsaal 2 des Physik-Departments / TUM* am Forschungsgelände, James-Franck-Straße 1 in Garching. Das Forschungsgelände kann mit der U6 (bis Garching-Forschungszentrum) erreicht werden.

Charge transport in organic nanoscopic systems: From organic semiconductors to 2d layered materials

Prof. Dr. Thomas Weitz TUM **2016-11-07**
Physics of Nanosystems, Department of Physics, LMU München

In this seminar I will review our recent results in 1) the field of organic electronics and 2) on charge transport in bilayer graphene. 1) Charge transport in small-molecule organic semiconductors is not only dominated by the π-overlap of adjacent molecules, but also by discontinuities in the crystal such as grain boundaries and the semiconductor / dielectric interface. For example, we have recently shown, that such grain boundaries significantly contribute to degradation of the thin film during extended operation (Mueller et al. PSS RRL 10 (2016) 339). 2) Bilayer graphene is a fascinating material, since it has a finite density of states at the charge-neutrality point (i.e. where valence and conduction band meet). One of the consequences is, that exchange interaction in this system is large, even in the absence of a magnetic field. We have identified, that it opens a gap in the spectrum whose origin is still under discussion in the field (Weitz et al. Science, 330 (2010) 812).

Building planets – a journey along 40 orders of magnitude

Dr. Til Birnstiel LMU **2016-11-14**
Max Planck Institute for Astronomy, Heidelberg, Germany and Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA

Building planets is a dirty business. First of all, planets are made out of the dirt we call interstellar dust. Secondly, the physics involved is not ''clean'' in a sense that neither all the forces and effects involved, nor all the initial conditions of this process are known. Solid state physics, radiation transport, gas phase and surface chemistry, magnetic fields and hydrodynamic instabilities at high Reynolds numbers are just some of the aspects that are certainly involved in growing the sub-micrometer sized interstellar dust by 40 orders of magnitude in mass to a full-grown planet. Given this complexity and dynamic range, it is perhaps not surprising, that the formation processes of planets are still poorly understood, even though thousands of planets beyond our solar system are known today. In this talk, I will focus on the early stages of planet formation: how to grow the asteroid sized building blocks of planets out of sub-micrometer sized dust. I will discuss the basic theoretical concepts, the problems we are facing, and outline how they might be overcome. I will also show recent observational results that are currently revolutionizing this exciting field and show how they are not only a big step towards solving the puzzle of planet formation, but also how they trace effects that critically affect the future habitability of the forming planets.

Broken detailed balance in active biological systems

Prof. Dr. Chase Broedersz TUM **2016-11-21**

LMU München

Living systems function out of thermodynamic equilibrium. We present a method to identify such nonequilibrium dynamics based on broken detailed balance. Using this, we study active dynamics in beating flagella and non-periodic fluctuations of primary cilia. Finally, we show with a model how tracer filaments can also be used to infer nonequilibrium dynamics in active networks. Specifically, the filament's normal modes exhibit current cycles in phase space, revealing information about activity. This analysis may provide a general tool to quantify nonequilibrium dynamics in cells and tissues.

Topological order: Phases of matter with fascinating properties

Prof. Dr. Frank Pollmann LMU **2016-11-28**

Technische Universität München

Condensed matter is found in a variety of phases, the vast majority of which are characterized in terms of symmetry breaking. For example, magnets spontaneously break time-reversal and spin-rotation symmetries. A notable exception was provided by the discovery of the quantum Hall effects which exhibit new kinds of topological orders not associated with any symmetry breaking. One of the characterizing features of topological order is the existence of excitations with exotic properties. These so-called anyonic excitations might make topologically ordered systems ideal building blocks of fault-tolerant quantum computers. In this colloquium, I will start by giving a general introduction to the concept of topological order and then address some of the recent developments. In particular, I will introduce theoretical frameworks that allow us to classify topological phases and discuss dynamical signatures that are useful to experimentally detect them.

The origin of mass of the visible universe

Prof. Dr. Zoltán Fodor TUM **2016-12-05**

Bergische Universität Wuppertal

More than 99 % of the mass of the visible universe is made up of protons and neutrons. Both particles are much heavier than their quark and gluon constituents. The existence and stability of atoms rely on the fact that the mass difference between the neutron and the proton is about 0.14 %. A slightly smaller or larger value would have led to a dramatically different universe. I show how theoretical breakthroughs and high-performance computing resources have transitioned to a point where these masses, their differences and similar physics observables can be calculated accurately on space-time lattices directly from Quantum Chromodynamics, the strongly interacting theory of quarks and gluons.

Twisting DNA: The role of twist-bend coupling

Prof. Dr. Enrico Carlon LMU **2016-12-12**

KU Leuven, Belgium

DNA is well-known for its role as the carrier of genetic information. To perform its function, the double helix interacts with proteins and these interactions are responsible for its bending, twisting, and stretching. Understanding the mechanical properties of DNA is therefore essential to know how the molecule of life interacts with other biomolecules. In this talk I will discuss some recent work on the torsional properties of double stranded DNA. It has been known for some time that the standard elastic model of DNA fails to reproduce precision single molecule torsional measurements. Here we show that an extended model with a direct twist-bend coupling term can reconcile theory and experiment. The role of this coupling on other static and dynamic properties of DNA is also discussed.

Precession in the dark: the CASPEr and GNOME experiments

Prof. Dr. Dmitry Budker TUM **2016-12-19**

Helmholtz Institute Mainz, Johannes Gutenberg University and University of California at Berkeley, USA

The Cosmic Axion Spin-Precesion experiment and the Global Network of Optical Magnetometers for Exotic physics searches will be discussed. These are based on magnetic resonance and are designed to search for axions and axion-like particles, which are excellent candidates for being Dark Matter.

Particle physics beyond colliders

Prof. Dr. Asimina Arvanitaki LMU **2017-01-09**

Perimeter Institute, Canada

When we think about Particle physics the first thing that comes to mind is colliders and high energies. Recently there have been several proposals of low-energy precision experiments that can also look for new particles, new forces, and the Dark Matter of the Universe in a way that is complementary to collider searches. In this talk, I propose two different experiments that search for a type

of Dark Matter naturally arising in String Theory. In String Theory fundamental constants, such as the electron mass or charge, are determined by fields known as moduli. When these fields are the Dark Matter of our Universe, they cause the fundamental constants to oscillate with a frequency set by the Dark Matter mass. For frequencies smaller than 1 Hz atomic clocks with their unprecedented sensitivity can pick up these oscillations. For higher frequencies above 1 kHz, Dark Matter can excite acoustic modes in resonant mass detectors originally designed to detect gravitational radiation from astrophysical sources. Both techniques extend searches for this type of Dark Matter by several orders of magnitude in the near future.

Materials physics in space: the benefit of experiments in weightlessness

Prof. Dr. Andreas Meyer TUM **2017-01-16**

German Aerospace Center, Cologne

Through the absence of gravitationally driven phenomena, like convection and sedimentation, investigations in weightlessness provide well-defined experimental conditions. This enables the application of measurement techniques, that cannot be realized on earth, it guides the development of novel earth-bound measurement principles, and it allows for the accurate and precise measurement of physical quantities. With the development of advanced container-less processing techniques, such as electrostatic levitation (ESL), and in-situ X-ray radiography, on earth as well as in microgravity on parabolic flights, sounding rockets and the International Space Station, in particular coefficients of transport of mass in liquid metals and alloys are accurately measured. Quasielastic neutron scattering and neutron diffraction on levitated liquid droplets complements these experiments. Results are discussed in the context of generally accepted text book knowledge, i.e. the relation of self- and interdiffusion (Darken's equation), of the relation of self-diffusion and viscosity (Stokes-Einstein relation), and structure-property relations (Mode-Coupling-Theory).

Extrasolar planetary systems

Prof. Dr. Wilhelm Kley LMU **2017-01-23**

Institut für Astronomie und Astrophysik, Universität Tübingen

As of today more than 2600 exoplanetary systems that contain over 3500 planets have been discovered. Due to the tremendous success of the Kepler space-mission the majority of these systems have been detected using the transit method followed by the Radial Velocity technique. More, complementary discoveries are to be expected by the Gaia and PLATO space-missions in the near future. The observations indicate that planets are likely to be found in systems with several objects rather than being lonesome travelers with very interesting orbital dynamics. In the talk, first the present observational status of exoplanets will be presented, followed by an analyses of the theoretical attempts to understand the complex orbital dynamics as a consequence of the formation process of planetary systems.

What's going on in a battery and how far can we go?

Prof. Dr. Helmut Ehrenberg

TUM **2017-01-30**

Institut für Angewandte Materialien-Energiespeichersysteme (IAM-ESS), Karlsruher Institut für Technologie (KIT)

Electrochemical energy storage is a key component for electromobility and the efficient use of renewable energy sources. Pushing batteries to higher energy and power densities is full of challenges. This talk will compile the different points of view from physicists, chemists and engineers. Selected examples are shown to demonstrate how modern characterisation techniques can bridge fundamental physics with the development of new materials for a sustainable energy technology. The high level of complexity and the huge number of structural and chemical degrees of freedom in the design of electrochemical cells require a solid understanding of the most relevant underlying working and degradation mechanisms for a systematic optimization of such energy storage devices. Most of the lessons learned from Li-ion batteries also apply for the so-called "post-Li" battery concepts and are discussed.

From self-amplification of chirality to the imaging of the absolute configuration by Coulomb explosion

Prof. Dr. Oliver Trapp LMU **2017-02-06**

LMU München

We developed new strategies based on stereochemically labile ligands and designed catalytic systems, which are able to switch their configuration by interaction with suitable selectors leading to self-amplifying enantioselective processes. Such processes are important in the context of Origins-of-Life to understand the formation of a homochiral world. Furthermore the presented strategy opens up new approaches for the development of improved self-amplified asymmetric syntheses.

In the second part a new technique to determine absolute configurations of chiral molecules will be presented. Very recently, we reported the first assignment of the absolute configuration of enantiopure (R,R)-2,3-dideuterooxirane by direct visualization of the sense of chirality using foil-induced Coulomb explosion imaging (CEI). In this experiment a small sample of the compound is ionized, accelerated by 2.0 MeV and mass-selected. The valence electrons are stripped off within 1 fs by passing through an ultrathin diamond foil providing an enlarged molecular picture. We also show the unambiguous chemical correlation of the absolute configuration of cryptochiral (R,R)-2,3-dideuterooxirane with the stereochemical key reference (+)-glyceraldehyde.

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 der modernen 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.

Student event: Meet the speaker

We invite you to a **student-only** discussion-round with the speakers before each Munich Physics Colloquium talk. *Be curious and feel free to ask any question.*

Venue: Mondays, 16:00 h

TUM Seminar room PH 3076 (upper floor), Physik-Department TUM, James-Franck-Straße 1, Garching

LMU Room H U123 (basement), Fakultät für Physik der LMU, Schellingstraße 4, München

Veranstaltende Einrichtungen

Max-Planck-Institute physikalischer Arbeitsrichtung
München / Garching

Technische Universität München
Physik-Department, James-Franck-Straße 1, 85748 Garching
TUM-Koordinatoren:
Prof. J. Finley, Prof. K. Krischer

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

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