Fachbereich Physik

Vorträge im Physikalischen Kolloquium

Wintersemester 2016/17

Mittwochs 16 Uhr c.t., Hörsaal _.111 (EG), Max-von-Laue-Str. 1

19.10.2016 **Prof. Dr. Thomas Wilhelm**
Institut für Didaktik der Physik, Goethe-Universität Frankfurt am Main

Physikalisches Experimentieren
mit Smartphones

Smartphones und Tablets haben bei jungen Leuten mittlerweile eine große Verbreitung gefunden und nahezu jeder Student hat ein solches Gerät immer dabei. Diese können beim Experimentieren zum Physiklernen recht unterschiedlich genutzt werden. Z.B. ermöglichen die in ihnen verbauten Sensoren die Aufnahme von Messwerten. Die Geräte können damit einerseits wie klassische Messwerterfassungssysteme verwendet werden und anderseits ermöglichen sie das Herausgehen aus dem Physiksaal, die experimentelle Erschließung von Alltagskontexten sowie die Auslagerung und Vertiefung experimenteller Inhalte außerhalb der Universität.
Der Vortrag möchte einen Überblick über Experimentiermöglichkeiten geben und zeigen, wie vielfältig die mobilen Endgeräte zum Experimentieren genutzt werden können.

26.10.2016 **Dr. Oleksandr Dobrovolskiy**
Physikalisches Institut, Goethe-Universität Frankfurt am Main

A n t r i t t s v o r l e s u n g
SUPER meets NANO: From nanopatterned superconductors to metamaterials

A blank piece of paper is open for further patterning. It can be covered with words, symbols, or colors, breaking the symmetry of the blank paper and producing a sensory or abstract pattern. This pattern tells us a story, depicts an object, invokes a hidden feeling... . In this sense, patterning can generate a variety of new properties. In analogy to that, breaking the symmetry of superconducting films by nano-patterning results in novel properties unseen in pristine materials. This sets the stage for a new fascinating domain of science and engineering at the interface between superconductivity research and nanotechnology – Abrikosov fluxonics – which will be introduced in the present talk with a particular focus on microwave applications and metamaterials as miniature devices with high operation frequencies and low energy losses.

02.11.2016 Prof. Dr. Anatoli Kheifets
Correlated Many-Particle Dynamics Research School of Physics,
Australian National University Canberra, Australia

Time Delay in Atomic and Molecular Photoionization

Time Delay in Atomic and Molecular Photoionization Modern laser techniques allow access to the ultrafast electron dynamics in atoms and molecules on the timescale of 10 to 100 attoseconds (1as = 10−18 s). This development allowed to re-examine and re-evaluate decade old concepts of the Wigner time delay and the tunneling time delay. The Wigner time delay is unambiguously established in atomic and molecular photoionization and serve as a useful tool to study both one-electron potentials and collective many-electron effects. The tunneling time delay is still the subject of a considerable debate and controversy In this presentation, the story lines of the Wigner and tunneling time delays will be followed and illustrated by the most recent and significant experimental and theoretical results.

09.11.2016 Apl. Prof. Jürgen Schaffner-Bielich
Institut für Theoretische Physik, Goethe-Universität Frankfurt am Main

A n t r i t t s v o r l e s u n g
Neutronensterne und hochdichte Materie

Beobachtungen von Neutronensternen geben Einblicke in die Eigenschaften von Materie unter extremen Bedingungen. Die kürzliche Entdeckung von massiven Pulsaren, rotierenden Neutronensternen, mit zwei Sonnenmassen führt zu neuen Einschränkungen an die Zustandsgleichung von hochdichter Materie und die mögliche Existenz von exotischen Phasen im Kern eines Neutronensternes. Die Auswirkungen der aktuellen astrophysikalischen Beobachtungen wird diskutiert und mit den Erkenntnissen über die Zustandsgleichung der Materie aus der Kernphysik, aus der Schwerionenphysik bei relativistischen Einschussenergien und aus der fundamentalen Theorie der starken Wechselwirkung, der Quantenchromodynamik, bei hohen Dichten konfrontiert.

16.11.2016 Prof. Cristina Manuel
Instituto de Ciencias del Espacio (CSIC-IEEC) Barcelona, Spain

Chiral Transport Phenomena

For systems made up by massless fermions the conventional hydrodynamics and transport equations are modified, leading to new transport phenomena related to the quantum anomalies of quantum field theories. I will explain the main conceptual ideas behind these new transport effects, and also how to derive these equations and effects from simple semi-classical arguments. These chiral anomalous effects are relevant and have wide range applications in condensed-matter systems(with the recently new discovered materials, the so called Weyl semimetals), in heavy-ion collisions, in astrophysics or in cosmology. I will then concentrate in the fact that chiral transport phenomena may allow us to explain the generation of magnetic fields with magnetic helicity in different settings.

23.11.2016 **Prof. Dr. Manfred Albrecht**
Institute of Physics, University of Augsburg, Germany

Future concepts and materialsfor magnetic data storage

Due to the increasing demand in high-density recording media, magnetic thin films with high magnetic anisotropy are widely studied in order to overcome the superparamagnetic effect. To fulfill the requirements of thermal stability, hard magnetic alloys, i.e. FePt alloys in the L10 phase are promising candidates as storage layer. However, owing to the large magnetic anisotropy, the magnetic field required to reverse the magnetization of the media may become higher than the field provided by a conventional recording head. To solve this, so-called writeability issue, the concepts of exchange-coupled composite (ECC) media as well as bit patterned media based on L10 FePt were suggested, which will be discussed in this presentation.
Furthermore, ultrafast magnetization switching is at the heart of both modern information storage technology and fundamental science. In this regard, it was recently observed that ultra-fast mag-netization reversal processes can be induced by circularly polarized laser pulses in amorphous ferrimagnetic GdFeCo alloy thin films. This novel observation resulted in a broad range of exciting and challenging fundamental questions, and may enable new applications based on ultra-fast spintronics. An overview of our activities on all-optical switching in amorphous ferrimagnetic Tb-Fe alloy films will be presented.

30.11.2016 **Prof. Dr. Jairo Sinova**
Alexander von Humboldt Professor, JGIU - SPICE – INSPIRE, Institut für Physik, Mainz

Relativity shakes future technology:
how the spin Hall effect and relativistic torques are opening new paths for information storage

Understanding the origin and properties of the different phases of materials and how to control them is at the heart of condensed matter physics and physics in general. One of the grand challenges of the field is to control spin-dependent properties without using magnetic fields. To do so, one must resort to the relativistic nature of electrons, which arises directly from its particle-antiparticle description that gives its spin. In the relatively slow world of solids this leads to the spin-orbit coupling (SOC) that connects the spin and charge of the electron. We have learned how to exploit the relativistic SOC to create new paradigms of spin control in complex materials and discover new unexpected connections between seemingly disparate ideas as topology, materials science, high energy physics, ferromagnetism, thermoelectricity, and current-induced magnetization manipulation. I will broadly describe joint theoretical and experimental efforts on how we now generate and manipulate spin-currents that are being used in devices relevant for future MRAM technology. I will also show in some detail how insights on the spin Hall effect have yielded novel ways to manipulate magnetization using relativistic torques, and how to extend these ideas to a new a phase of spintronics by exploiting anti-ferromagnetic materials in an active way.

07.12.2016 **Prof. Dr. Jens Müller**
Physikalisches Institut, Goethe-Universität Frankfurt

Learning from Noise – Studying the Dynamics of Electrons by Fluctuation Spectroscopy

Any physical quantity is subject to fluctuations. Particularly fascinating are low-frequency, so-called 1/f-type fluctuations, which apparently are universal in nature, since they are found in light curves of quasars, the human heartbeat, earthquakes, Autobahn traffic, the distribution of prime numbers, etc. Here, we aim to give a general overview of fluctuation phenomena and what can be learned from fluctuations (or noise) in the motion of electrons in solids. One the one hand, noise often is considered an unwanted nuisance, since it ultimately limits the accuracy of physical measurements. In this spirit, understanding the microscopic origin of fluctuations may help to improve the performance of semiconductor devices and sensors. A different point of view is to consider "noise as the signal". Indeed, fluctuation spectroscopy – revealing 'hidden' pieces of information, not present in the mean quantity (e.g. the electrical resistance) itself – is a powerful tool for studying the microscopic kinetics of charge carriers in condensed matter systems. We will give an overview of recent noise studies on different systems ranging from switching dynamics of electrons in micro- and nano-scale semiconductor devices (thereby enabling high-resolution magnetic measurements) to glassy structural dynamics in molecular metals. For these materials, we will discuss examples of the low-frequency dynamics of strongly-correlated electrons, namely recent findings of nano-scale electronic phase separation and percolation as well as the critical slowing down of the fluctuations at the Mott metal-to-insulator transition, a key phenomenon in modern condensed-matter physics.

14.12.2016 **Prof. Claus Hilgetag**
Department of Computational Neuroscience, University Medical Center Eppendorf, Hamburg University

Relating topology and dynamics of excitable neural networks

Brain connectivity is characterised by a number of distinctive topological features, such as a heterogenous degree distribution with hubs, hierarchically organised modules, as well as a characteristic spectrum of motifs and cycles. These features have consequences for different aspects of brain dynamics, such as self-sustained network activity, the wave-like propagation of activity as well as correlations and anti-correlations of activity patterns. We have systematically investigated the relation between neural network topology and dynamics with the help of a general excitable (cellular automaton) model which allows a mechanistic understanding of the contribution of different topological features of brain networks to brain dynamics.

11.01.2017 **Prof. Andrey Varlamov**
Institute of Superconductivity and Innovation Materials (SPIN-CNR), Italy

Physics in the Kitchen

How heat propagates in media, what is the difference between pizza baking in the traditional wood oven and in the electric one, why tastes of the boiled meet and the grilled one are so different, how scientifically calculate cooking time of the soft-boiled duck egg and spaghetti, why cin-cin with crystal glasses filled by sparkling wine is not accompanied by nice canorous sound, why vodka usually contains around of 40 % of alcohol, why professional barman varies the degree of coffee beans grounding depending on weather, and many other questions of surrounding gastronomic universe are discussed in this lecture.

18.01.2017 **Prof. Dr. Matthias Weiss**
Experimental Physics I, University of Bayreuth

Dynamic self-organization of living matter – from molecules to embryos

Understanding living entities, from single cells to whole organisms, eventually requires knowledge about the physics that governs the secret life of biological specimen. On the nanoscale, macromolecules need to travel and interact such that mesoscopic structures, e.g. organelles, and patterns are formed and maintained. On even larger scales, cells need to arrange in a spatiotemporally coordinated fashion to enable, for example, proper embryogenesis. Focusing on experiments, the talk will touch upon recent results on causes and consequences of anomalous and anisotropic transport of macromolecules in biological fluids , and on the influence of mechanical cues that guide the early embryonal development of the model organisms Caenorhabditis elegans .

25.01.2017 Prof. Dr. Roser Valenti
Institut für Theoretische Physik, Johann Wolfgang Goethe-Universität, Frankfurt am Main

Towards computational design of quantum materials

Unconventional superconductivity with high critical temperatures, frustrated magnetism, spin liquid behavior, heavy fermions are a few examples of exotic phases in correlated quantum materials. In a correlated system electrons experience strong Coulomb repulsion and one of the big challenges in solid state physics is the microscopic description of such systems. Moreover, being able to understand these materials implies the possibility of designing compounds with desirable properties.
This talk will discuss the world of some families of correlated materials ranging from unconventional superconductors, frustrated magnets and possible correlated Dirac metals and present some strategies on how to model them microscopically.
We will further show how the ideas of the awarded Nobel Prize in Physics 2016 on "topological phases of matter" has revolutionized our way of understanding quantum matter.

01.02.2017 Prof. Dr. Michael Schnabel
Harris School for Public Policy, University of Chicago, Chicago, IL, USA

Field Theory meets Neuroscience:
A symmetry based approach to model orientation maps in the mammalian brain

Neurons in primary visual cortex of the mammalian brain that processes the information of the visual stream are specialized in detecting the presence of local contours that match their preferred orientation. Orientation preferences of individual neurons vary in a systematic manner along the 2-d cortical sheet and form a remarkable pattern, called the orientation map, that can be represented as a complex valued field z(x). A characteristic feature of orientation maps is the occurrence of topological point defects, called pinwheel centers, around which all orientations are represented once, however not necessarily to an equal amount. I will present a phenomenological model that can be used to describe the emergence of pinwheel rich patterns and then discuss the fine structure of pinwheel defects, notably the pinwheel anisotropy. Analytical predictions for the distribution of pinwheel anisotropies calculated for Gaussian random fields will be compared to the actual distribution obtained from optical imaging recordings of the ferret, cat and galago visual cortex. In the second part of my talk I will discuss how the joint representation of orientation and space by visual cortical neurons may induce a non-trivial (Shift-Twist) representation of the Euclidean group in the orientation map layout. I will introduce an appropriate order parameter that is able to quantify the presence (or absence) of this effect in an ensemble of orientation maps and compare the predictions to actual data.

08.02.2017 Prof. Dr. Dr. h.c. Manfred Lindner
Max Planck Institut fuer Kernphysik, Heidelberg, Germany

Direct Dark Matter Search

Various indirect hints for Dark Matter point towards promising solutions. The talk will cover these indications and different methods suited to verify or refute these hints for new physics. The direct detection experiment XENON1T will be described in detail to illustrate the challenging requirements and opportunities of leading projects in the field. The talk will conclude with the latest results and an outlook for the coming years.