TUT 1: Tutorial on Multiferroics and Magnetoelectrics

Time: Sunday 16:00–18:30 Location: HSZ 401

Tutorial TUT 1.1 Sun 16:00 HSZ 401

Magnetic and ferroelectric materials — •Wolfgang Kleemann — Angewandte Physik, Universität Duisburg-Essen, Lotharstr.1, 47048 Duisburg, Germany

In this introductory lecture, pertinent examples, mechanisms and basic theories of magnetic and ferroelectric phase transitions will be presented. We discuss the respective ordered states, the domain structures and some functional properties of relevant materials. Owing to their close vicinity to multiferroic and magneto-electric materials, oxidic systems will be brought into focus.

5 min. break

Tutorial TUT 1.2 Sun 16:50 HSZ 401

Magnetoelectric coupling in multiferroics: Recent developments — •Manfred Fiebig — HISKP, Universität Bonn, Bonn, Germany

Currently, an enormous interest in multiferroics – compounds uniting two or more forms of primary ferroic ordering in one phase – is observed. Aside from technological aspects the interplay of different forms of (anti-) ferroic ordering is a rich source for exploring the fundamental science of phase control. Magnetic ferroelectrics may constitute the most interesting type of multiferroics because they may exhibit an unusually strong, so-called magnetoelectric (ME), coupling of magnetic and electric properties which is useful for controlling magnetic order with electric fields and vice versa. In my talk I will discuss the intricate relation between multiferroicity, ME behavior, and symmetry in ME single-phase multiferroics with particular emphasis on recent developments. For example, simultaneous breaking of time- and space-inversion symmetry by magnetic spirals leads to a new type of “induced” ME multiferroic observed, e.g., in orthorhombic $RMnO_3$, pyroxenes, or $MnWO_4$. This has to be distinguished from multiferroicity in the popular compound $BiFeO_3$ which also forms spin-spirals, but independent of the ferroelectric order. On the other hand, space-time asymmetry can also lead to ferrotoroidicity (a spontaneous order of magnetic vortices) as an entirely different form of ferroic ordering observed, e.g., in $LiCoPO_4$.

5 min. break

Tutorial TUT 1.3 Sun 17:40 HSZ 401

Multiphase multiferroics — •Kathrin Dörr — IFW Dresden, Postfach 270116, 01171 Dresden, Germany

This tutorial addresses multiferroic materials and devices comprising two or more ferroic (ferroelectric or magnetic) phases. Single-phase multiferroics are rare and typically work at low temperatures. A combination of appropriate phases can provide multiferroicity and large magnetoelectric coupling also at ambient temperatures, and early applications have been realized.

One crucial issue is how the different ferroic phases must be coupled in order to achieve a large ”composite”magnetoelectric effect, i. e. the desirable electric control of magnetic order (or magnetic control of dielectric order). The coupling mechanisms by (i) elastic strain and (ii) charge at the interface between the phases will be discussed. Examples for these cases are a piezoelectric-magnetostrictive layered ”sandwich”structure and a field-effect transistor with ferroelectric gate and magnetic channel, respectively. The various designs of the composite materials will be followed through history, ending with self-organized and artificially patterned thin film nanostructures. Finally, the most promising approaches known today will be introduced. These include multiferroic sensors for magnetic ac fields, spin-polarized tunnel junctions with multiferroic barrier and the electrically controlled magnetic exchange bias effect from a $BiFeO_3$ layer.

TUT 2: Tutorial on Nanooptics

Time: Sunday 16:00–18:30 Location: HSZ 04

Tutorial TUT 2.1 Sun 16:00 HSZ 04

Ultrafast Nanooptics: Bringing Ultimate Time Resolution to the Nanoscale — •Walter Pfeiffer — Fakultät für Physik, Universität Bielefeld, 33615 Bielefeld, Germany

The coherent broadband optical excitation of nanostructures forms the basis of the emerging field of ”ultrafast nanooptics”. In metallic nanostructures and hybrid nanostructures, electromagnetic excitations tend to be highly localized and strongly enhanced. The coherent excitation of such nanostructures by ultrafast light pulses adds the temporal degree of freedom and allows for controlling the spatiotemporal properties of these nanolocalized fields. The spatio-temporal evolution of such optical near-field distributions could play a key role in a variety of important applications across the disciplines, including the realization of novel laser structures, the exploitation of optical nonlinearities for ultrasensitive chemical and biological probing, and the development of enhanced single-photon sources for quantum communication.

Starting from the fundamentals of nanooptics and ultrafast optics this introductory lecture will provide an overview of recent progress in the field of ”ultrafast nanooptics”.

15 min. break.

Tutorial TUT 2.2 Sun 16:55 HSZ 04

Ultrafast Nano-Optics: Applications in Nano-Science — •Christoph Lienau — Institut für Physik, Carl von Ossietzky Universität Oldenburg, 26129 Oldenburg, Germany

Ultrafast nano-optics is a comparatively young and rapidly growing field of research aiming at probing, manipulating and controlling ultrafast optical excitations on nanometer length scales. The ability to control light on nanometer length and femtosecond time scales opens up exciting possibilities for probing dynamic processes in nanostructures in real time and space. This tutorial gives a brief introduction into the experimental tools of this emerging field and discusses recent progress in in ultrafast nano-optics.

We specifically discuss how ultrafast nano-optical techniques can be used to (i) visualize light propagation in novel photon waveguides, (ii) probe and manipulate coherent optical excitations in individual and dipole-coupled pairs of quantum dots, (iii) probe the dynamics of surface plasmon polariton excitations in metallic nanostructures, (iv) generate novel nanometer-sized ultrafast light and electron sources and (v) to reveal the optical interaction between excitons and surface plasmon polaritons in hybrid metal-semiconductor nanostructures. The results will indicate that combining light localization on nanometer-length and femtosecond time scales carries significant potential for realizing novel optoelectronic devices such as ultrafast nano-optical switches or surface plasmon polariton amplifiers and lasers.

15 min. break.

Tutorial TUT 2.3 Sun 17:50 HSZ 04

Near-field Dynamics Probed with Time-Resolved PEEM — •Michael Bauer — IEAP, Christian-Albrechts-Universität zu Kiel, Kiel, Germany

Photoemission Electron Microscopy (PEEM) in combination with nonlinear photoemission has recently attracted considerable attention due to its high sensitivity to light-induced collective (plasmonic) electron excitations in nanoscale objects at a lateral resolution in the 10 nm regime. A highly promising aspect in this context is the potential of two-photon PEEM to be performed in a time-resolved stroboscopic mode enabling real-time experiments at a temporal resolution in the femtosecond-regime. This allows one to monitor for instance the spatio-temporal dynamics of the local near-field associated with the plasmon mode.

This paper gives an overview of some recent results to exemplify the potential of the PEEM technique in this field. The focus is set on the investigation of periodic and random assemblies of silver nanoparticles in interaction with femtosecond light fields. Aspects, such as the imaging of local near fields [1] and the local field enhancement [2], plasmon dynamics [3], and the manipulation of local near-fields using coherent control schemes [4] will be addressed.

[1] L.I. Chelaru et al., Phys. Rev. B 73, 115416 (2006), L. Douillard al., Nanoletters 8, (2008) 935 [2] M. Chinchetti et al., Phys. Rev. Lett. 95 (2005) 257403 [3] A. Kubo et al., Nanoletters 5 (2005) 1123 [4] M. Aeschlimann et al., Nature 446 (2007) 301

TUT 3: Tutorial on Theory of Traffic Flow

Time: Sunday 16:00–19:00 Location: HSZ 403

Tutorial TUT 3.1 Sun 16:00 HSZ 403

A General Theory of Traffic Flow — •Dirk Helbing — ETH Zurich, Universitätstr. 41, 8092 Zürich, Switzerland

The multi-disciplinary study of traffic and transport has revealed many interesting observations such as the existence of a large variety of different congested traffic states and counterintuitive effects such as the slower-is-faster effect. At the same time, great theoretical progress has been made, which is reflected by a large number of models aiming at the reproduction of empirical or experimental findings. However, many of these models have been standing side by side, and an integrative view has been missing to a large extent. This has its roots in the fact that traffic constitutes a complex, self-organizing system, and there is no general theory of complex systems, in contrast to many-particle systems close to equilibrium.

This tutorial will present elements of an integrative approach to traffic systems. Starting from simple car-following models, it will be shown how to derive consistent macroscopic, fluid-dynamic-like traffic models. It will be discussed how the linear and non-linear stability properties of these models can be analytically studied, and what kinds of congested traffic states can be derived from the related instability diagram. If time allows, further issues such as effects of multi-class multi-lane traffic will be studied, as well as network effects and elements of traffic signal control.