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