HL 30: Plasmonics and Nanophotonics II (Joint Session with O/DS)

Time: Tuesday 15:00–16:30 Location: H2

HL 30.1 Tue 15:00 H2

Nanolocalization of time-reversed optical fields propagating in random scattering media — •Dominik Differt[1], F. Javier García de Abajo[2], and Walter Pfeiffer[1] — [1]Fakultät für Physik, Universität Bielefeld, Universitätstr. 25, 33516 Bielefeld, Germany — [2]Instituto de Optica, CSIC, Serrano 121, 28006 Madrid, Spain

The far field emission pattern of a nanoscale light emitter positioned in a nanoscale random scattering environment contains information about the localized emission. Because of the reciprocity of electromagnetic wave propagation time-reversing the outgoing wave creates an excitation that propagates back to the emitter and localizes on a sub-diffraction length scale. The electromagnetic response of a random scattering environment is calculated based on a multiple scattering approach. The here investigated scattering environment is characterized by a geometrical hierarchy. On a subwavelength scale the emitter is surrounded by metal nanoparticles acting as a random antenna coupling radiation to the far field. On the scale of tens of microns, several wavelengths distance to the emitter, this structure is embedded in randomly distributed dielectric scatterers acting a permeable reverberation shell. The degree of nanolocalization of a time-reversed planar wave component of the outgoing scattered wave depends on this geometrical hierarchy and the density of scatterers, i.e. the wave mixing occurring in the reverberation shell.

HL 30.2 Tue 15:15 H2

Towards Nanostructure-Enhanced High-Harmonic Generation — Murat Sivis[1], Katrin Siefermann[2], Yaxing Liu[2], Bernd Abel[2,3], and •Claus Ropers[1] — [1]University of Göttingen, Courant Research Center Nano-Spectroscopy and X-Ray Imaging, Friedrich-Hund-Platz 1, D-37077 Göttingen, Germany — [2]University of Göttingen, Department of Physical Chemistry, Tammannstr. 6, D-37077 Göttingen, Germany — [3]University of Leipzig, Wilhelm-Ostwald-Institute for Physical and Theoretical Chemistry, Linnestr. 2, D-04103 Leipzig, Germany

Recent efforts to utilize optical field enhancements in metallic nanostructures for high-harmonic generation (HHG) have generated significant interest [S. Kim *et al.*, Nature **453**, 575 (2008)]. Using local plasmon resonances, the threshold for HHG can be substantially reduced, allowing for HHG by using unamplified few femtosecond laser oscillators. To date, rather limited information on the characteristics and scaling behavior of the relevant processes is available.

Here, we present the first results of our study on harmonic generation with metallic nanostructures in the presence of a noble gas jet. We demonstrate the significant enhancement of harmonic generation of low orders. Experimental limitations and prospects of the approach are discussed.

HL 30.3 Tue 15:30 H2

Third-Harmonic Generation Spectroscopy in Hybrid Plasmonic Systems — •Tobias Utikal[1,2], Thomas Zentgraf[3], Markus Lippitz[1,2], and Harald Giessen[1] — [1]4. Physikalisches Institut, Universität Stuttgart — [2]Max-Planck-Institut für Festkörperforschung, Stuttgart — [3]NFS Nano-Scale Science and Engineering Center, University of California, Berkeley, USA

In this work we perform third-harmonic generation (THG) spectroscopy in metallic photonic crystals consisting of gold nanowires buried in a dielectric slab waveguide. In these structures particle plasmon polaritons, which are optically excited in the wires, can be hybridized with photonic waveguide modes, which are excited due to the periodic arrangement of the wires. By tailoring the structure geometry the spectrally broad particle plasmon resonance can exhibit an ultra-narrow and pronounced extinction dip. We excite this hybrid plasmonic system with 150 fs laser pulses which can be spectrally tuned over the modulated plasmonic resonance and measure the generated third-harmonic light. The experiments show that it is insufficient to deduce the shape of the THG spectrum from the linear extinction. It is rather essential to consider the full information of the linear response, i.e. amplitude and phase. We find indications that the increased group index and the associated slow light around the extinction dip leads to an increase in the THG signal.

HL 30.4 Tue 15:45 H2

Ultrafast optical nonlinearities in hybrid metal-semiconductor nanostructures — •Parinda Vasa[1], Robert Pomraenke[1], Wei Wang[1], Stephan Schwieger[2], Erich Runge[2], and Christoph Lienau[1] — [1]Carl von Ossietzky Universitaet, Institut fuer Physik, 26111 Oldenburg, Germany — [2]Technische Universitaet Ilmenau, Institut fuer Physik, 98684 Ilmenau, Germany

Understanding and manipulating the interactions between quantum emitters and Surface Plasmon Polaritons (SPPs) is the key to designing and implementing novel nano-optical devices such as nanolasers or ultrafast optical switches. We report the first measurement of an ultrafast optical nonlinearity resulting from the strong interaction between SPPs excited on a gold grating and excitons in either a semiconductor QW or a J-aggregated cyanine dye. The hybrid nanostructures are characterized using far-field linear reflectivity as well as photoluminescence measurements and exhibit enhanced SPP-exciton coupling in the linear optical regime. The experimental results are explained within a phenomenological, coupled oscillator model. The nonlinearity is investigated by low-temperature, angle-resolved, ultrafast pump-probe spectroscopy with 20-fs-time resolution. Due to the strong coupling a significant shift in the resonance wavelength and changes in the response time of the third order nonlinearity of the exciton are observed. Such a strong ultrafast nonlinear interaction between metal and excitons will be of key importance to amplify SPP excitations in such hybrid structures.

HL 30.5 Tue 16:00 H2

Plasmon Hybridization Enhances the Nonlinear Response of Single Metal Nanoparticles — •Thorsten Schumacher[1,2], Kai Kratzer[1,2], David Molnar[1,2], and Markus Lippitz[1,2] — [1]Max-Planck-Institut für Festkörperforschung, Stuttgart — [2]4. Physikalisches Institut, Universität Stuttgart

The optical investigation of single metal nanoparticles is limited to rather large sizes due to their weak influence on focused laser radiation. Therefore it is very difficult to detect small dielectric variations, which is crucial for modern plasmonic nanosensors. We induce small, periodic variations of a nanoparticle's plasmonic properties by a heating pump puls that triggers acoustical breathing oscillations. The particle's response is monitored by a probe pulse. An optical nanoantenna increases the influence of these single dielectric objects on the laser focus. Such an antenna can be implemented by placing a bigger nanoparticle close to the smaller one that is probed.

We will show measurements of single metal nanoparticles' acoustic breathing modes as well as their first antenna enhanced detection. A model of the antenna-effect of plasmon hybridisation is presented. At the end, it allows us to analyze the individual nanomechanical properties of tiny single metal nanoparticles and study plasmonic coupling effects, without averaging over big ensembles.

HL 30.6 Tue 16:15 H2

Enhanced Raman scattering at nanoparticles and gratings with nanoparticles — •Manuel Gonçalves and Othmar Marti — Universität Ulm - Inst. für Experimentelle Physik, Albert-Einstein-Allee 11, 89081 Ulm, Deutschland

Silver and gold nanoparticles of triangular shape in periodic arrays are appropriate templates for molecular detection by means of surface enhanced Raman scattering (SERS). The near-field enhancements may reach 100 and the corresponding Raman electromagnetic enhancements are of the order of 10^8. On the other hand, surface plasmon modes supported in gratings contribute as well to near-field enhancements, and allow an easy excitation of the long-range surface plasmons in the grating.

We show how plasmonic systems built of gratings and nanoparticles can be of interest for SERS, and how strong near-fields may be achieved. SERS measurements done with a confocal Raman microscope permit to study the dependence of near-field intensity on the shape of the particle and on the excitation conditions.