In hybrid systems which consist of semiconductor nanostructures and dielectric photonic crystals significant aspects of the light-matter interaction can be tailored. Such structures are described by a microscopic theory which provides a self-consistent solution of the dynamics of the electromagnetic field and the material excitations. The theory is applied to investigate spatial inhomogeneneities of the optical properties, in particular, excitonic resonances, wave packet dynamics, and the optical gain are analyzed [1,2]. Additionally, the optical properties of quantum wells embedded in one-dimensional photonic crystals are investigated. If such structures are placed inside a microcavity, the gain increases superlinearly with the number of wells [3].

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Q 35.8 Di 16:30 Labsaal

Nonlinear time-domain simulations with exponential integrators using Krylov-subspace methods — •Martin Pototschnig[1], Jens Niegemann[1,2], Lasha Tkeshelashvili[3,2], and Kurt Busch[1,3,2] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe — [2]DFG Forschungszentrum Center for Functional Nanostructures (CFN), Universität Karlsruhe — [3]Institut für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft

In recent years, nonlinear optical systems have attracted broad interest. We propose to use exponential-integrators combined with Krylov-subspace methods to solve the corresponding nonlinear time-dependent Maxwell equations as well as coupled optical quantum-mechanical systems, such as the Maxwell-Bloch equations. These techniques are known to be well suited for highly oscillatory and stiff problems and, therefore, we expect fast and accurate simulations. We will present comparisons of the performance and accuracy of our approach relative to commonly used methods, in particular to nonlinear Finite-Difference Time-Domain techniques. In addition, we demonstrate that the method is capable of describing the Non-Markovian radiation dynamics of emitters in finite Photonic Crystals.

Q 35.9 Di 16:30 Labsaal

Numerical Investigation of Magnetic Metamaterials — •Sven Burger, Benjamin Kettner, Lin Zschiedrich, and Frank Schmidt — Zuse Institute Berlin, Takustraße 7, D - 14195 Berlin

Arrays of miniaturized split ring resonators allow to realize systems with a negative effective permeability in the near infrared regime [1,2]. We discuss the use of adaptive, higher-order, vectorial finite elements for the numerical simulation of the time-harmonic light field in the elementary cell of the periodic array [3]. These methods allow us to investigate resonances of the system.

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Q 35.10 Di 16:30 Labsaal

Phase-resolved pulse propagation in metallic photonic crystal slabs — •Anja Schönhardt[1], Dietmar Nau[1], Hedi Gräbeldinger[2], Christina Bauer[3], and Harald Giessen[2] — [1]Institut für Angewandte Physik, Universität Bonn, 53115 Bonn — [2]4. Physikalisches Institut, Universität Stuttgart, 70550 Stuttgart — [3]Max-Planck Institut für Festkörperforschung, 70569 Stuttgart

We present measurements of the electromagnetic field of ultra-short laser pulses after propagation through metallic photonic crystal structures featuring simultaneous photonic and plasmonic resonances. We used cross-correlation frequency resolved optical gating to measure the complete pulse information, i.e., the envelope and phase of the electromagnetic field. In good agreement, measurements and scattering matrix simulations [1] show a dispersive behavior of the spectral phase at the position of the resonances. Asymmetric Fano-type resonances go along with asymmetric phase characteristics. Furthermore, the spectral phase is used to calculate the dispersion of the sample. Possible application in dispersion compensation is investigated. The behavior of the extinction and the spectral phase can be understood from a fundamental model using the complex transmission amplitude [2,3]. An associated depiction in the complex plane is a new approach in this context [3]. This method promises to be of valuable use also in photonic crystal and filter design, for example with regards to symmetrization of the resonances.

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Q 35.11 Di 16:30 Labsaal

Plasmonic metal-semiconductor-metal photodetectors — •Jurana Hetterich[1], Ulf Geyer[1], Georg Bastian[1], Gero von Plessen[2], and Sergei G. Tikhodeev[3] — [1]Lichttechnisches Institut, Universität Karlsruhe, Kaiserstr. 12, 76131 Karlsruhe, Germany — [2]I. Physikalisches Institut, RWTH Aachen, 52056 Aachen, Germany — [3]A .M. Prokhorov General Physics Institute RAS,Vavilova 38, Moscow 119991, Russia

We have investigated the interplay of plasmonic field enhancement and semiconductor absorption in planar metallic photonic crystals consisting of periodically patterned gold and silver deposited on GaAs/GaInNAs heterostructures. Our goal is to exploit the resulting resonance effects to fabricate a novel class of fast metal-semiconductor-metal (MSM) photodetectors. We have established a new technique for the fabrication of metallic electrodes with dimensions below 100 nm, which are expected to perform two tasks: First, surface plasmon polaritons improve the light transmission through the metal layer, and the local field enhancement associated with these excitations increases the optical absorption in the semiconductor. Second, optically generated electrons and holes are rapidly extracted into the metallic electrodes like in conventional MSM photodetectors. We present theoretical calculations based on the scattering matrix approach and compare the results with experimental spectral and dynamical properties. The resulting ultimate limits of quantum efficiency and bandwidth depending on the absorption properties, RC-times and carrier transit times will be discussed.

Q 35.12 Di 16:30 Labsaal

Properties of Low Refractive Index Supports Made of Mesoporous Silica — •Denan Konjhodzic, Helmut Bretinger, and Frank Marlow — Max-Planck-Institut für Kohlenforschung, D-45470 Mülheim an der Ruhr

Mesoporous silica thin films were synthesized by dip-coating in evaporation-induced self-assembly process. In this modified sol-gel process a nonionic triblock copolymer has been used as a template. The formed structure depends strongly on the processing conditions, especially humidity. Film thickness can be tuned by drawing rate. The structures of two different types of films were investigated by small angle x-ray scattering, transmission electron microscopy and atomic force microscopy [1]. Low humidity allows reproducible synthesis of low refractive index films, which were used as optical waveguide supports.

Here we investigate the influence of processing parameters on their optical properties. Refractive index, birefringence and film thickness were determined by angular-dependent interferometry. Porosity can be determined from refractive index applying different effective media models. The film scattering was characterized in the visible spectral range.

In another sol-gel process very transparent PZT films were synthesized and deposited onto mesoporous films. The compatibility of these films with mesoporous supports is investigated.

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Q 35.13 Di 16:30 Labsaal

QED in an absorbing crystal: the fate of the band structure — •Andreas Kurcz and Carsten Henkel — Institut für Physik, Universität Potsdam, Germany

The Bloch theorem is of fundamental importance for the field quantization in a periodic medium because the quasi-periodic Bloch functions can be used as modes. This approach becomes problematic in the presence of absorption because the Bloch frequencies are complex [1]. We generalize the mode expansion of the field operator using a quantization scheme for the macroscopic Maxwell equations [2,3]. The usual Bloch modes are recovered for vanishing absorption. We also show that the band structure in the (k, ω)-plane gets broadened by the absorption. The calculation is based on the spontaneous decay of a collective state of N two-level systems, similar to the emission by a phased antenna array.