conductors, since they capture more and more fields of application (e. g. light emitting diodes, organic photovoltaics). It is known that the Einstein relation, which states that the ratio of the diffusion to the mobility equals the thermal voltage, does not hold for organic semiconductors with a gaussian density of states distribution. Deviations were observed in the case of high energetic disorder and low temperatures. We studied these deviations by means of Monte Carlo simulations, paying particular attention to the so far mostly neglected electric field. We discuss the relevance of our findings to the physical description of organic devices.

HL 9.96 Mon 14:30 P2

Observation of single quantum dots in GaAs/AlAs micropillar cavities — •Philipp Burger, Matthias Karl, Dongzhi Hu, Daniel M. Schaadt, Heinz Kalt, and Michael Hetterich — Institut für Angewandte Physik and DFG Center for Functional Nanostructures (CFN), Universität Karlsruhe (TH), 76128 Karlsruhe, Germany

In our contribution we present the fabrication steps of micropillar cavities and their optical properties. The layer structure consisting of a GaAs-based lambda-cavity sandwiched between two GaAs/AlAs distributed Bragg reflectors is grown by molecular-beam epitaxy. In(Ga)As quantum dots, emitting at around 950 nm, are embedded as optically active medium in the middle of the cavity. The pillars are milled out of this structure with a focused ion-beam. A confocal micro-photoluminescence set-up allows to measure optical cavity modes as well as single quantum dots in the pillars when using low excitation intensity. This enables us to observe a (thermal) shift of the single quantum dot peaks relative to the cavity mode. In addition, we increased the numerical aperture of the set-up (originally 0.4) with a solid immersion lens up to 0.8. Thus we are able to detect the fundamental mode of pillars with very small diameters. Furthermore, the collection efficiency increases substantially.

HL 9.97 Mon 14:30 P2

Few-Photon-Quantum Transport Through a Photonic-Crystal Waveguide With A Two-Level System — •Paolo Longo[1], Kurt Busch[1,2], and Peter Schmitteckert[2] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe (TH) — [2]Institut für Nanotechnologie, Forschungszentrum Karlsruhe

Quantum optics in photonic crystals is a very fascinating field of research. Recent work [1] shows that scattering of a two-photon state with a two-level impurity is qualitatively different from single-particle physics which effectively enables the possibility to induce interactions between photons.

Exact numerical studies of the interaction of a multi-photon, multi-moded, quantized light field with a single two-level impurity are presented. The time evolution of photonic wave-packets, observables and correlation functions can be calculated by using a discrete finite-lattice version of a generalized Dicke-Hamiltonian.

For first considerations the Hamiltonian is reformulated as a tight-binding model,

$$H = -t\sum_{i=1}^{M-1}(a^\dagger_{i+1}a_i + a^\dagger_i a_{i+1}) + \frac{\Omega}{2}\sigma_z + V(a^\dagger_l\sigma^- + a_l\sigma^+),$$

with which we evolute photonic quantum states in time in order to calculate scattering properties of single- und multi-photon states.

[1] J. T. Shen and S. Fan, Phys. Rev. Lett. 98, 153003 (2007).

HL 9.98 Mon 14:30 P2

Untersuchungen von Metamaterialien aus Split-Ring-Resonatoren bei Millimeterwellen — •Andreas Schneider, Sebastian Engelbrecht, Alexey Shuvaev und Andrei Pimenov — Experimentelle Physik 4, Universitaet Wuerzburg, Am Hubland D-97074 Wuerzburg

In dieser Arbeit wurden Millimeterwellen-Eigenschaften von Metamaterialien bestehend aus Split-Ring-Resonatoren (SRR) in einem Frequenzbereich von ca. 60 GHz bis 260 GHz untersucht. Split-Ring-Resonatoren sind wegen ihrer ungewöhnlichen Eigenschaften, wie Magnetismus, Bianisotropie oder negativer Brechung besonders interessant. Konventionelle Methoden des Elektromagnetismus eignen sich nicht zur Charakterisierung der SRR, da sie zusätzlich zur ihrer dielektrischen Funktion (ϵ) und ihrer Permeabilität (μ) einen Kreuzterm, den sog. Bianisotropie-Term (ξ), besitzen. Die daraus resultierenden Zusatzeffekte können nicht vernachlässigt werden und erfordern spezielle Verfahren zur Bestimmung der elektromagnetischen Eigenschaften. Für die Millimeterwellen Experimente wurden die SRR mit einem Standardverfahren der Photolitographie auf Textolitplatinen hergestellt. Zur Charakterisierung der Split-Ring-Resonatoren wurden Transmissionsspektren und ihre zugehörigen Phasen für sechs verschiedene Anregungsgeometrien der Ringe gemessen. Mittels einer Transfermatrixmethode wurden komplexe Transmissionsfunktionen berechnet. Die komplexen Größen ϵ, μ und ξ wurden direkt aus den Transmissions- und Phasenwerten in der Nähe der Resonanzfrequenz bestimmt.

HL 9.99 Mon 14:30 P2

Sources as an Extension of the Fourier Modal Method — •Christian Klock[1], Thomas Zebrowski[1,2,3], Sabine Essig[1,2,3], and Kurt Busch[1,2,3] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe — [2]Karlsruhe School of Optics & Photonics (KSOP) — [3]DFG Center for Functional Nanostructures (CFN)

The Fourier Modal Method (FMM) enables the study of electromagnetic field distribution in structures with periodicity in the lateral plane. A nonlinear conformal coordinate mapping realizes absorbing boundaries and also allows us to treat aperiodic, finite-sized structures. Commonly, the method is used to simulate a system's response to an incoming wave.

Our poster illustrates how to extend the method to include the emission from line sources in 2D and point sources in 3D. We present comparisons of numerical and analytical field distributions for the case of an emitter in an infinite dielectric cylinder. Furthermore, we demonstrate the method's potential for applications related to the designs of structured, plasmonic enhanced light emitting diodes.

HL 9.100 Mon 14:30 P2

Modelling of metamaterials using a coupled dipole approach — •Jens Küchenmeister[1], Sabine Essig[1,2,3], Lasha Tkeshelashvili[1,3], and Kurt Busch[1,2,3] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe — [2]Karlsruhe School of Optics & Photonics (KSOP), Universität Karlsruhe — [3]DFG Centrum für Funktionelle Nanostrukturen (CFN), Universität Karlsruhe

Controlling the properties of metamaterials using different sizes and shapes of the basic building blocks, i.e. metallic nanostructures allows for a far-reaching control of the effective material properties. Fully numerical approaches via, e.g., the Fourier Modal method (FMM) or the Finite Element Method that directly solve Maxwell's equations require siginificant computational resources and are usually not suitable for design studies.

We present a coupled-dipole approach to metamaterials which allows for efficient parameter studies. The model contains few free parameters that are determined by comparison with exact numerics via FMM for simple systems such as periodic arrays of metallic rods. More complex structures can be systematically constructed, thus providing physical insights and allowing for rapid designs studies. We apply this approach to certain (chiral) multi-layer structures.

HL 9.101 Mon 14:30 P2

Transmission line circuit analysis of split-ring resonator metamaterials — •Liwei Fu, Heinz Schweizer, and Harald Giessen — 4th Physics Institute, University of Stuttgart, 70550 Stuttgart, Germany

Split-ring resonators (SRRs) are well studied due to their application potentials for superlenses, cloaking devices, perfect absorbers, and magnetic levitation. There are different interpretations about the dependence of their resonance frequency on structure parameters using LC circuit models. However, these models can not explain the blue-shift of the resonance frequency with the metal thickness [1]. In this report, we show that by distinguishing between series impedance and shunt admittance and by fitting the numerical results using transmission line circuit models [2,3], we can quantitatively derive the dependence of the circuit parameters on the SRR structure parameters. Novel thickness dependent interpretations will be given. Clear physical insight in SRR-based metamaterials is obtained.

[1] H. Guo, N. Liu, L. Fu, S. Kaiser, H. Schweizer, and H. Giessen, Phys. Stat. Sol. (b) 244, 1256 (2007).

[2] L. Fu, H. Schweizer, H. Guo, N. Liu, and H. Giessen, Phys. Rev. B, 78, 115110 (2008).

[3] L. Fu, H. Schweizer, H. Guo, N. Liu, and H. Giessen, Appl. Phys. B 86, 425 (2007)

HL 9.102 Mon 14:30 P2

Modification of emission of internal emitters in Photonic Crystals — •Rebecca Wagner, Sven Zimmermann, and Frank Cichos — Molecular Nanophotonics Group, University of Leipzig,