Q 16: Photonics II

Time: Monday 16:30–18:30 Location: A 310

Q 16.1 Mon 16:30 A 310

Experimental demonstration and control of pulsed modulation — •Maximilian Brinkmann, Michael Kues, and Carsten Fallnich — Institut für Angewandte Physik, Westfälische Wilhelms-Universität, Corrensstr. 2, 48149 Münster

Modulation instability refers to the process in which a weak perturbation of an electromagnetic wave is exponentially amplified due to a nonlinear phase matching condition. The process is known to affect cw-signals in optical fibers and leads to the generation of multiple sidebands symmetrically spaced around the pump frequency. The effect also plays an important role in the initial stage of fiber supercontinuum (SC) generation with pulsed laser sources. However, so far only one pair of sidebands has been observed using pulsed laser sources, namely at the maxima of the gain curve. Here we report the generation of multiple sidebands in a microstructured fiber using only a short (few ps) chirped pump pulse in combination with a frequency-shifted weak seed pulse acting as a perturbation. The seed pulse is extracted from a prior formed SC. The generated sidebands have a minimum 3-dB linewidth of 2 THz, span over the whole parametric gain-spectrum of the pump (more than 300 THz) and can be shifted as close to the pump as 10 THz. The exact frequency and power of the sidebands can be simply controlled via the power and frequency of the seed. Thereby this technique bears the potential to be used as a multiwavelength laser pulse source. The experimental results agree with simulations based on the nonlinear Schrödinger equation and with analytic expressions.

Q 16.2 Mon 16:45 A 310

Exploring whispering-gallery modes in rolled-up vertical microcavities — •Stefan Böttner[1], Shilong Li[1], Matthew R. Jorgensen[1], and Oliver G. Schmidt[1,2] — [1]Institute for Integrative Nanosciences, IFW Dresden, Helmholtzstr. 20, 01069 Dresden, Germany — [2]Material Systems for Nanoelectronics, Chemnitz University of Technology, Reichenhainer Str. 70, 09107 Chemnitz, Germany

Vertically rolled-up microcavities (VRUMs), have a fascinating resonator geometry that confines light in a vertical plane. By carefully designing patterns before roll-up using standard photolithography, the VRUM shape can be tuned to facilitate axial light confinement and a reduction of optical losses to the substrate, both enhancing the optical quality factor [1, 2]. Furthermore VRUMs can be fabricated in large scales and integrated fabrication is, in principle, possible. Their thin walls lead to evanescent fields useful for a variety of applications such as microfluidic sensing or wavelength filtering in optical data processing.

In this talk we present fabrication methods of nontoxic low refractive index SiO_2 VRUMs and corresponding optical measurements. We detect optical resonances with high quality factors of more than 5000 using a photoluminescence setup [2]. In a second approach we use evanescently coupled tapered fibers to investigate optical properties at 1550 nm far from the photoluminescence of the VRUMs. This method is also favorable for integrated applications.

[1] Ch. Strelow et al., Phys. Rev. B. **85**, 155329 (2012).
[2] S. Böttner et al., Opt. Lett. **37**, 5136 (2012).

Q 16.3 Mon 17:00 A 310

Directional emission of dielectric disks with a finite scatterer in the THz regime — •J. Evers[1], S. I. Schmid[1], S. Preu[2], F. Sedlmeir[3,4], G. Leuchs[3,4], and H. G. L. Schwefel[3,4] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg — [2]Lehrstuhl für Angewandte Physik, Universität Erlangen-Nürnberg, D-91058 Erlangen — [3]Institut für Optik, Information und Photonik, Universität Erlangen-Nürnberg, D-91058 Erlangen — [4]Max-Planck-Institut für die Physik des Lichts, D-91058 Erlangen

Directional emission of a whispering gallery mode resonator perturbed by a small hole acting as a scatterer in the vicinity of the resonator edge is discussed. We model the setup using finite-difference time-domain (FDTD) calculations of the electromagnetic field in a spatial region containing the resonator, but not the detector placed at larger distance in the far field. We then extrapolate the detection signal based on a Poynting vector analysis of the FDTD data. The numerical predictions agree well to experimental data obtained with cm scale resonators in the Terahertz domain.

Q 16.4 Mon 17:15 A 310

Chemical surface protection of optical microfibres examined with Raman spectroscopy — •Jan Hartung, Marcel Spurny, Wolfgang Alt, and Dieter Meschede — Institut für Angewandte Physik, Universität Bonn

The strong evanescent field of tapered optical microfibres makes them an excellent tool for light-matter interaction experiments. However, their high sensitivities to surface adsorbed molecules impose a problem: Microfibre transmission can be strongly influenced by surface adsorbates and chemical reaction of dangling bonds with the surrounding medium, especially in a chemically aggressive environment such as hot caesium vapour.

We present a method for surface passivation of tapered optical microfibres by silylation with methyl chlorosilanes and the examination of our microfibre samples with Raman spectroscopy before and after the treatment. This chemical surface passivation extends the range of environments in which optical microfibres can be used.

Q 16.5 Mon 17:30 A 310

Soliton molecules: possibility of fibre-optic transmission of two bits per clock period — •Alexander Hause, Philipp Rohrmann, and Fedor Mitschke — Universität Rostock, Institut für Physik, Universitätsplatz 3, 18051 Rostock

New concepts of optical data transmission are demanded in the near future. Most common coding principles rely on transmitting weak light pulses to avoid perturbations arising from fiber nonlinearity. In contrast we propose a soliton-based concept which includes nonlinear effects in dispersion-managed fibers. Using trains of solitons also known as soliton molecules it is possible to have more symbols for a new coding scheme available. Recently we succeeded to show the existence of a two- and three-soliton molecule in a proof-of-principle experiment[1]. With this achievement it is shown to be possible to transmit 2 bits of information in a single clock cycle.

Here we present experimental results and comparisons with numerical data. The multi-soliton input states are created using a pulse shaper. Parameter scans reveal molecule properties. Finally a full amplitude and phase reconstruction of the soliton molecules is done with a homemade FROG setup. We obtain a good agreement between experimental and numerical results.

[1] P. Rohrmann et al., Scientific Reports **2**, 866 (2012)

Q 16.6 Mon 17:45 A 310

On the possible creation of short intense pulses from a family of solutions of the NLSE — •Christoph Mahnke and Fedor Mitschke — Institut für Physik, Universität Rostock

The Nonlinear Schrödinger equation (NLSE) governs the propagation of light fields in optical fibers. We consider a family of solutions including the Akhmediev Breather (AB), the Peregrine soliton (PS), and the Kuznetzov-Ma soliton (KM). Despite being known for a long time, the existence of PS and KM were confirmed in experiments just recently [2,3]. All three solutions share the property that their field consists of a cw part with a modulation on top of it. This combination leads to a growth of the modulation up to a culmination value during propagation, and subsequent decay. The AB and the KM have in common that the modulation exhibits an infinitely broad extent in one coordinate (time or space) but is localized in the other. The PS case is a transition between these two and is localized in both time and space.

We investigate whether it is possible to utilize the growth of the modulation to create short, powerful pulses from the culmination state. We present a technique to isolate the amplified modulation by splitting and recombining the field with suitable time and phase shifts. We discuss the properties of the extracted pulses and the limitations of our method.

[1] N.N. Akhmediev, V.I. Korneev, Th. Math. Phys. 69, 1089 (1986)
[2] B. Kibler et al., Nature Physics 6, 790 (2010)
[3] B. Kibler et al., Scientific Reports 2, article number 463 (2012)

Q 16.7 Mon 18:00 A 310

Kicked Rotor Dynamics in Optical Fibers — •Felix Ziegler, Marius Blaesing, and Sandro Wimberger — Institut für Theoretische Physik, Philosophenweg 19, 69120 Heidelberg

A new perspective of the well-known quantum kicked rotor model is offered by recent experiments investigating the dynamics of optical signals in fibers with nonlinearities. We consider the properties of a kicked particle wave function in position space in order to explain experimental data. The wave function is calculated by a modulation integral over the quasimomentum, which results from Bloch's theorem. For small kicking parameters the wave function shows a continuous dependence on the kicking strength. This can be explained by a tunnelling process of a particle in the ground band in a periodic potential. For higher values of the kicking strength the dynamics of the wave function exhibit a more interesting behaviour. The survival probability of the wave packet to stay in the central zone of the periodic potential shows either localisation or delocalisation depending on the kicking strength. This is in good qualitative accordance with the experiment. To explain this phenomenon, we use the fact that the kicking period corresponds to the effective $\hbar$. Semi-classical and quantum mechanical properties of the system are analysed with respect to tunnelling processes and classical phase space structures.

Q 16.8 Mon 18:15 A 310

Probing Planck's Law for a Silica Nanofiber — •Christian Wuttke and Arno Rauschenbeutel — VCQ TU Wien - Atominstitut, Stadionallee 2, A-1020 Wien

We investigate the thermalization via heat radiation of a silica fiber with a diameter smaller than the thermal wavelength. The temperature change of the subwavelength-diameter fiber is determined through a measurement of its optical path length in conjunction with an ab initio thermodynamic model of the fiber structure. The results differ significantly from the predictions of Planck's law based on the spectral emissivity of silica. Excellent agreement is obtained with a theoretical model that considers heat radiation as a volumetric effect and that takes the emitter shape and size relative to the emission wavelength into account. These results are of fundamental interest, may lead to technical applications, and can contribute to improved models of the earth's climate system