Q 57: Photonik I

Zeit: Freitag 10:30–12:30 Raum: Audi-A

Q 57.1 Fr 10:30 Audi-A

Visualization of the Gödel Universe — •Michael Buser[1], Endre Kajari[1], Wolfgang P. Schleich[1], Frank Grave[2], Günter Wunner[2], and Hanns Ruder[3] — [1]Universität Ulm — [2]Universität Stuttgart — [3]Universität Tübingen

The Gödel universe is an intriguing solution of the Einstein's field equation and was found by Kurt Gödel in 1949. It is the first cosmological solution of a universe which includes closed time-like worldlines on which an observer can travel back in time. In our talk we address the issue how an observer located in such a universe would perceive his surrounding visually. This is particularly interesting since the Gödel universe provides a couple of compelling optical effects such as the existence of an optical horizon. Since the light propagation, which determines the visual appearance of objects to an observer, is intrinsically tied to the curvature of the underlying spacetime, the visualization we present in our talk also gives an deeper insight into the structure of the Gödel universe.

Q 57.2 Fr 10:45 Audi-A

Detection and Spectroscopy of Preselected Single Nanoparticles Soft-Landed on Optical Fibre Tapers — •Alexander Kuhlicke, Markus Gregor, and Oliver Benson — Humboldt-Universität zu Berlin, Institut für Physik, AG Nano-Optik, Hausvogteiplatz 5-7, 10117 Berlin

Due to their evanescent field, tapered optical fibres offer the opportunity for efficient sensing and probing of nano-sized particles on or near their surface. We developed a method to place single dye-doped polystyrene beads on tapered fibres with the help of a linear Paul-trap and to detect them by the change of the fibre transmission as well as through their fluorescence collected by the fibre.
Our segmented trap geometry allows for high degree of spatial control of the particles inside the trap. It is possible to confine several particles at once, move them within the trap and separate a single particle from the others. The fluorescence spectrum of such a preselected particle can be taken before it is placed on the fibre taper.
This method of controllably storing several and manipulating single particles permits to repeat a landing experiment several times without the necessity to reload the trap and also avoids deposition of unwanted particles on the taper.
We present recent results concerning the detection of single nanoparticles placed on a tapered optical fibre and give an outlook on possible applications of such a system.

Q 57.3 Fr 11:00 Audi-A

Integrated photonic devices in organic media for optical networks — •Christian Stark, Jens Adams, Jonas Gortner, and Susanna Orlic — Optical Technologies Lab, Technische Universität Berlin

Integrated photonic devices represent an essential part of modern network technology. Photosensitive organic materials provide a powerful and flexible solution to build these devices. Compact de/multiplexers for WDM can be created by combining waveguides with holographic grating filters. We compare different approaches to writing waveguides for operation in the single mode regime. Methods to maximize the field overlap within the fiber are investigated in order to minimize coupling losses. Increasing integration of network systems demands continuous shrinking of individual devices. Thus we look for possibilities of decreasing bending losses. Waveguides with different geometries and refractive index profiles are analyzed in terms of field distribution, coupling and bending losses. Holographic WDM filters are created by transferring an interference patterns created by two laser beams into a periodic index modulation of a photopolymer bulky sample. We show filter characteristics of holographic gratings and discuss their applicability in WDM networks.

Q 57.4 Fr 11:15 Audi-A

Amplitude and Phase Dynamics in Silicon Compatible Waveguides with Highest Kerr-Nonlinearities — •Nicole Lindenmann[1], Thomas Vallaitis[1], René Bonk[1], Christian Koos[2], Wolfgang Freude[1], and Juerg Leuthold[1] — [1]Institute for Photonics and Quantum Electronics , University of Karlsruhe, 76131 Karlsruhe, Germany — [2]Carl Zeiss AG, Corporate Research and Technologies, 73447 Oberkochen, Germany

Hybrid integration of silicon waveguides with nonlinear organic materials is a way to enhance nonlinear optical properties of silicon-on-insulator nanophotonic devices. Highly nonlinear slot waveguides have been fabricated using deep-UV lithography, standard CMOS processing, and organic molecular beam deposition of a small molecule with a high third-order optical polarizability. The waveguides feature ultrafast Kerr-nonlinearities with nonlinear parameters of 104000 1/[W km] and without measurable impairment by two photon induced free carriers. Amplitude and phase dynamics of these waveguides have been characterized using a heterodyne pump-probe technique.

Q 57.5 Fr 11:30 Audi-A

Superkontinuumserzeugung in einem Glasfaser-Ringresonator — •Sebastian Knitter, Michael Böhm, Felix Bremerkamp und Fedor Mitschke — Institut für Physik, Universität Rostock, Universitätsplatz 3, 18055 Rostock

Verschiedenste Anwendungen erfordern spektral breitbandige und raumkohärente Lichtquellen. Superkontinuumsquellen [1], in denen das Spektrum von ultrakurzen Pulsen in Glasfasern unter Einwirkung nichtlinearer Effekte verbreitert wird, erfüllen diese Anforderungen. Im Gegensatz zur etablierten „single-pass“-Methode [2] ist in unserem System die (mikrostrukturierte) Glasfaser in einem passiven Ringresonator eingebaut und wird von einem modengekoppelten Nd:YAG-Laser synchron gepumpt.

Durch die Rückkopplung erfolgt die spektrale Verbreiterung besonders wirkungsvoll. Wir konnten mit Pumppulsen einer Dauer von 15 ps und einer Spitzenleistung von 500 W ein Spektrum erzeugen, das sich über 160 THz erstreckt. Bei Verstimmung der Ringlänge bezüglich der Wiederholfrequenz des Pumplasers entstehen THz-Frequenzkämme.

In numerischen Simulationen und Laborexperimenten wurde untersucht, wie sich die besonderen Dispersionseigenschaften der Glasfaser auf die Erzeugung des Superkontinuums auswirken. Die in der Numerik identifizierten Prozesse beschreiben die Lage der dominanten Strukturen im experimentellen Spektrum gut.

[1] J. Dudley et al., Rev. Mod. Phys. **78**, 1135 (2006)
[2] J. Ranka et al., Opt. Lett. **25**, 25 (2000)

Q 57.6 Fr 11:45 Audi-A

Nonlinear optics and interferometric sensing with subwavelength-diameter optical fibres — •Dimitri Pritzkau, Ulrich Wiedemann, Konstantin Karapetyan, Wolfgang Alt, and Dieter Meschede — nstitut für Angewandte Physik, Wegelerstr. 8, 53115 Bonn

We report on the progress of our project aimed on investigation of subwavelength-diameter optical fibres application for non-linear optics as well as molecule detection and manipulation. A subwavelength-diameter fibre is manufactured from a commercial optical fibre by flame- heating and stretching in a specially built fibre pulling machine. We are using fibres with the waist of about 500 nm diameter and several millimeters length. Due to the subwavelength diameter, more than half of the electromagnetic field of the guided light propagates outside the fibre, in the evanescent wave. For the investigation of non-linear effects, a Ti:Sa laser tunable between 850 and 1020 nm and operating in both mode-locked and CW modes is used.

Previous experiments have demonstrated the possibility of third-harmonic generation using the non-linearity of the silica fibre itself. However, efficiency of just 10^{-6} has been obtained so far. Our goal is to achieve highly efficient third-harmonic generation by interaction of the evanescent field with dense caesium vapour. A different application of interest is the dispersive detection of surface-adsorbed molecules using a dual-mode in-fibre Mach-Zehnder interferometer.

The current status of our research as well as the analysis of self-phase modulation recently observed in our lab will be presented.

Q 57.7 Fr 12:00 Audi-A

Optimization of microcavities in diamond-based photonic crystals — •Janine Riedrich-Möller, Elke Neu, and Christoph Becher — Fachrichtung 7.3 (Technische Physik), Universität des Saarlandes, Campus E 2.6, 66123 Saarbrücken

In recent years color centers in diamond have attracted significant interest as isolated, photostable single photon emitters. For many future applications of color centers, e.g. quantum networks or probabilistic quantum computers [1], it is essential to couple these single emitters to a cavity mode of high Q-factor and small modal volume. Microcavities in diamond-based photonic crystal slabs offer the possibility for efficient coupling and large enhancement of the spontaneous emission (Purcell effect). Using Fourier- and real space analysis (FDTD), we optimize the structure according to the principles of "gentle confinement"[2]: By gentle variation of the field envelope vertically radiated power can be suppressed and the Q-factor can be improved significantly up to $Q \approx 320000$ at a modal volume of $V = 0.35(\lambda/n)^3$. In practice, the Q-factor is primarily limited by absorption of the dielectric material. We investigate the influence of material absorption and discuss possible techniques to fabricate photonic crystal structures in thin nanocrystalline diamond films.

[1] S. Prawer and A. D. Greentree, Science **320**, 1601 (2008)
[2] Y. Akahane, T. Asano, B.-S. Song and S. Noda, Nature **425**, 944 (2003)

Q 57.8 Fr 12:15 Audi-A

A fully tunable ultra-high Q whispering-gallery-mode microresonator – experimental results and use for ultralow-power photonics applications. — •Michael Pöllinger, Danny O'Shea, and Arno Rauschenbeutel — Abteilung QUANTUM, Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz

We present experimental results on a fully tunable whispering-gallery-mode microresonator. Our so-called "bottle microresonator" confines light by a mechanism similar to the confinement of electrons or ions in a magnetic bottle. In contrast to microspheres and microtori, where the light is typically guided in a narrow ring along the equator of the structure, the prolate shape of the bottle microresonator gives rise to an advantageous mode structure, containing equidistantly spaced axial modes similar to a Fabry-Pérot microcavity. The frequency spacing of these modes only depends on the curvature of the resonator profile and thus allows tuning the resonator to an arbitrary frequency. This is not possible for other WGM geometries due to their large mode spacing. Moreover, the resonator yields an ultra-high intrinsic quality factor of 3.6×10^8 and a mode volume around 1300 μm^3. These values in conjunction with the tunability reveal the enormous potential of our bottle microresonator for cavity quantum electrodynamics applications and nonlinear optics. As an example, we present first results towards the use of the resonator as an all-optical-fibre-based four-port device for ultralow-power photonics applications like, e.g., all-optical switching.

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