Q 36: Photonics I

Time: Wednesday 14:30–16:45 Location: P 11

Group Report Q 36.1 Wed 14:30 P 11

Light Localisation Schemes in Microstructured Optical Fibres — •Stavros Pissadakis — FORTH-IESL, Heraklion, Greece

Microstructured optical fibres (MOFs) and photonic crystal fibres (PCFs) are considered high versatility photonic platforms for the development of multi-functional and high-performance optical devices for optical communication, sensing and imaging applications. Light localisation examples in those fibres types will be presented, while referring to the implementation into those fibres of whispering gallery mode (WGM) resonances, photonic band gap tailoring, and multicore guidance, while targeting sensing, material studies, and slow light applications.

Q 36.2 Wed 15:00 P 11

Whispering Gallery Mode microbarrel resonators fabricated by multiphoton polymerization technique onto tapered standard telecom fibers — Vasileia Melissinaki[1,2], Maria Farsari[1], and •Stavros Pissadakis[1] — [1]Foundation for Research and Technology-Hellas (FORTH), Institute of Electronic Structure and Laser (IESL), 71110 Heraklion, Greece — [2]Department of Physics, University of Crete, Heraklion, Greece

Whispering Gallery Mode (WGM) microbarrel resonators fabricated by multiphoton polymerization technique onto tapered standard telecom fibers are demonstrated. The material used for the fabrication of the microstructure is a zirconium-silicon, organic-inorganic hybrid photosensitive material. Spectra recorded in transmission mode correlate to the diameter of the microbarrels, as well as their thickness and the fabrication position onto the tapered fiber. Moreover, considering the symmetry of these microbarrel resonators, polarization spectra were also studied. Finally, these WGM microbarrel resonators are used as sensing probes for tracing the vapors of common organic solvents.

Q 36.3 Wed 15:15 P 11

Efficient extraction of photons from a single defect in hBN using a nanofiber — •Andreas W. Schell[1], Hideaki Takashima[1], Toan Trong Tran[2], Igor Aharonovich[2], and Shigeki Takeuchi[1] — [1]Kyoto University, Kyoto, Japan — [2]University of Technology, Sydney, Australia

Efficient extraction of photons from quantum emitters is an important prerequisite for the use of such emitters in quantum optical applications as single photons sources or sensors. One way to achieve this is by coupling to a suited photonics structure, which guides away the emitter light. Here, we show the coupling of a single defect in hexagonal boron nitride (hBN) to a tapered optical fiber via a nanomanipulation technique. Defects in hBN are capable of emitting single photons at room temperature while being photostable at the same time two properties that make them ideal candidates for integration in single photon sources. The high control the manipulation technique provides avoids covering the whole nanofiber with emitters. We characterize the coupled system in terms of achievable count rates, saturation intensity, and spectral properties. Antibunching measurements are used to proof the single emitter nature of the defect. Our results pave the way for integration of single defects in hBN into photonic structure and their use as single photon sources in quantum optical applications.

Q 36.4 Wed 15:30 P 11

Nanofiber Bragg grating cavities — •Andreas W. Schell, Hideaki Takashima, Atsushi Fukuda, Hironaga Maruya, and Shigeki Takeuchi — Kyoto University, Kyoto, Japan

Coupling the light emitted from quantum emitters like atoms, molecules, or defect centers into the guided mode of a single mode optical fiber is highly important for scaling up quantum optics experiments, since it provides the possibility to interconnect experiments at different locations and ensures high mode overlap of photons from different sources. Here, we present a photonic nanocavity on a tapered optical fiber. The cavities are formed by two Bragg mirrors fabricated by an ion beam [1]. Characterization in terms of transmission, reflection, and polarization are performed and compared with numerical simulations [2]. The quality factors of the fabricated devices can reach values over 300 while the mode volume is smaller than the cubic wavelength. Simulations indicate that a Purcell enhancement of 19.1 with 82 % coupling efficiency can be reached using this cavities. A comparison of cavities fabricated using a gallium beam is compared with cavities made using a helium beam giving insights about implantation of gallium in the ion beam milling fabrication of resonators. Using the knowledge from experiment and simulation, new designs for nanofiber Bragg grating cavities are developed and tested. [1] A W Schell et al. Sci. Rep. 5, 9619 (2015) [2] H Takashima et al. Opt. Express 24, 15050-15058 (2016)

Q 36.5 Wed 15:45 P 11

The Akhmediev Breather in the presence of loss — •Alexander Hause, Christoph Mahnke, and Fedor Mitschke — Universität Rostock, Institut für Physik, Albert-Einstein-Str. 23, 18059 Rostock

Light propagation in optical fibers is described by the nonlinear Schrödinger equation. A type of solution known as Akhmediev Breather receives much attention recently. It describes a cw background wave on top of which a perturbation waxes and wanes; at its culmination point it forms a periodic sequence of pulses. In realistic situations, the growth-and-decay undergoes periodic recurrence; this has been described in terms of the Fermi-Pasta-Ulam phenomenon [1].

If for realism we introduce (localized) loss (or gain) we find an expression for the recurrence period, and a peculiar behavior: The recurrence pattern phase-shifts by π if there is loss; for gain it remains unshifted. Recently researchers have discovered a similar phase shift in corresponding experiments in a lossy wave tank [2]. However, the Nonlinear Schrödinger equation is integrable and does not describe a lossy channel. We are looking for a comprehensive description of these phenomena. Surely, such description must, in the low-power limit, reproduce the Temporal Talbot effect [3] which has the same phase reversal.

[1] S. A. Chin et al., Phys. Rev. E **92**, 063202 (2015)
[2] O. Kimmoun et al., ArXiv 1602.01604v1 (2016)
[3] U. Morgner, FM, Optics & Photonics News **9**, 45 (1998)

Q 36.6 Wed 16:00 P 11

Solitons and loss: a new take at nonintegrability — •Christoph Mahnke, Alexander Hause, and Fedor Mitschke — Universität Rostock, Institut für Physik, Albert-Einstein-Str. 23, 18059 Rostock

Fiber-optic soliton pulses are described by the Nonlinear Schrödinger equation which is integrable. Integrability is an idealization, rendered invalid even by a minimal amount of loss (or gain). Attempts to assess the fate of the soliton in the lossy case have been restricted to perturbation analysis where it is assumed that the loss is very small. We present a new approach which is physically intuitive but does not make this last assumption. It can quantify the reshaping of the soliton, as well as the generation of linear radiation, for both localized and distributed loss. The perturbative limit is recovered as a special case. Outside this limit, we can quantitatively describe how the soliton eventually decays when it continuously loses energy. The approach can also be applied to the case of gain.

Q 36.7 Wed 16:15 P 11

Bloch oscillations sustained by nonlinearity — •Rodislav Driben[1], Vladimir Konotop[2], Torsten Meier[1], and Alexey Yulin[3] — [1]Department of Physics and CeOPP, University of Paderborn, Warburger Str. 100, D-33098 Paderborn, Germany — [2]Centro de Fisica Teorica e Computacional and Departamento de Fisica, Universida de Lisboa — [3]ITMO University, 49 Kronverskii Ave., St. Petersburg 197101, Russian Federation

We demonstrate that, contrary to general belief, a nonlinearity may play a constructive role in supporting Bloch oscillations in a model which is discrete, in one dimension and continuous in the orthogonal one. Such a model can be experimentally realized in several fields of physics such as optics and Bose-Einstein condensates. We demonstrate that designing an optimal relation between the nonlinearity and the linear gradient strength provides extremely long-lived Bloch oscillations with little degradation. Such robust oscillations can be observed for a broad range of parameters and even for moderate nonlinearities and large enough force gradients. We also present an approximate analytical description for the wave packet evolution featuring a hybrid Bloch oscillating wave-soliton behavior that excellently corresponds to

the direct numerical simulations.

Q 36.8 Wed 16:30 P 11

Breathers in nonlinear metamaterials with amplification and absorption — •Sascha Böhrkircher, Sebastian Erfort, Holger Cartarius, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart, Germany

$\mathcal{PT}$-symmetry originates from non-Hermitian quantum mechanics in the presence of gain and loss, and was experimentally proven in analogous optical systems. Recently, $\mathcal{PT}$-symmetry was realized in metamaterials. As examinations have shown, a $\mathcal{PT}$-symmetric nonlinear dimer chain composed of split-ring resonators can form discrete breather oscillations [1]. Previous works have been limited to one-dimensional systems. In our work we extend the one-dimensional dimer chain to a two-dimensional dimer surface and investigate the breather oscillations of this system starting from the one-dimensional solution. We study the behaviour of these breather oscillations by adiabatically increasing the coupling parameters.

[1] N. Lazarides and G. P. Tsironis, Phys. Rev. Lett **110**, 053901 (2013)