KFM 7: Whispering-Gallery-Mode Resonators

Time: Tuesday 12:00–13:40 Location: TOE 317

KFM 7.1 Tue 12:00 TOE 317

Super-directional light emission and emission reversal from micro cavity arrays — Jakob Kreismann, Jaewon Kim, Martí Bosch, Matthias Hein, Stefan Sinzinger, and •Martina Hentschel — Institute for Micro- und Nanotechnologies, Technische Universität Ilmenau, Germany

Optical microdisk cavities with certain asymmetric shapes are known to possess uni-directional far-field emission properties. Here, we investigate arrays of these dielectric microresonators with respect to their emission properties resulting from the coherent behaviour of the coupled constituents. This approach is inspired by electronic mesoscopic physics where the additional interference effects are known to enhance the properties of the individual system. As an example we study the linear arrangement of nominally identical Limaçon-shaped cavities and confirm the increase of directionally emitted light. We find its angular spread to diminish from 20 degrees for the single cavity to about 3 degrees for a linear array of 10 Limaçon resonators, in fair agreement with a simple array model. Moreover, varying the inter-cavity distance we observe windows where the emission directionality is further enhanced (super-directionality), as well as windows with a reversal of the emission direction, another effect that may be interesting for applications like optical sensing or interconnects. We introduce a generalized array factor model that takes the coupling into account.

KFM 7.2 Tue 12:20 TOE 317

Flexible Photonics based on Whispering-Gallery-Mode Resonators and Liquid-Crystal-Elastomers — •Simon Woska, Osman Karayel, Pascal Rietz, Roman Oberle, Jannis Hessenauer, Evelyn Kaiser, Stefan Pfleging, Carolin Klusmann, Tobias Siegle, and Heinz Kalt — Institute of Applied Physics, Karlsruhe Institute of Technology, 76131 Karlsruhe, Germany

Whispering-Gallery-Mode (WGM) resonators confine light due to total internal reflection at their outer rim and feature both high quality factors and low mode volumes. Therefore, they hold huge potential as building blocks for photonic devices or for investigation of topological properties. Many of these applications require a precise tunability of the resonant wavelengths and/or the inter-cavity distance between several resonators. Meeting these requirements, flexible photonics come into play. We include Liquid Crystal Elastomers (LCEs) into our polymeric building blocks in order to exploit their directional, temperature-responsive, and reversible mechanical actuation. Thereby, we are able to tune the optical properties of our systems by precisely controlling their dimensions using temperature as an external stimulus.

In this contribution, we address two different systems: On the one hand, we introduce a pair of rigid WGM resonators mounted on an LCE substrate and show first results of reversible temperature-induced coupling. On the other hand, we present detailed investigations on fully tunable flexible WGM resonators. To this end, the cavities are entirely made from LCE. Hereby, also the effect of the birefringence of LCE on the temperature dependency of different WGMs is discussed.

KFM 7.3 Tue 12:40 TOE 317

Far-field polarization states of 3D-whispering-gallery-mode resonators — •Jakob Kreismann and Martina Hentschel — Technische Universität Ilmenau, Weimarer Straße 25, 98693 Ilmenau, Germany

We investigate the far-field polarization states of whispering gallery modes in three-dimensional optical cone-shaped cavities. In particular, we study how the inclination angle of the cavity wall influences the polarization state of the far field. We show that the far-field lobes separate the helicities of light as a consequence of the spin-orbit coupling of light present in the cavity due to strong transverse confinement. Furthermore, the polarization states depend on the viewing angle, the opening angle of the conical cavity and the axial mode number. This is accompanied by a transition from linear to circular polarization without utilizing anisotropic or inhomogeneous materials.

KFM 7.4 Tue 13:00 TOE 317

Nonhermitian defect states from lifetime differences — •Marti Bosch[1,2], Simon Malzard[2,3], Martina Hentschel[1], and Henning Schomerus[2] — [1]TU Ilmenau, Ilmenau, Deutschland — [2]Lancaster University, Lancaster, UK — [3]Imperial College London, London, UK

Nonhermitian systems provide new avenues to create topological defect states. An unresolved general question is how much the formation of these states depends on asymmetric backscattering, be it nonreciprocal as in the nonhermitian skin effect or reciprocal as encountered between the internal states of asymmetric microresonators. Here, we demonstrate in a concrete, practically accessible setting of a lossy coupled-resonator optical waveguide that nonhermitian defect states can exist in open optical systems due to lifetime differences, without the need for asymmetric backscattering within or between the individual resonators. We apply our findings to a finite system of coupled circular resonators perturbed by nanoparticles, following the concept of creating an interface by inverting the position of the nanoparticles in half of the chain. We compare a coupled-mode tightbinding approximation to full-wave numerical simulations, showing that spectrally isolated defect states can indeed be implemented in this simple nonhermitian photonic device.

KFM 7.5 Tue 13:20 TOE 317

Splitting and combining of exceptional points — •Jaewon Kim[1] and Jung-Wan Ryu[2] — [1]Technische Universität Ilmenau, Germany — [2]Institute for Basic Science, Daejeon, South Korea

At Exceptional point(EP) of non-Hermitian system, not just eigenvalue of Hamiltonian but also its eigenfunctions are degenerated. For the sensor application of microcavity, it was shown that EP can be used to increase its sensitivity and it actually demonstrated experimentally. Since then, interests on higher order EP, where more than 3 eigenfunctions are degenerated, naturally arose.

We studied splitting and combining of higher order EPs. The results of splitting are depend on the form of perturbation. For instance, EP3 can break into 2 EP2 or 3 EP2. Also we interpreted that many EP2, as an analogy of atom, can combine to make higher order EPs. By studying how they combine we can classify higher order EP.