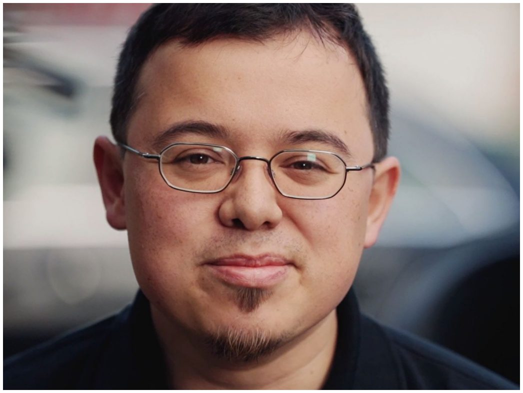
Speaker Abstracts Karlsruhe Days of Optics & Photonics



Prof. Dr.-Ing. Thao Dang

University of Applied Sciences, Esslingen

Stereo Vision and Object Tracking in Self-Driving Cars

This talk will give an introduction to stereo vision for self-driving vehicles. Stereo vision has a long history in advanced driver assistance systems. It has proven useful for many tasks such as obstacle detection, pedestrian classification, and traffic light recognition and it has been used in many autonomous vehicle prototypes.

This presentation will review the fundamentals of stereo vision and describe state-of-the-art stereo 3D reconstruction methods. It will outline benefits and shortcomings of stereo vision in environmental perception. Selected capabilities for autonomous driving that rely on stereo vision will be elaborated. Special focus will be put on tracking objects in stereo image sequences. Tracking algorithms based on 3D motion models and object tracking inspired from monocular vision (such as e.g. discriminative correlation filters) will be discussed.

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Dr. Ivan Fernandez-Corbaton

Institute of Nanotechnology (INT), KIT

Using symmetry for understanding and engineering light-matter interactions

Symmetry is one of the most general and useful concepts in physics. Correspondingly, symmetry-based results are among the most general statements that can be made about a given physical system. While this potential is routinely exploited in advanced theoretical physics, the use of symmetry as the primordial tool for understanding and engineering light-matter interactions is a less common approach. In my talk, I will first explain how symmetries and conservation laws help us advance our theoretical understanding, and then I will show that the symmetry-based insights provide us with useful guidelines for system design. I will illustrate the discussion with theoretical results in optical activity and backscattering suppression, and practical designs for enhanced sensing of chiral molecules and improved anti-reflection performance in solar cells.

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Dr. Guillaume Gomard

Light Technology Institute (LTI), KIT

Harnessing disorder for energy applications

Light management is key to design highly efficient solar cells, be it for collecting or for trapping sunlight. One challenge associated to photovoltaics is the need to develop light harvesting materials that are efficient over a broad spectral range and under various incidence angles. Here, structural disorder, often seen as a defect in engineered materials, can be purposely exploited to fulfill these requirements. The working principles of such disordered structures in different optical regimes will be introduced together with the fabrication routes developed at the KIT. As solar cells and light-emitting diodes are reciprocal devices, we will discuss how the concepts matured for photovoltaics can also benefit to light sources for improving their emission properties, for example in general lighting applications.

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Prof. Dr. Javier Garcia de Abajo

ICFO, Barcelona, Spain

Control of Light at the Atomic Scale: Fundamentals and Applications

Plasmons in atomic-scale structures exhibit intrinsic quantum phenomena related to both the finite confinement that they undergo and the small number of electrons on which they are supported. Their interaction with two-level emitters is also evidencing strong quantum effects. In this talk we will discuss several salient features of plasmons in atomic-scale materials, such as graphene and atomic layers of noble metals. In particular, we will explore their ability to mediate ultrafast heat transfer, the generation of high harmonics, their interaction with molecules and quantum emitters, and their extreme nonlinearity down to the single-photon level. We will further analyze intriguing details in the plasmonic response of atomically-thin crystalline films of silver, the plasmons of which have been recently revealed experimentally.

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Jun.- Prof. Dr. Lennart Hilbert

Institute of Toxicology and Genetics (ITG), KIT

3D organization and genetic information retrieval in the biological cell nucleus

The biological cell selectively retrieves genetic information from its genome. The specific genomic regions that are accessed depend on the type and current function of a given cell, and the selective access is directly reflected in the three-dimensional (3D) organization of the genome. In our work, we investigate how physical properties, such as diiferential compaction of genomic regions, and molecular information transfer are coordinated. While our approaches also include molecular cell biology and mathematical modeling, in this talk I will especially highlight our use of live cell and super-resolution fluorescence microscopy.

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Prof. Dr.-Ing. Stefan Hinz

Institute of Photogrammetry and Remote Sensing (IPF), KIT

Hybrid SLAM Approaches - Automatic Pose Estimation and 3D Mapping with Small Mobile Mapping Platforms

SLAM (Simultaneous Localization and Mapping) algorithms belong to the core components of almost any automatic mobile mapping system in Computer Vision, Robotics, Photogrammetry or Remote Sensing. While the basic foundations have been developed decades ago and are understood very well, many today's developments concentrate on improving or re-designing SLAM algorithms under the light of new light-weight consumer sensors which, for instance, could also be mounted on drones or other flexible and small mobile mapping platforms. With this background, the talk will touch topics like new camera models, on-the-fly self-calibration, sensor fusion, navigation, 3D mapping and accuracy estimation. Examples taken from „real-world" applications will show the potentials, yet also the remaining deficiencies and fields for future research in this topic.

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Prof. Dr. Ralph Krupke

Institute of Nanotechnology (INT), KIT

Light emission from electrically driven carbon nanotubes

Our work is motivated by recent efforts to use light as carrier of information for on-chip data transmission. Whereas photonic chips are available, there appears to be a need for the development of nanoscale, electrically driven light sources that can be seamlessly integrated into complex photonic structures. Carbon nanotubes could be part of a solution due to their unique electrical, optical and structural properties, and their use as on chip light sources integrated in optical waveguides and cavities was demonstrated [1,2]. But even though these results are promising, there are still unresolved issues in gaining full control on reliable and reproducible light emission. I will report on the current status and ongoing developments and show results from first low-temperature electroluminescence data measured with pristine nanotubes and nanotubes with defect induced deep exciton traps; the latter being of interest for the development of single-photon sources operating in the telecom band [3].

[1] Khasminskaya et al., Nature Photonics 10 (2016) 727–732

[2] Pyatkov et al., Nature Photonics 10 (2016) 420–427

[3] He et al., Nature Materials. 17 (2018) 663-670

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Dr. Jonas Ries

EMBL Heidelberg

Towards structural cell biology using superresolution microscopy

Recent advances in superresolution microscopy now allow us to address structural questions in cell biology with optical methods. A quantitative interpretation however is often limited by sub-optimal performance and calibration of the microscope, undetermined performance of the fluorescence label and imaging conditions, unknown labeling efficiencies and systematic errors in counting protein numbers. To overcome these limitations, we developed reference standards based on the precise 3D arrangement and stoichiometry of proteins in the nuclear pore complex. We demonstrate their use as a) simple and robust resolution standards for calibration and quality control, b) accurate assays to quantify absolute labeling efficiencies in superresolution microscopy and c) precise counting reference standards for absolute stoichiometry measurements.

In the second part of this talk I will show how superresolution microscopy can be used to gain mechanistic insights into the structural organization of a complex protein machine, namely the machinery involved in clathrin-mediated endocytosis. We developed a high-throughput superresolution microscope to reconstruct the nanoscale structural organization of 23 endocytic proteins from over 100,000 endocytic sites in yeast. This allowed us to visualize where individual proteins are localized within the machinery throughout the endocytic process and resulted in a model of how the force is produced to pull in the membrane and form a vesicle.

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Dr. Rebecca Saive

Complex Photonic Systems Institute (COPS), University of Twente

The power of light – pushing the limits of solar energy conversion

Current energy production methods require a revolutionary shift away from historical, unsustainable practices. Technologies which harvest and convert sunlight to electricity are on the brink of creating such a revolution. The Saive research group develops light management strategies – combining realistic solar irradiance conditions with nanophotonics – that drive conversion efficiency of photovoltaic devices toward their upper limits. Our main focus areas are development of effectively transparent front contacts and design of nanophotonic albedo materials for bifacial solar power plants. The former enhances power conversion efficiency of almost all types of solar cells by mitigating shading losses related to electrical front contacts. In the second focus, the optical environment of solar power plants is designed to redirect light towards the solar modules.

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Prof. Dr. Vahid Sandoghdar

Max Planck Institute for the Science of Light, Erlangen

Organic Molecules Coming of Age in Quantum Optics

The interaction of light and matter at the nanometer scale lies at the heart of quantum optics because it concerns elementary processes such as absorption or emission of a photon by an atom. Over the past decade, we have shown that direct coupling of a photon to a single two-level atom should be possible via tight focusing. However, because transitions in quantum emitters are typically not closed, laboratory demonstrations of this idea fall short of the theoretical prediction. In this presentation I shall report on recent achievements, where the branching ratio of a single organic molecule is improved by a substantial Purcell effect when coupled to a microcavity. Furthermore, we will discuss coherent linear and nonlinear experiments on molecules coupled to subwavelength waveguides on a chip. Together with their ability to generate narrowband stream of single photons, these developments make organic molecules viable candidates for integration in chip-based quantum optical circuits.