The EPFL Doctoral Program in Photonics presents

Photonics Day

Thursday October 24, 2024

EPFL Forum Rolex Learning Center

08:30 Welcome and setting up of posters

09:00 Introduction Director of EDPO Prof. Camille Brès

09:05 Prof. Randy Bartels, Morgridge Institute for Research
Peering into the fog: computational nonlinear adaptive optical imaging in tissues

09:45 Prof. Robert Fickler, Tampere University
Quantum Photonics with Structured Photons

10:30 Coffee break - Poster session

11:00 8% EPFL Doctoral Program in Photonics Thesis Distinction

11:05 Presentation by the Laureate of the above distinction

11:25 Prof. Paul Cremer, Penn State University
Exploring Interfacial Water Structure Beneath Charged Surfactant Monolayers

11:55 Group Photo

12:15 Lunch - poster session

13:30 Prof. Martin Zanni, University of Wisconsin–Madison
2D IR spectroscopy and hyperspectral imaging:
application to amyloid aggregation in cataracts and diabetes

14:00 EPFL Photonics Chapter (EPC) Presentation & Best Poster Award

14:10 PhD Poster Presentations in 180 Seconds

14:30 Dr Hilton de Aguiar, École Normale Supérieure Paris
Nonlinear Beginnings, Linear Horizons

15:00 Dr Andrea Lovera, FEMTOprint SA
Beyond Academia: Turning Research into Entrepreneurial Innovation

15:30 Aperitif organized by EPC

EDPO acknowledges our sponsor

GMP
PHOTONICS & MICROTECHNOLOGY

Abstracts

09:05 Prof. Randy Bartels, Morgridge Institute for Research

Peering into the fog: computational nonlinear adaptive optical imaging in tissues

When light propagates through regions with spatial variations in the refractive index, the light is distorted. This distortion scrambles image information and obscures image scenes propagating through the atmosphere or through biological tissues. Astronomers have long used adaptive optics that can be distorted to correct for aberrations. While such adaptive optics strategies have been successfully applied to imaging of biological tissues, tissues introduce much stronger distortions to the light that the atmosphere, which limits the ability for correction with conventional adaptive optics for biological imaging.
I will present a tutorial on methods that we have recently developed to computationally correct for widefield imaging distortions that arise from coherent widefield nonlinear imaging. We have applied this strategy to demonstrate the correction of imaging distortions in second harmonic generation (SHG) and third harmonic generation (THG) holographic imaging. SHG is a powerful imaging modality for studying collagen in the extra cellular matrix and muscle. THG provides a powerful approach to probing biological systems, particularly looking at structures formed by lipids, such as cell membranes and vesicles. These nonlinear imaging modalities are normally acquired by scanning a focused beam through a specimen. Holographic imaging speeds up the nonlinear imaging process, however, the imaging process if more susceptible to distortions from the specimen. We introduce algorithms that enable computational estimation and correction of aberrations imparted both on the illumination light and the imaged light in holographic widefield SHG and THG imaging, which allows for aberration-free imaging. In addition, with these widefield holographic imaging methods, we obtain a new contrast mechanism: the phase of the SHG and THG images.

09:45 Prof. Robert Fickler, Tampere University

Quantum Photonics with Structured Photons

Light with a complex shape in its polarization and spatio-temporal domain invokes interesting fundamental properties and enables novel applications in both, classical and quantum optics. For the latter, structured single photons can be beneficially applied to a variety of different fundamental and applied quantum photonics experiments.
In this presentation, I will give an overview over the field of structured photons and discuss some of their main benefits, e.g., their ability to act as laboratory realizations of high-dimensional quantum states. These so-called qudits are known to be beneficial in quantum communication as well as quantum computation tasks due to the enlarged information capacity per photon. I will discuss the recent progress in this research direction, with a particular focus on an advanced qudit manipulation scheme of structured photons known as multi-plane light conversion. On one hand, this scheme enables the implementation of all elementary quantum operations for quantum computing with qudits. On the other hand, it can be used to generate novel quantum states using structured photons, which in turn ca be leveraged to explore quantum features such as entanglement for quantum-enhanced sensing applications.

11:25 Prof. Paul Cremer, Penn State University

Exploring Interfacial Water Structure Beneath Charged Surfactant Monolayers

This presentation will explore the ordering of water at charged aqueous interfaces as probed by infrared-visible sum frequency generation (SFG) vibrational spectroscopy. Experiments were conducted at the water/air interface in the presence of well-ordered charged surfactant monolayers. Data was collected as a function of two-dimensional charge density, head group chemistry, and salt solution concentration in the aqueous subphase. Water ordering increased as the surface charge density rose, but decreased as the salt concentration in the subphase was increased. The degree of water ordering also depended on the identity of the salt. In all cases, the interfacial water structure in the OH stretch region could be modeled by the Grahame equation.

13:30 Prof. Martin Zanni, University of Wisconsin-Madison

2D IR spectroscopy and hyperspectral imaging:
application to amyloid aggregation in cataracts and diabetes

Amyloid aggregation is involved in more than 20 different human diseases, caused by the precipitation of proteins into very stable beta-sheet structures. 2D Infrared spectroscopy probes protein structures via the coupling between the vibrational modes within proteins. This talk will explain the spectroscopic signatures of protein aggregates and report the hyperspectral images generated from 2D IR spectra of tissues from cataract patients and a transgenic mouse model for type 2 diabetes. Using 2D IR spectroscopy, we report that cataracts contained amyloid pancreas tissue degrades even when fixed. This talk will contain a mixture of technology and applications.