Symposium Frontiers of Light (SYFL)

jointly organized by the divisions of the Condensed Matter Section (SKM)

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United Nations proclaimed 2015 as the "International Year of Light and Light-based Technologies". With this cross-disciplinary Symposium we want to feature the prominent role of "light" (in a broad sense also beyond visible frequencies) at the forefront of fundamental research in the context of condensed matter.

Overview of Invited Talks and Sessions

(Lecture room: H 0105)

Plenary Talk Stefan Hell

SYFL 1.1	Tue	13:00–13:45	H 0105	**Nanoscopy with focused light** — •Stefan Hell

Invited Talks

SYFL 2.1	Tue	13:50–14:20	H 0105	**Quantum Optomechanics** — •Markus Aspelmeyer
SYFL 2.2	Tue	14:20–14:50	H 0105	**Single Photons and Spins: The quest for the ultimate quantum tool** — •Joerg Wrachtrup
SYFL 2.3	Tue	14:50–15:20	H 0105	**Science at the Timescale of the Electron: Tabletop Ultrafast X-rays and Applications in Nano and Materials Science** — •Margaret Murnane

Sessions

SYFL 1.1–1.1	Tue	13:00–13:45	H 0105	**Plenary Talk Stefan Hell**
SYFL 2.1–2.3	Tue	13:50–15:20	H 0105	**Frontiers of Light (SYFL)**

SYFL 1: Plenary Talk Stefan Hell

Time: Tuesday 13:00–13:45 Location: H 0105

Plenary Talk SYFL 1.1 Tue 13:00 H 0105

Nanoscopy with focused light — •Stefan Hell — Max-Planck-Institut für biophysikalische Chemie, Göttingen, Deutschland

For more than a century, it has been widely accepted that diffraction of light precludes any lens-based optical microscope from discerning details smaller than about half of the wavelength of light (˜200 nm). However, in the 1990*s it was discovered that basic state transitions in a fluorophore can be exploited to eliminate the resolution-limiting role of diffraction. Since then, fluorescence microscopes have been developed that are now able to resolve on the nanometer scale. We discuss the basic principles of these nanoscopy (superresolution) concepts with particular emphasis on the first viable far-field *nanoscopy* method, STED microscopy. We show their scope of applications in the life sciences and beyond.

SYFL 2: Frontiers of Light (SYFL)

Time: Tuesday 13:50–15:20 Location: H 0105

Invited Talk SYFL 2.1 Tue 13:50 H 0105

Quantum Optomechanics — •Markus Aspelmeyer — University of Vienna, Faculty of Physics, Vienna Center for Quantum Science and Technology (VCQ), Vienna, Austria

The quantum optical control of solid-state mechanical devices, quantum optomechanics, has recently emerged as a new frontier of light-matter interactions. It offers fascinating opportunities both for fundamental tests of quantum physics, eventually at the interface with gravity, and for radically new applications in laser science and quantum information. In this talk I will highlight the current promises, achievements and challenges in the field.

Invited Talk SYFL 2.2 Tue 14:20 H 0105

Single Photons and Spins: The quest for the ultimate quantum tool — •Joerg Wrachtrup — 3rd Institute of Physics and IQST, Stuttgart University, Stuttgart, Germany

Precise control of single quantum degrees of freedom like photons and spins is a prerequisite for their application in quantum technology. The recent past has seen a surge of activities such that the combination of high fidelity quantum control, nanostructure technology and proper material choice has resulted in unique solid-state quantum tools for future information science, quantum simulations and precision sensors. The talk will highlight advances in using single solid-state impurities for such applications and emphasize their unique role, especially for highly precise quantum sensors.

Invited Talk SYFL 2.3 Tue 14:50 H 0105

Science at the Timescale of the Electron: Tabletop Ultrafast X-rays and Applications in Nano and Materials Science — •Margaret Murnane — JILA, University of Colorado, Boulder, CO 80309, USA

Ever since the invention of the laser 50 years ago, scientists have been striving to extend coherent laser-like beams into the soft X-ray region of the spectrum. Very recently, we used tabletop mid-infrared femtosecond lasers to achieve this goal, and create bright high harmonic X-ray beams at wavelengths spanning from the UV to <10Å.[1] The X*ray supercontinua that are generate represent a coherent version of the Rontgen X-ray tube in the soft X-ray region.

X-rays are powerful probes of the nanoworld. They penetrate thick samples and can image small objects with spatial resolution near the wavelength limit. Therefore, using a tabletop setup, we can probe the fastest charge, spin and energy transport processes in materials. Examples include probing the dynamics of the quantum exchange interaction fundamental to magnetic materials; the use of coherent high harmonic beams for tabletop nanoimaging with record resolution; and uncovering the physical limits of energy flow at the nanoscale.

Moreover, the limits of this new light source are not yet known. In exciting recent work in collaboration with Technion, we also demonstrated bright circularly-polarized harmonics and used them to implement X-ray magnetic circular dichroism measurements on a tabletop.

[1] T. Popmintchev et al., Science 336, 1287 (2012). [2] O. Kfir et al., Nature Photoncs, in press (2014).