K 5: Optical Methods

Time: Thursday 11:00–12:30 Location: HS 20

Invited Talk K 5.1 Thu 11:00 HS 20

Scientific imaging in experimental physics: from photon flux to detector requirements and challenges for scientific cameras — •Simon Assmann — Excelitas PCO GmbH, Donaupark 11, 93309 Kelheim

Optical imaging is essential in experimental physics whenever spatially and/or temporally resolved measurements are required. The motivation for using a camera arises from the need to capture intensity distributions, structural features, and spatial or temporal dynamics of light emission, scattering, or transmission that cannot be adequately measured with point detectors. Depending on the application, the underlying light conditions, such as photon flux, spectral characteristics, contrast, and relevant timescales, impose distinct requirements on detector performance. This contribution provides an overview of how these conditions translate into concrete camera specifications and highlights the relevance of key parameters such as spectral quantum efficiency, photon-shot and readout noise, dynamic range, pixel size, temporal sampling capability, and data-interface bandwidth. The current state of scientific camera technology is examined, and it is assessed how closely modern detectors approach the properties expected from an ideal sensor. A brief overview of the main camera system classes in the PCO portfolio, as well as recent challenges and developments, is discussed with respect to different types of experimental measurement scenarios.

K 5.2 Thu 11:30 HS 20

Nonlinear absorption and lasing properties of Rhodamine-110 dye composites using a 532 nanosecond laser — •Abeer Salah, Elham M. Mostafa, Randa Saad Hassan, and Ahmed M. Saad for the Z Scan Abeer Salah-Collaboration — National Institute of Laser Enhanced Sciences, Cairo University, Egypt

Rhodamine 110 (Rh-110) is a xanthene-based fluorescent dye that has garnered significant attention in scientific and industrial communities. The linear and nonlinear optical properties of the laser dye Rhodamine 110 in an ethanol solvent at various concentrations, ranging from 2 mM to 0.001 mM, were studied. The maximum lasing was observed at 1 mM via 532 nm pumping; the absorption and emission wavelengths were found to be 501 nm and 522 nm, respectively. RH-110 was polymerized in methyl methacrylate MMA, Glycidyl Methacrylate GMA, and GMA-MMA polymer matrices. The absorption and emission are slightly shifted compared to the liquid samples. The absorptivity, oscillator strengths, and emission cross sections were calculated. Observations indicate apparent concentration-dependent variations in spectral features, which is correlated with nonlinear optical measurements. Nonlinear absorption was carried out via a Z-scan using 532 nm nanosecond pulses. The measurements reveal saturable absorption, which provides an explanation for the lasing behavior of the Rh-100 series. The GMA-MMA dyes exhibit enhanced nonlinearity compared to GMA or MMA alone. The composite RH110 can be utilized in photonic devices due to its nonlinear optical properties.

K 5.3 Thu 11:45 HS 20

Comparing clocks: from time interval counting to timetagging — •Tizian Schmidt and Ilja Gerhardt — Institute of Solid State Physics, light & matter group, Leibniz Universität Hannover

Precise timing plays a crucial role in many areas of physics. Comparing ultra stable clocks is particularly challenging when the composite noise of the compared clocks is lower than the noise of the measurement system such as a conventional time interval counter.

The Dual Mixer Time Difference (DMTD) method overcomes this limitation by enabling a measurement of the relative phase and frequency differences between two such clocks without relying on a superior measurement system. Here, we present a setup based on digital post-processing of the DMTD signals using a commercially available timetagging device, negating the need for custom built electronic hardware. The setup is suitable for laboratory experiments as well as undergraduate lab courses. The resulting Allan deviations for the measured atomic clocks are compared to other standard time measurement techniques to compare clocks.

K 5.4 Thu 12:00 HS 20

Real-time tracking of the intramolecular vibrational dynamics of liquid water — Gaia Giovannetti[1], Sergey Ryabchuk[1,2], Ammar Bin Wahid[1], Hui-Yuan Chen[3], Giovanni Batignani[4], Erik P. Månsson[1], •Oliviero Cannelli[1], Emanuele Mai[4], Andrea Trabattoni[1,5], Ofer Neufeld[6], Angel Rubio[1,7], Vincent Wanie[1], Hugo Marroux[8], Tullio Scopigno[4], Majed Chergui[3,9], and Francesca Calegari[1,2,10] — [1]CFEL, DESY, Hamburg, Germany — [2]CUI, Hamburg, Germany — [3]LACUS, EPFL, Lausanne, Switzerland — [4]Università di Roma La Sapienza, Roma, Italy — [5]Leibniz Universität Hannover, Germany — [6]Technion Israel Institute of Technology, Haifa, Israel — [7]MPSD, Hamburg, Germany — [8]CEA-Saclay, Gif-sur-Yvette, France — [9]Elettra, Trieste, Italy — [10]Universität Hamburg, Hamburg, Germany

Water's vibrational motions, occurring on a few-femtosecond timescale, govern ultrafast energy transfer within its hydrogen-bond network. However, direct real-time observation of these motions has remained elusive due to the extreme temporal resolution required. Here, we investigate the ground-state vibrational dynamics of liquid water initiated by a sub-5 fs near-infrared pump pulse via Impulsive Stimulated Raman Scattering. Using few-fs ultraviolet probe pulses transmitted through a 5 um-thick liquid jet, we monitor the coherent vibrational wave packet dominated by the OH stretch mode, exhibiting a 10 fs oscillation period and a 25 fs damping time. These results reveal the rapid dephasing of the OH stretch mode preceding its relaxation through coupling to the bending vibrations.

K 5.5 Thu 12:15 HS 20

Photocurrent control in a light-dressed Floquet topological insulator — •Weizhe Li[1], Daniel Lesko[1,2], Tobias Weitz[1,2], Simon Wittigschlager[1], Christian Heide[3,4], Ofer Neufeld[5], and Peter Hommelhoff[1,2] — [1]Department of Physics, Friedrich-Alexander Universität Erlangen-Nürnberg — [2]Department of Physics, Ludwig-Maximilians Universität München — [3]Department of Physics, University of Central Florida — [4]CREOL, The College of Optics and Photonics, University of Central Florida — [5]Schulich Faculty of Chemistry, Technion - Israel Institute of Technology

Light-dressed materials, based on Floquet engineering, offers unique opportunities to shape transient band structures. Most commonly, circularly-polarized dressing light can generate topologically nontrivial nonequilibrium states known as Floquet topological insulators (FTIs) which host a variety of topological phenomena. Floquet engineering with strong optical fields opens routes to optically tunable band structures and devices for petahertz electronics.

Here we demonstrate coherent control of photocurrents in light-dressed graphene. Circularly-polarized laser pulses dress the graphene into an FTI, and phase-locked second harmonic pulses drive electrons in the FTI, forming a stroboscopic detection scheme. The two-color phase dependent photocurrents reflect the laser-induced symmetry breaking. This approach allows us to measure all-optical anomalous Hall currents and photocurrent circular dichroism. Furthermore, we map out the sub-optical cycle Floquet phase by varying the two-color phase.