KFM 9: Instrumentation and Methods

Chairman: Jan Schultheiß (NTNU Trondheim)

Time: Wednesday 12:00–12:45 Location: H1

KFM 9.1 Wed 12:00 H1

Broadband Coherent Anti-Stokes Raman Scattering (B-CARS) on Solid State Systems — •Franz Hempel[1], Sven Reitzig[1], Michael Rüsing[1], and Lukas M. Eng[1,2] — [1]Institut für Angewandte Physik, Technische Universität Dresden, 01062 Dresden, Germany — [2]ct.qmat Dresden-Würzburg Cluster of Excellence*EXC 2147, TU Dresden, 01062 Dresden, Germany

Broadband coherent anti-Stokes Raman scattering (B-CARS) combines the vibrational sensitivity of spontaneous Raman scattering (SR) with the gigantic signal amplification of coherent scattering techniques. B-CARS sees widespread applications in the biomedical fields for chemically-sensitive imaging, but has rarely been adapted to solid-state systems. In this work, we apply polarization-sensitive B-CARS to ferroelectric lithium niobate, and systematically investigate how the CARS signal depends on selection rules, power dependence and phase matching. In contrast to SR, B-CARS spectra are distorted in their spectral shape and position due to signal mixing with the non-resonant background (NRB). Here, we successfully apply Kramers-Kronig transformations, that originally were developed for biological samples but have been adapted here to crystalline-sample spectra. As a result, SR and B-CARS spectra become directly comparable, hence providing a brilliant basis for future inspections of nanoscale objects such as domain walls and defects in ferroelectrics.

KFM 9.2 Wed 12:15 H1

Silicon Highly Enriched in 28Si: Probing Artificial Crystals for the Dissemination of the Mole and Kilogram — •Axel Pramann and Olaf Rienitz — Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Germany

The revision of the SI units mole and kilogram has been enabled by the redetermination of the Avogadro constant with the lowest uncertainty by the the X-ray-crystal-density (XRCD) method *counting* silicon atoms in single-crystalline silicon spheres (1) and the complementary realization of the Planck constant using a Kibble balance (2). For the XRCD method applied by PTB, a few unique silicon single crystals highly enriched in 28Si has been produced and characterized. Using a high-resolution MC-ICP mass spectrometer and a tailored analytical methodology in a key experiment, the isotopic composition (the molar mass M) of these crystals has been determined with associated uncertainties of urel(M) $<$ 1 x 10-9, which is unique in chemistry up to now. After developing and improving this method during the last decade, the uncertainties u(M) were reduced by almost three orders of magnitude. The way how to disseminate the amount of substance and mass after the revision of the SI is outlined (1, 3).

(1) K. Fujii et al., Metrologia, 53, A19 (2016). (2) I. A. Robinson, S. Schlamminger, Metrologia, 53, A46 (2016). (3) B. Guettler, O. Rienitz, A. Pramann, Annalen der Physik, 1800292 (2018).

KFM 9.3 Wed 12:30 H1

High-Q microresonators facilitate efficient electron-photon interaction — Jan-Wilke Henke[1,2], Arslan Sajid Raja[3], Armin Feist[1,2], Guanhao Huang[3], •Germaine Arend[1,2], Yujia Yang[3], F. Jasmin Kappert[1,2], Rui Ning Wang[3], Marcel Möller[1], Jiahe Pan[3], Junqiu Liu[3], Ofer Kfir[1,2,4], Claus Ropers[1,2], and Tobias J. Kippenberg[3] — [1]Georg-August Universität, Göttingen, Germany — [2]Max Planck Institute for Biophysical Chemistry, Göttingen, Germany — [3]Swiss Federal Institute of Technology, Lausanne, Switzerland — [4]School of Electrical Engineering, Tel-Aviv University, Tel Aviv, Israel

High-Q Si_3N_4 microresonators are not only an ideal platform for studying nonlinear effects, such as Kerr solitons. Their flexible dispersion engineering capability also makes them an ideal candidate for phase-matched interactions between free electrons and confined light. This allows for nanoscale optical mode mapping and possibilities in free-electron quantum optics.

In this work, we demonstrate how velocity phase-matching can be used for highly efficient free-electron-photon coupling inside a transmission electron microscope [1]. The evanescent tail of optical near fields excited in an air-cladded Si_3N_4 microcavity via a continuous-wave laser beam interacts with passing electrons. We observe multiple orders of electron-photon scattering resulting in a strong broadening of the electron energy spectrum. This coupling enables various further studies such as electron-triggered single photon sources.

[1] J.-W. Henke, A. S. Raja, et al., preprint, arXiv:2105.03729 (2021)