

On-line SPICE-SPIN+X Seminars



Wednesday, 25th January 2023, 15:00 (CET)

The seminar will be via Zoom ([Meeting ID: 825 7460 8629](#)) and live streamed in the SPICE YouTube Channel.

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Developments in ultrafast electron microscopy



Providing the most detailed views of atomic-scale structure and composition, Transmission Electron Microscopy (TEM) serves as an indispensable tool for structural biology and materials science. The combination of electron microscopy with pulsed electrical or optical stimuli allows for the study of transient phenomena, involving magnetization dynamics, strain evolution and structural phase transformations. Ultrafast transmission electron microscopy (UTEM) is a pump-probe technique, in which non-equilibrium processes can be tracked with simultaneous femtosecond temporal and nanometer to atomic-scale spatial resolutions.

This talk will cover recent methodical developments and applications in UTEM based on laser-triggered field emitters, including real-space imaging [1] and ultrafast nanobeam diffraction [2] of a structural phase transition. Moreover, the mechanisms involved in free-electron beams interacting with optical fields at photonic structures will be discussed, emphasizing quantum effects. In particular, recent progress in the coupling of electron beams to whispering gallery modes [3] and integrated photonic resonators [4] will be presented. Finally, using event-based electron spectroscopy, electron-energy loss measured in coincidence with cathodoluminescence is used to demonstrate the preparation and characterization of electron-photon pair states [5].

[1] "Ultrafast nanoimaging of the order parameter in a structural phase transition", T. Danz, T. Domröse, C. Ropers, *Science* 371, 6527 (2022)

[2] "Light-induced hexatic state in a layered quantum material", T. Domröse et al., *arXiv:2207.05571(2022)*

[3] "Controlling free electrons with optical whispering-gallery modes", O. Kfir et al., *Nature* 582, 46 (2020)

[4] "Integrated photonics enables continuous-beam electron phase modulation", J.-W. Henke et al., *Nature* 600, 653 (2021)

[5] A. Feist et al., "Cavity-mediated electron-photon pairs", *Science* 377, 777 (2022)