Ultrafast Electron Microscopy and Diffraction

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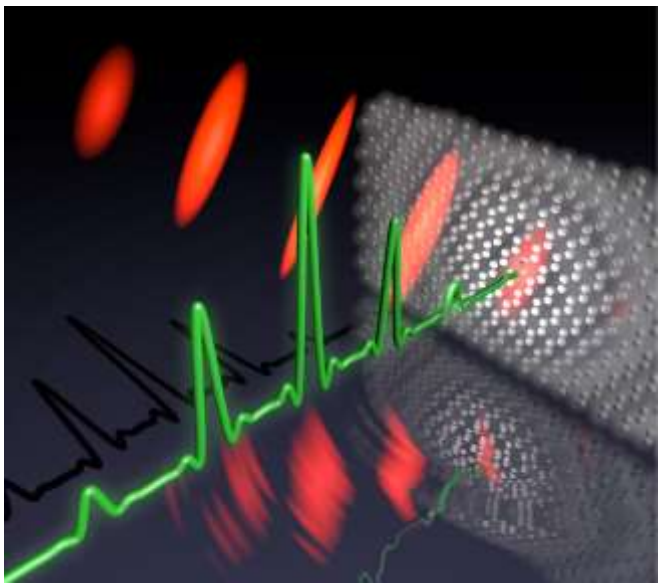
Time-resolved electron imaging, diffraction and spectroscopy are exceptional laboratory-based tools to trace non-equilibrium dynamics in materials with a sensitivity to structural, electronic and electromagnetic degrees of freedom. A particularly versatile method is Ultrafast Transmission Electron Microscopy (UTEM), which combines the high spatial resolution of electron microscopy with the temporal resolution of optical spectroscopy. Moreover, UTEM also provides for a unique test bench to study quantum optics phenomena with free electrons.

This talk will introduce the implementation of UTEM with nanoscale field emitter sources, which offer ultrashort electron pulses of exceptional beam quality and spatial coherence. Examples of structural and magnetization dynamics probed by UTEM will be discussed. Moreover, the mechanisms involved in free-electron beams interacting with optical fields near nanostructures and surfaces will be described, emphasizing quantum effects. The coherent manipulation of the longitudinal and transverse degrees of freedom of free-electron wave functions is shown, and the preparation and characterization of attosecond electron pulse trains will be demonstrated.



References

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