

Towards Quantum Coherent Control with Slow and Fast Electrons

Nahid Talebi

Max Planck Institute for Solid State Research, Stuttgart Germany

Electron beams interacting with nanostructures are not only vital tools for material characterizations – they are routinely used for unravelling the photonic density of states of nanostructures using spectroscopic techniques like electron energy-loss spectroscopy (EELS) and cathodoluminescence (CL) [1]. However, coherent control of photonic modes as performed by advanced optical metrologies like spectral interferometry, spectrography, and tomography has been not yet reported with electron beams.

Here we explore the possibilities of bringing the coherent control into the electron microscopy world, by employing shaped electron beams and understanding the interaction of those with matter, particularly polatitonic systems [2, 3]. Additionally, novel methods of spectral interferometry techniques using electron beams are proposed and discussed [4], where combination of those with shaped electron beams will pave our ways towards quantum coherent control of charge and energy transfer dynamics with slow and fast electrons [5]. We particularly investigate the dynamic interaction of slow and fast electron wave packets with nano-optical excitations theoretically and numerically, using self-consistent Maxwell-Schrödinger and Maxwell-Lorentz frameworks (Fig. 1).

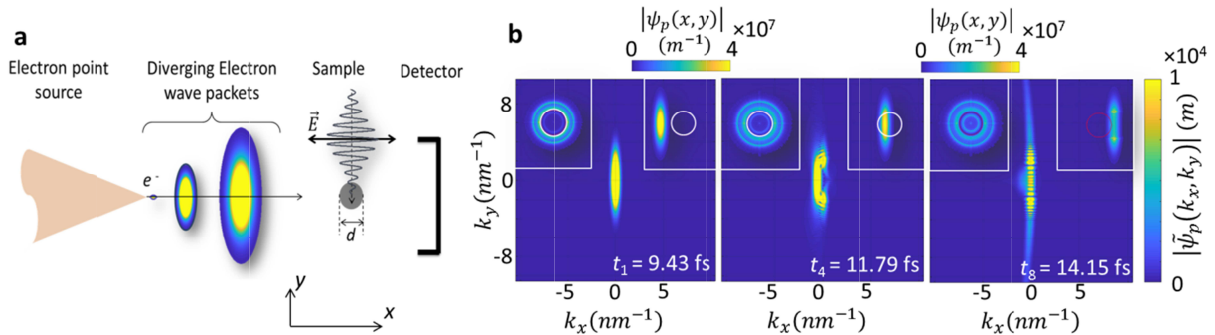


Fig. 1. (a) In a point-projection electron microscope, a divergent electron probe interacts with a sample which is pumped by the laser to a higher photonic states. (b) Dynamics of the probe at specific times in the momentum space. k_x and k_y are the wavenumbers along the specified directions. Left and right insets in each subpanel show the magnitude of the photoelectron wavefunction and sample wavefunction at the specified times, respectively.

References:

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