

# Quantum interactions between free electrons and optical excitations

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The control over the longitudinal and transverse properties of electron beams has recently experienced a tremendous boost because of the combination of new advances in electron microscope instrumentation, particularly in combination with ultrafast light pulses and the ability to synthesize femtosecond electron wave packets. In this presentation, we overview key concepts describing the associated interactions between free electrons, light, and photonic nanostructures, making emphasis on quantum aspects and exploring several remaining challenges and emerging opportunities. We further discuss potential applications in noninvasive spectroscopy and microscopy, the possibility of sampling the nonlinear optical response at the nanoscale, the manipulation of the density matrices associated with free electrons and optical sample modes, optical modulation of electron beams, and improved schemes for electron-driven light emission over a wide range of photon energies.

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