Slow electron waves interacting with gratings

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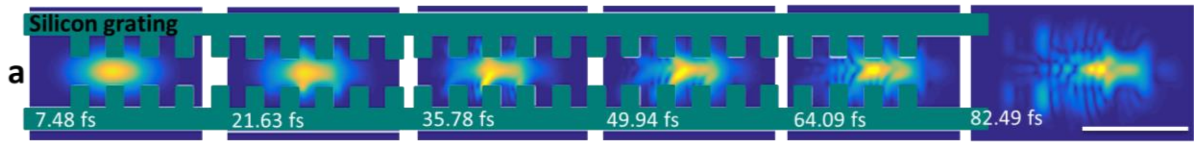
Slow electron beams in comparison with relativistic ones have lower self-inertia and hence are more sensitive to electromagnetic fields. Due to these reasons, they can be better probes for weak electromagnetic interactions in solids. However, theoretical and numerical approaches for slow electrons are more demanding, since the well-known Wolkow solutions and adiabatic approaches [1] break down for slow electrons. Here, I will show numerically, how slow electrons (at energy of 500 eV) can interact with dielectric gratings and electromagnetic radiations in an inverse Smith-Purcell effect [2] (see Fig. 1). The approach utilized here is to incorporate a self-consistent numerical toolbox within a conjugate system of Maxwell and Schrödinger equations to simulate the dynamical evolution of single-electron pulses during their interaction with ultrafast and intense laser radiation. Moreover, the dynamic exchange of energy between the electron and the grating and also the radiation created by the electron wave will be discussed. It will be shown that the electron wave is diffracted enormously and the overall electron wave-packet experiences a huge dispersion during its interaction with gratings and nanostructures.



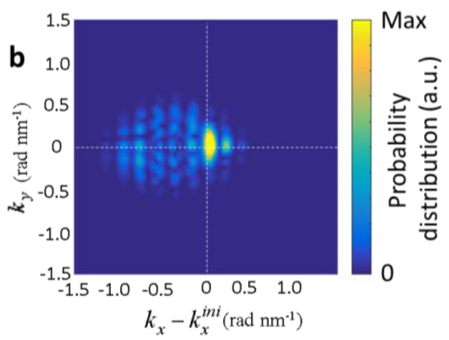


Fig. 1. (a) space-time representation of the electron wavefunction interacting with a silicon grating. The grating is illuminated with light with the electric field amplitude of 1×10^{8} V/m. Scale bar is 200 nm. (b) The final distribution of the electron wavefunction in momentum space.

References

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