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Imperfect recollisions in HHG in solids: real space vs reciprocal space pictures

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The dynamical process that leads to the generation of high order harmonics in solids can be described in either real space or reciprocal (k) space. In both pictures, the process starts by an electron tunneling from the valence to the conduction band and is followed by acceleration by the strong field. In k-space, the resulting dynamics is described in terms of the electron moving on the conduction band, which leads to intra- and interband emission processes. In real space, one can think of laser-driven oscillations of highly delocalized electron and hole wave packets, extending over many unit cells of the lattice, which leads to emission of (interband) harmonics when the electron and hole reencounter each other in space. Using the two-dimensional hexagonal boron nitride (h-BN) system as an example, I will discuss how the delocalized nature of the quantum wave packet means that even imperfect recollisions – when the center of the electron and hole wave packets do not exactly overlap – contribute significantly to the harmonic emission. Imperfect recollisions arise naturally in systems with non-zero Berry curvatures, or any system driven by elliptically polarized laser pulses, and should thus be taken into account when interpreting experimental spectra.