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Direct Numerical Observation of Real-Space Recollision in High-Harmonic Generation from Solids

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Real-space picture of electron recollision with the parent ion guides our understanding of the highly nonlinear response of atoms and molecules to intense low-frequency laser fields. It is also among several leading contestants for the dominant mechanism of high harmonic generation (HHG) in solids, where it is typically viewed in the momentum space, as the recombination of the conduction band electron with the valence band hole, competing with another HHG mechanism, the strong-field driven Bloch oscillations. In this work, we use numerical simulations to directly test and confirm the real-space recollision picture as the key mechanism of HHG in solids. Our tests take advantage of the well-known characteristic features in the molecular harmonic spectra, associated with the real-space structure of the molecular ion. We show the emergence of analogous spectral features when similar real-space structures are present in the periodic potential of the solid-state lattice as shown in the figure. This work demonstrates the capability of HHG imaging of spatial structures of a unit cell in solids.

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