High harmonic generation imaging in solids

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High harmonic generation (HHG) in solids was first observed in a bulk semiconductor [1], and more recently has been explored in a wider variety of materials such as dielectrics [2], two-dimensional semiconductors [3], and nanostructures [4]. Since HHG occurs on a sub-cycle timescale, its discovery has laid the foundation of attosecond science in condensed matter. HHG in solids has also attracted attention as a way to optically reconstruct band structural properties such as energy bands, [5], transition dipole moments (TDMs), and Berry curvature [6].
The main mechanisms to explain HHG are an interband 3-step model of transition to the conduction band, propagation and recombination of an electron-hole pair [7] and an intraband model where HHG is generated due to the nonlinear band velocity of the conduction band [2]. While the first model explains HHG in semiconductors well, the second appears to match experiments in dielectrics better.
The first part of the talk is about identifying the main physical process responsible for different dominant mechanisms in different HHG experiments.
The second part is about theoretical aspects of HHG imaging of materials with broken inversion symmetry. In these materials Berry curvature and topological transitions are important. Various topics such as gauge invariance, imaging of the shift vector, and laser driven structural transitions, will be addressed.
Finally, I will briefly address theoretical analysis of HHG in nanostructures with the microscopic particle-in-cell (MicPIC) code. MicPIC can model HHG from the nonlinear dynamics of the metal antenna and in the underlying semiconductor substrate allowing a comparison of these two mechanisms. Plasmonic effects substantially enhance HHG making it an important tool for table top coherent xuv sources; optimization requires an accurate understanding of the underlying dynamics.

References

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