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High harmonic generation in solids and gases

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High harmonic generation (HHG) in transparent crystals has attracted much attention recently given its potential as a bright, compact, and easily controllable source of extreme utraviolet (XUV) radiation. Much effort has been devoted to the conceptual understanding of the HHG process in solids, and, interestingly, the dominant generation mechanism has been shown to be substantially different from that of HHG in gases. In this talk, I will give an overview of the similarities and differences between HHG in solids and gases, in terms of experimental and theoretical findings from the last several years. In particular, I will discuss how HHG in solids can be described as a three-step process in momentum space that involves tunneling from the valence to the conduction band(s), acceleration on one or multiple conduction bands, and radiation via coherence with the valence band. I will also show that for any given crystal this dynamics can be described using a multi-level system that originates as the Gamma-point band structure of that crystal. I will discuss how this points to a close connection between the band structure and a number of properties of the harmonic radiation such as: (i) the cutoff energy and yield of the often multiple plateaus that can be observed in the harmonic spectrum], (ii) the dependence of the harmonic yield on the relative orientation of the crystal and the laser polarization, and (iii) the sub-cycle time structure of the microscopic and macroscopic harmonic radiation. When possible, I will discuss the comparison of our predictions to recent experimental results.

Reference: G. Ndabashimiye, S. Ghimire, M. Wu, D. A. Browne, K. J. Schafer, M. B. Gaarde, and D. Reis, "Solid-state harmonics beyond the atomic limit," *Nature* **534**, 520 (2016).

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