Role of electron-hole recollision in high harmonic generation from solids and application to band structure spectroscopy

G. Vampa[1], T. J. Hammond[1], N. Thiré[2], B. E. Schmidt[2], F. Légaré[2], C. R. McDonald[1], T. Brabec[1], and P. B. Corkum[1,3]

[1] University of Ottawa, Ottawa, ON K1N 6N5, Canada

[2] National Research Council of Canada, Ottawa, ON K1A 0R6, Canada

[3] INRS-EMT, 1650 boulevard Lionel-Boulet, CP 1020, Varennes, Quebec, J3X 1S2, Canada

Corresponding author: gvamp015@uottawa.ca

When intense laser pulses interact with a medium, high order harmonics of the fundamental laser frequency can be created[1]. This field of research, which traditionally confined the interaction to atomic and molecular gases, has recently been expanded to bulk semiconductors[2].

Among the mechanisms responsible for the emission from solids, one of them is equivalent to its atomic counterpart[3]. In this scenario the strong under resonant laser field first tunnels electrons from the valence to the conduction band, then accelerates them away from their correlated holes. When the field reverses, they re-encounter with possibly large momentum and can recombine thereby emitting the excess energy as a harmonic photon.

By perturbing the generation process with a second harmonic field we are able to record the signature of the recolliding electron-hole pair, therefore linking the atomic to the solid state process for the first time.

The electron and hole carry information about the bands in which they moved. I will show how this information is accessed in the experiment. Our all-optical technique to reconstruct the 3D momentum-dependent band gap will allow measurement of band structures where photoelectrons are not easily accessible, such as in high pressure physics experiments.

[1] Corkum, P. & Krausz, F., *Nature Phys.* **3**, 381-387 (2007).

[2] Ghimire, S. *et al*., *Nature physics* **7**, 138-141 (2011).

[3] Vampa, G. *et al.*, *Phys. Rev. B* **91**, 064302 (2015).