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Nanoscale control of high-harmonic generation from solids[1]

GIULIO VAMPA, Stanford PULSE Institute

Borrowing concepts from gas-phase experiments, high-harmonic emission from solids is thought to benefit from the high density of the target. However, high density comes at the price of high absorption of above-bandgap high-harmonics the absorption length can be as short as few nanometers. As a result, high-harmonics have an extremely short emission depth: of the hundreds of microns that generate high-harmonics, only a tiny fraction (a few nanometers!) contributes to the measured high-harmonic signal. We have been using nanoscale structured surfaces to extract high-harmonics from deeper in the material, thereby overcoming the major limitation to the flux of above-bandgap high-harmonics.

In my talk I will show how to shape the material at the nanoscale to extract high-harmonics from depths as high as 1 um currently limited by the sample thickness, a great improve over 10 nm of the bulk material. Ill show that our structures generate a high-harmonic flux which exceeds that of the un-patterned surface, at any incident power up to the damage threshold. Our structures are currently made of Si to exploit the extensive expertise in nanofabrication methods. We measure and control high-harmonics up to 8 eV photon energies. Ill present ways that the same ideas can be applied to dielectric materials which are suitable to generate high-harmonics beyond 10 eV.

Future work will aim at finding distinct features of phase-matching effects, which are absent in absorption-limited harmonics from homogeneous materials. Our demonstration allows brighter nanoscale solid-state high-harmonic sources, that we plan to implement for superresolution microscopy.

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