Announcing the Final Examination of Troie Journigan for the degree of Doctor of Philosophy in Physics

Date: June 28th, 2024
Time: 12:30 p.m.
Room: Zoom link: https://bit.ly/45ktE9F and Room: PSB 160-161

Dissertation title: High-order Harmonic Generation in Bulk and Thin Film Solids

Abstract:
High-order harmonic generation (HHG), a non-perturbative nonlinear light-matter interaction resulting in coherent emission of high-frequency light, has demonstrated promise as an optical probe of carrier dynamics, structural symmetries, and other properties of solids. HHG from bulk solids in transmission geometry, however, is influenced by nonlinear propagation of the driving laser, which leads to spectral skewing and temporal phase variations in the harmonic emission. These effects obscure the microscopic underlying physics, making HHG-based spectroscopy of bulk solids difficult to interpret. HHG in few-to mono-layer materials, however, avoids strong nonlinear propagation effects, and can provide novel material properties for HHG studies.

In this work, I compare HHG driven by femtosecond mid-infrared laser pulses in bulk and thin film solids. First, HHG generated from epitaxial ZnO thin films grown using different preparations is compared with HHG from bulk ZnO. I identify spectral signatures that result from nonlinear propagation in bulk samples, while thin films generally yield clean harmonic spectra with features that depend on the crystal growth and preparation. Specifically, I find that as-grown plasma ALD (atomic layer deposition) samples yield monocrystalline polar films, which is modified by annealing. The dependence of the harmonic yield on thickness of the nano-meter scale films was also experimentally measured, and found to agree with simulations which incorporated nonlinear conductivity and linear propagation effects. Next, I examine the carrier envelope phase (CEP) dependence of HHG from bulk and thin-film ZnO. I observe a stronger-than-expected sensitivity of the HHG from bulk ZnO to CEP, which results from nonlinear self-compression of the pulse to single-cycle durations. Finally, experimental studies of HHG from novel van der Waals crystals are presented. Together, these results suggest novel frontiers for HHG from few-layer materials.

Outline of Studies:
Major: Physics

Educational Career:
M. S. University of Central Florida, 2022
B. A. University of Chicago, 2016

Committee in Charge:
Dr. Michael Chini (Chair)
Dr. Parag Banerjee
Dr. Volodymr Turkowski
Dr. Laurene Tetard
Dr. Leland Nordin (External Committee Member)

Approved for distribution by Dr. Michael Chini, Committee Chair, on June 10, 2024.

The public is welcome to attend.