Announcing the Final Examination of John E. Beetar for the degree of Doctor of Philosophy in Physics

Date: November 18, 2020

Time: 11:00 a.m.

Room: https://ucf.zoom.us/j/98435657411 (Meeting ID: 984 3565 7411)

Dissertation title: Tunable Few- To Many-Cycle Source for High-Order Harmonic Generation and Time-Resolved Spectroscopy

Abstract:

The temporal confinement of laser light pulses to durations approaching the optical period, and the subsequent conversion of these pulses into extreme ultraviolet and x-ray wavelengths through the process of high-order harmonic generation (HHG), has enabled measurement and control of ultrafast processes spanning picosecond to attosecond timescales. Typically achieved by nonlinear compression of multi-cycle pulses in gas-filled hollow-core fibers, compression to single-and even sub-cycle durations is now becoming routine due to the availability of state-of-the-art Ti:Sapphire laser amplifiers outputting millijoule level pulses with pulse durations below ten cycles. Even so, reliance on mJ-level Ti:sapphire lasers has in most cases limited repetition rates to the few kilohertz regime, therefore restricting their application to time-resolved spectroscopies for which high repetition rates are needed. Toward this end, nonlinear compression of Yb-doped solid state and fiber sources, for which small quantum defect allows for high average powers, has garnered considerable attention in recent years. In this dissertation, I investigate the spectral broadening and temporal compression of sub-millijoule, 280 femtosecond pulses from a high average power Yb-doped laser amplifier by nonlinear compression in gas and solid media. The application of these pulses to high-repetition rate time-resolved studies is further established through their use in both HHG and time- and angle-resolved photoemission spectroscopy. Moreover, I demonstrate the ability to harness the delayed nonlinearity of molecular gases to obtain multi-octave spectral broadening from pulses with long input durations and achieve compression to sub-two cycle durations. The fidelity of the sub-two cycle pulses is demonstrated through the generation of a high-order harmonic XUV continuum, suggesting a path to perform attosecond measurements with commercial laser systems. Finally, I investigate the potential to extend this technique to high average powers by studying the effects of nonequilibrium rotational state distributions in the repetitively laser-heated molecular gas on the supercontinuum spectrum.

Outline of Studies:

Major: Physics

Educational Career:

B.S. University of Central Florida, FL, 2015

M.S. University of Central Florida, FL, 2017

Committee in Charge:

Dr. Michael Chini (Chair)

Dr. Zenghu Chang

Dr. Yasuyuki Nakajima

Dr. Li Fang

Dr. Eric W. Vanstryland (External Committee Member)

Approved for distribution by Dr. Michael Chini, Committee Chair, on November 3rd 2020.

The public is welcome to attend remotely.