**Announcing the Final Examination of Shima Gholam Mirzaeimoghadar for the degree of Doctor of Philosophy in Physics**

**Date:** Apr 3, 2020
**Time:** 2:00 p.m.
**Zoom Link:** https://ucfmed.zoom.us/j/316050948
**Dissertation title:** Symmetry and High Harmonic Spectroscopy in Solids

**Abstract:**
High-order harmonic generation (HHG) by intense femtosecond laser pulses has, over the last three decades, provided new coherent sources of extreme ultraviolet and soft x-ray light and enabled the field of attosecond science. Furthermore, as properties of the target are encoded in the harmonic emission, high-order harmonic spectroscopy has allowed extraction of molecular structure and dynamics from the spectra and polarization states of harmonics generated from gas-phase molecules. HHG from solids, discovered in 2011, now promises to offer similar benefits to condensed matter physics. In this dissertation, I describe progress on two fronts: extending attosecond techniques to generate new high-order harmonic sources based on solid-state targets, and applying high-order harmonic spectroscopy to probe symmetry properties of solids.

First, I demonstrate HHG from ZnO crystals using a high-power source of femtosecond mid-infrared pulses, and characterize the dependence of the harmonic spectrum on the orientation of the crystal with respect to the laser polarization. New features are observed in the orientation-dependent spectrum, which can be explained using symmetries associated with the transition dipoles. The same features are then investigated through polarization-resolved measurements of even and odd harmonic orders, which suggest a universal polarization behavior that is dictated largely by symmetry properties of the target. To test this conclusion, I investigate HHG from ferroelectric $BaTiO_3$ and $LiNbO_3$ crystals, for which the symmetry properties can be externally controlled.

Due to their unique temporal resolution, high harmonic pulses are capable of probing rapidly occurring phenomena such as carrier interactions and phase transition dynamics. For this reason, it is desirable to develop harmonic sources with few-femtosecond to attosecond pulse durations. I take advantage of nonlinear compression in a bulk crystal to compress the mid-infrared laser pulse to <3 optical cycles. Employing these pulses for HHG may pave the way toward novel compact, high-power attosecond sources.

**Outline of Studies:**
Major: Physics

**Educational Career:**
M. S. University of Central Florida, USA, 2018
M. S. Amirkabir University of Technology (Tehran Polytechnic), Iran, 2011
B. S. Amirkabir University of Technology (Tehran Polytechnic), Iran, 2007

**Committee in Charge:**
Dr. Michael Chini (Chair)
Dr. Zenghu Chang
Dr. Luca Argenti
Dr. Stephen Kuebler (External Committee Member)

Approved for distribution by Dr. Michael Chini, Committee Chair, on March 16, 2020.

The public is welcome to attend only remotely.