**Announcing the Final Examination of Darian Smalley for the degree of Doctor of Philosophy in Physics**

**Date:** April 4, 2024
**Time:** 12:00 p.m.
**Room:** PSB 445 & Virtual
**Attendance Link:** https://ucf.zoom.us/j/94985157765
**Dissertation title:** Enhancing Scanning Tunneling Microscopy with Automation and Machine Learning

**Abstract:**
The scanning tunneling microscope (STM) is one of the most advanced surface science tools capable of atomic resolution imaging and atomic manipulation. Unfortunately, STM has many time-consuming bottlenecks, like probe conditioning, tip instability, and noise artificing, which causes the technique to have low experimental throughput. This dissertation describes my attempts to address these challenges through automation and machine learning. It consists of two main sections each describing four projects for a total of eight studies.

The first section details two studies on nanoscale sample fabrication and two studies on STM tip preparation. The first two studies describe the fabrication of graphene-based Josephson Junction devices and the factorial optimization of patterned carbon nanotube forest synthesis. The second two studies focus on the factorial optimization of electrochemical STM tip etching and automated STM tip functionalization via in-situ silicon nanocolumn growth.

The second section details four studies on the use of neural networks for STM image and spectroscopy analysis. The third two studies are on the effectiveness of convolutional neural networks for identifying images of conditioned STM tips on the Au(111) surface and on the detection and metrology of atomic scale defects in single crystal Transition Metal Dichalcogenide Tungsten Diselenide. The fourth two studies are on the use of variational autoencoders to identify Bismuth and Nickel atoms from cross sectional STM images of doped Gallium Arnside and to autonomously classify scanning tunneling spectra of various materials, molecules, and surface structures.

**Outline of Studies:**
Major: Physics

**Educational Career:**
M. S. University of Central Florida, USA, 2024
B. S. University of Central Florida, USA, 2019

**Committee in Charge:**
Dr. Masahiro Ishigami (Chair)
Dr. Talat Rahman
Dr. Enrique Del Barco
Dr. Gita Sukthankar (External Committee Member)

Approved for distribution by Dr. Masahiro Ishigami, Committee Chair, on March 14, 2024.

The public is welcome to attend.