

## **Announcing the Final Examination of Rebecca Cebulka for the degree of Doctor of Philosophy in Physics**

**Date:** April 2, 2019

**Time:** 9:30 a.m.

**Room:** CSB 221

**Dissertation title:** Light-Matter Interaction in Single Molecule Magnets

### **Abstract:**

This dissertation includes a series of experimental realizations which focus on studying the coupling between photons and single-molecule magnets (SMMs) in both the weak and strong coupling regimes. In the weak coupling regime, the aim is to achieve coherent control over the time evolution of the spin of SMMs while applying rapid microwave pulses at sub-Kelvin temperatures, where polarization of the spin bath may be achieved without large magnetic fields, allowing the suppression of dipolar dephasing. The continuing results of this experiment will be to provide a window into fundamental sources of decoherence in single-crystal SMMs in an energy range not thoroughly investigated. We expect that these conditions would allow us to study the quantum dynamics of the spins as governed by the intrinsic molecular magnetic anisotropy, which should give rise to non-well-defined Rabi oscillations of the spin state, including metastable precessional spin states. In the strong coupling regime, high quality factor superconducting resonators with nano-constrictions have been designed and fabricated to investigate the vacuum Rabi splitting between a photon and the SMM spin. The proposed setup will permit measurements of coherent collective coupling between molecular spins and a low number of photons, ideally down to a single photon. This experiment may ultimately provide the opportunity for reaching the strong coupling regime with a single spin. Finally, this thesis also documents a research study into the impact of service-learning methodology on students' depth of learning and critical thinking skills during a novel nanoscale science and technology course offered in the UCF Physics Dept. The overall learning of students was assessed and results clearly showed improvement in both multiple choice pre/post-tests and critical reflection papers. We associate this improvement at least partially to the service-learning experience.

### **Outline of Studies:**

Major: Physics

### **Educational Career:**

M. S. University of Central Florida, Orlando FL, 2016

B. S. Rutgers University, New Brunswick NJ, 2014

### **Committee in Charge:**

Dr. Enrique del Barco (Chair)

Dr. Eduardo Mucciolo

Dr. Richard Klemm

Dr. Fernando Luis (External Committee Member)

Approved for distribution by Dr. Enrique del Barco, Committee Chair, on March 14, 2019.

The public is welcome to attend.