Announcing the Final Examination of James Atkinson for the Degree of Doctor of Philosophy in Physics

Date: Wednesday, March 30, 2016
Time: 9:30 am –12:00 pm
Room: PSB 161 (UCF Main Campus)
Dissertation title:
Internal Degrees of Freedom and Spin Transitions in Single Molecule Magnets

Abstract:

This thesis covers a range of study detailing the transitions between spin eigenstates in molecular magnet systems. Broadly speaking, these transitions can be divided into two kinds: Those that involve the tunneling of spin through a potential barrier to a resonant state on the other side, a phenomenon known as quantum tunneling of magnetization, and those that occur through the absorption or emission of a photon. In this latter case, the energy of the photon must match the energy difference between two eigenstates with a difference in angular momentum of $\hbar$.

We will detail research performed on single molecule magnets, a class of systems that has established itself as an exemplar of higher-order spin interaction. Specifically, we will present the results of studies focused on two Manganese based systems, both of which represent good examples of single molecule magnet behavior. By performing magnetization measurements below the temperature threshold where these systems' polarizations become hysteretic, we find that the precise form of the observed resonant tunneling features (which includes evidence for strong interference of geometric phase a.k.a. Berry phase) can be related to the specifics of the intramolecular interaction. We have analyzed our results using the "giant spin" model (which approximates the system as a single spin) as well as with a "multi-spin" method which considers all interactions between the ions in the molecular core.

We will also discuss the results of measurements performed on a crystalline sample under stress (uniaxial pressure). The data has been analyzed in a framework in which a physical distortion is modelled as a modification of the molecular anisotropy, with different directions of applied stress represented as changes to different parameters governing the molecular energy landscape. This analysis includes simulation of the magnetic relaxation through a master equation approach to the spin-phonon interaction.

Finally, our discussion will outline efforts toward understanding the coherent behavior of spin systems. The "weak" and "strong" coupling between a photon and spin represent two regimes of an interaction by which the information within a spin can be accessed and manipulated. We will discuss the challenges involved in exploring these regimes, both from a theoretical and experimental standpoint. The purpose of these experiments dovetails with those outlined above in attempting to form an intimate basis of knowledge describing the universal relationships to spin at the most fundamental level.

Outline of Studies:
Major: Physics

Educational Career:
M. S. University of Central Florida, USA, 2012
B. A. Hampshire College, Massachusetts, USA, 2006

Committee in Charge:
Dr. Enrique del Barco (Chair)
Dr. Bo Chen

Dr. Eduardo Mucciolo
Dr. Fernando Luis (External Committee Member)

Approved for distribution by Dr. Enrique del Barco, Committee Chair, on March 28, 2016.

The public is welcome to attend.