LA-SiGMA

Louisiana Alliance for Simulation-Guided Materials Applications

Fall Seminar Series

3:30pm - 4:30pm, Wednesday, October 24, 2012

Tulane University

Lindy Boggs, Room 242

Coherence and Decoherence in Molecular Magnets

by

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Molecular Magnets (which are basically large molecules having a large spin moment) are a fascinating playground for physicists and chemists, interested in everything from molecular spin chemistry to fundamental tests of quantum mechanics. At low temperatures they display a very remarkable quantum tunneling dynamics, which has led some to hope that a future generation of quantum computers may be built from arrays of such molecules.

I will first describe in fairly elementary terms the main properties of molecular magnets, showing a 'rogue's gallery' of some of the 8,000 or so such molecules that chemists have isolated. I will then discuss their low-T quantum dynamics, which shows a fascinating interplay between spin tunneling controlled by spin anisotropy and applied fields, and by the coupling of the electronic spins to nuclear spins and phonons, as well as to each other. We will then see how one might imagine building molecular scale quantum devices from these molecules, as well as the big problem facing this, viz., decoherence. Finally, I will discuss how some fundamental experimental tests of quantum mechanics have been envisaged for these molecules, and explain some of the background to this.

Research Overview

I began research as a low-T experimentalist, working on superfluids for my MSc project; my first 4 papers were experimental. I switched to theory for my PhD, and throughout my postdoc years, and for the first few years as a faculty member, I worked mainly on strongly-correlated fermion systems, including He-3, heavy fermions, and high-Tc superconductivity. Beginning in about 1997 I started to concentrate more on problems involving large-scale quantum phenomena, particularly in magnetic systems, where I pioneered a lot of the theory. I also developed a stronger interest in a broad range of 'statistical physics' problems, which led to, eg., the development of a 'spin bath theory' for localized environmental modes (this development is still very active), to work on decoherence and quantum information theory, and some more unusual work related to this (eg., collaboration with string theorists on models of decoherence). Currently I am working on problems in both nanoscience and general statistical physics, as well as some work on strongly-correlated systems.