Fall 2013 Joint Colloquium

Friday, October 11th, 2013

4:00 PM, ESB 1001

The Materials Department

&

Materials Research Laboratory

Proudly Welcome...

LANGE LECTURER

Dr. Stephen Wilson

Department of Physics

Boston College

Exploring the role of electron-electron correlations in spin-orbit driven Mott phases

Abstract

Some of the most physically fascinating materials and, often, some of the most challenging systems to understand are found within the class of perovskite transition metal oxides. Perovskite-type oxides built of transition metal cations with *3d*-electron valence states are now well known to exhibit strongly correlated phase behavior largely driven by the on-site Coulomb repulsion (U) between electrons. This results in a variety of emergent phenomena ranging from high temperature superconductivity to colossal magnetoresistive phases that stem fundamentally from a carrier-doped Mott insulating ground state. As the *3d* transition metal cations in these systems are replaced with their heavier *5d* cousins, the larger spatial extent/overlap of the electronic radii and the correspondingly reduced U should naively destabilize this parent Mott state; however, surprisingly, a growing class of *5d* transition metal oxides built from Ir^{4+} ions shows that this is not always the case. Instead, the interplay between the amplified spin-orbit interaction intrinsic to these *5d*-electron iridates and their residual U conspires to stabilize a novel class of spin-orbit assisted insulators with a proposed $J_{eff}=1/2$ Mott insulating ground state. The idea of this spin-orbit Mott state has been the focus of recent interest due to its potential of hosting a variety of new phases driven by correlated electron phenomena (such as high temperature superconductivity or enhanced ferroic behavior) in a strongly spin-orbit coupled setting. Currently, however, there remains little to no consensus regarding the relative importance of electron-electron interactions in governing the ground state properties of these spin-orbit Mott insulators—an essential ingredient for realizing many of their hoped-for properties. Here I will present our group's recent experimental work exploring one such spin-orbit driven Mott material ($Sr_3Ir_2O_7$) with the ultimate goal of determining the relevance of U and electron correlation effects within the system's ground state. Our results suggest that U is not only critical to the parent state's insulating phase formation but also that it remains essential as in-plane carriers are introduced, resulting in an electronically phase separated ground state. I'll argue that the resulting experimental picture of a doped spin-orbit Mott phase where correlations remain relevant largely validates many of the theoretical hopes of realizing novel electronic phases in this class of perovskite iridates.

MATERIALS UC Santa Barbara

HOSTED BY: PROFESSOR RAM SESHADRI

LIGHT REFRESHMENTS WILL BE SERVED BEFORE THE SEMINAR AT 3:45

MRL MATERIALS RESEARCH LABORATORY *the innovation engine for new materials* UC Santa Barbara