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WEEKLY CALENDAR

November 16, 2009

Departmental Colloquium

"Magnetic Moments in Superconductors: From Assassin to Facilitator"

3:40 PM, November 19, 2009
109 Nicholson Hall

Jeffrey W. Lynn
National Institute of Standards and Technology (NIST)

Host: Jiandi Zhang

• Refreshments served at 3:15 PM in 232 (Library) Nicholson Hall •

Note: This talk will briefly review the history of "Magnetic Superconductors" (as detailed below), will discuss the magnetic properties of the high TC cuprates, but will primarily focus on the new iron-based high TC superconductors.

Abstract: The magnetic properties of superconductors have a rich and interesting history. Early work showed that even small concentrations of magnetic impurities destroyed the superconducting pairing through the exchange-driven spin depairing mechanism, prohibiting any possibility of magnetic order coexisting with superconductivity. The first exceptions to this rule were provided by the ternary Chevrel-phase superconductors (e.g. HoMo6S8) and related compounds, which exhibit long range magnetic order coexisting with superconductivity. The very low magnetic ordering temperatures (~1 K) suggested that dipolar rather than exchange interactions dominate, thus (it was thought) allowing the coexistence. These materials also provided the first examples of the competition between ferromagnetism and superconductivity. In the newer borocarbide class of magnetic superconductors (e.g. ErNi2B2C), however, it became clear that the magnetic order is in fact exchange driven. The borocarbides also provided the first example of the spontaneous formation of flux quanta (vortices). For the high-TC cuprate superconductors we now have come full circle, as the spins are not only tolerated but are intimately tied to the superconductivity. The "parent" systems are Mott-Hubbard antiferromagnetic insulators with very strong magnetic interactions that are two-dimensional in nature. These strong exchange interactions survive into the superconducting state, yielding highly correlated electrons that participate directly in the superconducting pairing. The "parent" materials of the new iron-based high TC superconductors are also antiferromagnets with very energetic spin excitations, and in the superconducting regime they form a "magnetic resonance" that is directly tied to the superconducting order parameter, just like the cuprates. Our understanding of this new family of systems is now arguably better than for the cuprates, and perhaps the iron-based superconductors will provide the key to a full understanding of both classes of materials.