MAR09-2008-002719

Abstract for an Invited Paper
for the MAR09 Meeting of
the American Physical Society

Frustrated and Quantum Antiferromagnetism on the Diamond Sublattice of A-site Magnetic Spinels[1]

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Spinel crystals, with the chemical formula AB_2X_4, in which only the A atom is magnetic, realize antiferromagnetism on a diamond sublattice. We first discuss examples, such as $CoAl_2O_4$ and $MnSc_2S_4$, which exhibit "bond frustration" due to the competing effects of first and second neighbor interactions. This is well modeled by a classical Heisenberg Hamiltonian, which leads to a remarkable ground state degeneracy of coplanar spirals, in which the wavevector of the spiral can lie anywhere on a "spiral surface" in momentum space. We describe how thermal fluctuations lead to a broad spin liquid regime, with unique properties, and magnetic ordering at low temperatures. We next discuss the intriguing case of $FeSc_2S_4$, in which orbital degeneracy leads to a persistant "spin orbital liquid" down to the lowest temperatures. We argue that this material is in the vicinity of an unusual quantum critical point driven by a competition between exchange and spin-orbit interactions.

[1]supported by NSF-DMR-0804564