Condensed Matter Physics Seminar

The quest for quantum spin liquid behavior in a honeycomb magnet

Monday

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4:00 P.M.

Rm 184 NSH

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It is known from Alexei Kitaev's seminal work in 2006 that anisotropic Ising interactions on the three bonds of a honeycomb lattice can lead to a quantum spin liquid (QSL) ground state. A special property of this QSL is the emergence of Majorana Fermions and non-abelian anyons that can be used for topological quantum computation. It has been proposed that honeycomb materials possessing a low-spin ground state mediated by an edge-sharing octahedral crystal structure and strong spin-orbit coupling can realize this behavior. In this talk, I will describe the synthesis, properties and the excitation spectrum of a two-dimensional honeycomb magnet alpha-$RuCl_3$. Using neutron scattering we show that, although the ground-state is antiferromagnetic, the excitation spectrum at medium energies (~7 meV) contains an unusual broad feature matching the predictions for the QSL behavior. Detailed theoretical analysis allows us to compare our spectrum with Kitaev exact solutions, as well as extensions based on mean-field approximations, strongly suggesting that the broad features are best described by magnetic Majorana fermions arising from strong antiferromagnetic Kitaev interactions. Finally, we will talk about our recent endeavors to extend this work using doping, thin-films and application of magnetic field. The later, most interestingly, suppresses the long-range order hopefully leading to a true spin-liquid state.