QPhysics
AT QUEENS COLLEGE

Colloquium Notice

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Developing dynamical probes of quantum spin liquids inspired by techniques from spintronics

This talk is broken into two sections. In the first, we propose an experimental method utilizing a strongly spin-orbit coupled metal-to-quantum magnet bilayer as a probe of quantum magnets lacking long range magnetic order, e.g., quantum spin liquids, via examination of the voltage noise spectrum of the metal layer. The bilayer is held in thermal and chemical equilibrium, and spin fluctuations arising across the interface are converted into voltage fluctuations in the metal as a result of the inverse spin Hall effect. We elucidate the theoretical workings of the bilayer system and provide precise predictions for the frequency characteristics of the enhancement to the ac electrical resistance measured in the metal layer for three candidate quantum spin liquid models. Application to the Heisenberg spin-1/2 kagome lattice model should allow for the extraction of any spinon gap present. A quantum spin liquid consisting of fermionic spinons coupled to a U(1) gauge field should show subdominant Ω^{4/3} frequency scaling of the resistance of the coupled metal. Finally, if the magnet is well-captured by the Kitaev model in the gapless spin liquid phase, then the proposed bilayer can extract the two-flux gap energy which arises in spite of the gapless spectrum of the fermions. We therefore show that spectral analysis of the ac resistance in the metal in a single interface, equilibrium bilayer can test the relevance of quantum spin liquid models to a given candidate material.

In the second section, we examine the temperature dependence of the dc conductivity of a disordered 2d metal when it is interfaced with an insulating paramagnet. The metal contains short-range, isotropic impurities, we consider quantum interference effects, and we include Rashba spin-orbit interactions that arise due to structural inversion symmetry breaking at the interface. The paramagnet acts as a bath of spin fluctuations from the perspective of the metal layer, and the presence of spin fluctuations renormalizes the metallic conductivity. If the affixed insulator is a gapless quantum spin liquid, we show that a lnT correction arises in the absence of spin-orbit interactions while accounting for spin-orbit interactions induces a more divergent T^{-1/2} correction. For temperatures T > T^* ~ 10mK, the lnT correction dominates, whereas for T < T^* the T^{-1/2} correction arising due to spin-orbit interactions takes over. We therefore show that a bilayer as here explicated can act as an all-electrical probe of quantum spin liquid ground states.

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Starts at **12:15 pm**
Zoom