Searching for New Excitations in Topological Places

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The combination of electronic correlation and spin-orbit coupling is thought to precipitate a variety of highly unusual electronic phases in solids, including topological and quantum spin liquid states. Such states are predicted to produce Majorana Fermions, whose statistics are direct evidence of the topological nature of the ground states. In this talk I will outline our efforts to pursue novel quasi-particles at the interface between high Tc superconductors and topological insulators, where we have observed a new excitation.[1] I will then discuss in detail our efforts to find a Kiteav quantum spin liquid and its associated fractional excitations in $RuCl_3$ (see Fig. 1a).[2] The Combination of IR and Raman spectroscopy provides direct access to all the energy scales, which are well separated and easily identifiable in this strongly correlated material (Fig 1b). Raman not only reveals the sharpest spin-orbit exciton, but a continuum indicative of fractional excitations (Fig 1c). However the material reveals low temperature magnetic order, as such I will also discuss our efforts to search for a true spin liquid in this material via mechanical exfoliation.

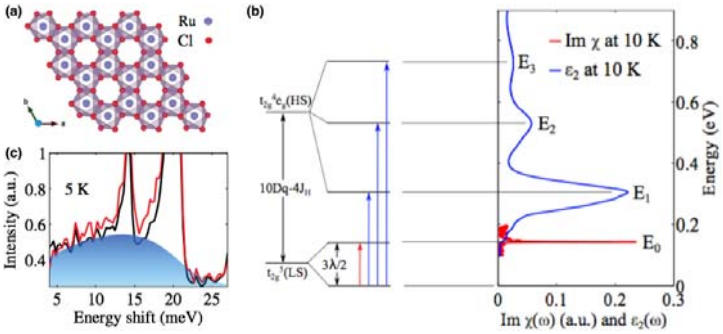

Figure 1. (a) Honeycomb structure of a single plane of RuCl3. (b) Spin-Orbit excitations expected from a Ru atom in the Jeff = ½ state and their observation with Raman and IR spectroscopy. (c) The broad continuum observed in Raman indicating the fractional excitations in this potential Kitaev spin liquid.

References:

[1] Physical Review B 90, 241106(R) (2014).

[2] Physical Review Letters 114, 147201 (2015)