Probing Magnetic Excitations in α-$RuCl_3$ Using Inelastic Electron Tunneling Spectroscopy

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The search for Quantum Spin Liquids (QSLs) intensified in 2006 when A. Kitaev proposed an exactly solvable model on the honeycomb lattice that now bears his name. The Mott insulator α-$RuCl_3$ was recently put forward as a candidate for this phenomenon, and has been potentially shown to host the anyonic excitations expected for this model [1,2]. However, probing this elusive phase of matter and its excitations has proven highly challenging. The observation of a half quantized thermal hall effect has been touted as a smoking gun evidence of the Kitaev QSL under applied field [3], but a lack of reproducibility has cast a doubt on these results [4].

Recently, several theoretical studies have proposed Inelastic Electron Tunneling Spectroscopy (IETS) as a method for probing fractional excitations in α-$RuCl_3$ [5]. This powerful tool, which provides information on the various excitations present in an insulating tunnel barrier, has been used to detect magnons in many 2D magnetic materials [6], including α-$RuCl_3$ [7].

Here, we present preliminary IETS measurements performed on mono- and bilayer α-$RuCl_3$, sandwiched between graphite contacts. We observe a peak in magnetoconductance with a width that appears to depend on the number of layers, and becomes constant for applied fields above ~ 2 T. This peak may be the result of a decrease in magnetoconductance due to quenching by hot electrons, as previously observed in other magnetic tunnel junctions [8]. We discuss future measurements to investigate the physical origin of this phenomenon.

References

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