PROBING SPIN EXCITATIONS USING MAGNETO-RAMAN SPECTROSCOPY.

K. Thirunavukkuarasu[1], Z. Lu[1], J.R. Simpson[2,3], A.H. Walker[3], K. Burch[4] and D.Smirnov[1]

[1]*National High Magnetic Field Laboratory,Tallahassee, FL 32310, USA*
[2]*Department of Physics, Astronomy and Geosciences, Towson University, Towson, MD 21252-0001, USA*
[3]*Nanoelectronics Group, National Institute of Standards and Technology, Gaithersburg MD 20899-8120, USA*
[4]*Department of Physics, Boston College, Chestnut Hill,* MA 02467-3804, USA

One of the very elusive and intriguing states of matter is a quantum spin liquid (QSL) where quantum fluctuations hinder long range order at low temperatures. Recently, it was suggested that a two-dimensional QSL might manifest in a spin-orbit coupled Mott insulator such as α-$RuCl_3$ with honeycomb lattice.[1] Optical spectroscopy and Raman scattering studies on α-$RuCl_3$ performed at low temperatures identified elementary excitations due to electronic correlations and spin-orbit coupling.[2]

In particular, low temperature Raman scattering revealed a broad continuum of magnetic scattering at very low energies (below 25 meV) which was found to persist at temperatures much higher than the magnetic ordering temperature suggesting the presence of frustrated magnetic interactions.[2] Furthermore, specific heat and magnetic susceptibility measurements also found evidence for unconventional magnetism driven by spin-orbit coupling and electronic correlations.[3] The observations appear to be consistent with theoretical expectations for Heisenberg-Kitaev model for QSL.[4]

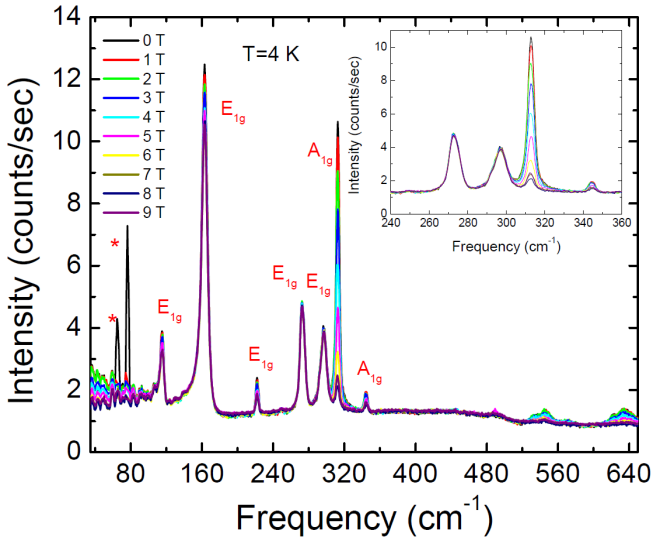

Figure 1. Raman scattering spectra of $RuCl_3$ at T=4K for magnetic fields from 0 T up to 9 T. Inset gives the expanded view of the frequency range of A_{1g} phonon modes showing the change in intensity of the strongest A_{1g} mode with respect to increasing field.

The underlying mechanism for magnetism in α-$RuCl_3$ was further investigated by probing the effect of external magnetic field on the Raman spectroscopic signatures. Raman scattering experiments were performed at temperatures down to 5 K and magnetic fields up to 10 T. Among the Raman-active phonons (see Figure 1), the intensity of strongest A_{1g} phonon at about 312 cm^{-1} was found to decrease with increasing magnetic field strength. This suggests the presence of strong magnetic interactions. The experimental observations and its implications will be presented and discussed in detail.

[1] K.W. Plumb, *et al*., Phys. Rev. **90**, 041112 (2014).
[2] L.J. Sandilands, *et al*., arXiv:1503.07593 and Phys. Rev. Letters **114**, 147201 (2015).
[3] J.A. Sears, *et al*., Phys. Rev. **91**, 144420 (2015).
[4] H.-S. Kim, *et al*., Phys. Rev. **91**, 241110 (2015).

Category: MO
Email: komalavalli@magnet.fsu.edu