Experimental report

23/04/2019

Proposal: 4-05-689 **Council:** 4/2017

Title: Probing Kitaev interactions in a quantum-spin-liquid candidate alpha-RuCl3 via polarized neutron scattering

Research area: Physics

This proposal is a new proposal

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Samples: RuCl3

Instrument	Requested days	Allocated days	From	To
IN3	1	1	27/05/2018	28/05/2018
IN22	8	3	28/05/2018	31/05/2018

Abstract:

Considerable research has been focused on the effects of spin-orbit coupling (SOC) in transition metal compounds because they are responsible for exotic topological features. In particular, SOC has also been identified to be critical in realizing the Kitaev spin liquid states. Recently, the layered honeycomb magnet alpha-RuCl3 has been proposed as a candidate to realize the Kitaev spin physics. In our previous work, we have detected a broad continuum centering at the Brillouin zone center (Gamma point), which may result from a spin-liquid phase with an antiferromagnetic Kitaev exchange interaction. In order to clarify whether this continuous mode is of pure magnetic origin or has some contributions from nuclear (coherent/incoherent), we propose to perform polarization measurements on RuCl3 single crystals. IN22 with the polarized option is an ideal instrument for our purpose. Totally, we ask for 8 days (3 days unpolarized+5 days polarized) on IN22. If IN22 is not available, IN20 will also work for us.

Experiment reports for "Probing Kitaev interactions in a quantum-spin-liquid candidate alpha-RuCl3 via polarized neutron scattering"

The ground state of the analytically solvable Kitaev model is an exotic quantum spin liquid (QSL) phase, where spin excitation is fractionalized into the itinerant Majorana fermions and localized Z_2 flux. α-$RuCl_3$ is a two-dimensional honeycomb-lattice topological quantum magnet, in which the bond-direction dependent Kitaev exchange interaction between the strongly spin-orbit coupled Ru^{3+} ions with J_{eff} = 1/2 dominates. α-$RuCl_3$ has thus attracted tremendous research interests due to its proximity to QSL. Despite that α-$RuCl_3$ transforms to a long-range ordered antiferromagnetic state below T_N~7 K, it has been demonstrated that this zigzag magnetic order can be suppressed by magnetic fields applied parallel to the honeycomb plane theatrically and experimentally and a quantum disorder emerges, which was proposed to be a quantum spin liquid state.

We have carried out unpolarised neutron scattering experiment at IN22 to research it magnetic excitation. Before our experiment at IN22, we used IN3 to help us to check the goodness of our sample's alignment.

Scattering beam with suitable wave vector was selected to measure the excitation and our scattering plane was [HHL] plane as shown in figure.1.

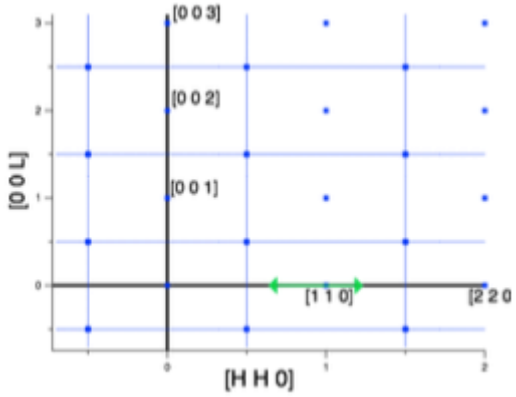

Fig.1 Schematic picture of scattering plane plotted in reciprocal space

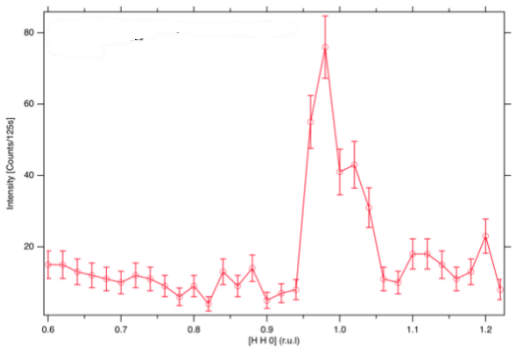

Fig. 2 magnetic excitation along [110] reciprocal direction measure with constant E =0.5 meV at T =15 K

Our measurement strategy was to make Q scan along different reciprocal direction then we could map out the excitation. Since our sample was aligned by several small crystals, thus it took us several hours to align our samples well. We started with the measurement of the low energy excitations along (110) direction (fig.2) and it took us 2 days to get resealable counting statistics since the signals of our samples were very low due to the rather small moment of Ru^{3+} (~0.2 μ_B) and high background from sample holder and the glue. For every point we have to measure 2 minutes and several cycles. Then we used another left one day to measure excitation along (001) reciprocal direction. Due to the time limitation, our measurement was not fully finished, and a further experiment will be done to fulfill our measurement plan. Many thanks to the fruitful help and useful suggestion from our local contact Dr. Frederic and we are looking for the future cooperation.