Experimental report

14/02/2017

Proposal:	**4-01-1517**		**Council:**	4/2016
Title:	Low energy magnetic dynamics of Sr_2IrO_4			
Research area:	Physics			

This proposal is a new proposal

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Samples: Sr_2IrO_4

Instrument	Requested days	Allocated days	From	To
THALES	8	7	10/11/2016	17/11/2016

Abstract:

Strontium iridate, Sr_2IrO_4, has recently received special attention due to its close resemblance to the undoped high-TC cuprates in terms of structural, electronic, and magnetic aspects. We have measured the spin-wave dispersion of Sr_2IrO_4 using the resonant inelastic x-ray scattering (RIXS) technique, which revealed a magnon branch with a bandwidth of ~200 meV. Intriguingly, our very recent Raman spectroscopy data reveals the emergence of additional magnetic modes at between 0 and 10 meV. This mode has a magnetic field dependence distinct from that of the magnon, and we suspect that it may be related to recently reported hidden odd-parity order. We propose to utilize the cold neutron spectrometer ThALES in order to access this energy regime and study the magnetic nature of the excitation spectrum around the magnetic zone center and zone boundary, with the objective of elucidating the nature of the hidden order and developing a comprehensive description of the magnetic dynamics and a better understanding of the link between Sr_2IrO_4 and the high-TC cuprates.

Experiment Report

Low energy magnetic dynamics of Sr_2IrO_4

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Proposal ID: 4-01-1517
Instrument: Thales
Contact: Paul Steffens

Introduction

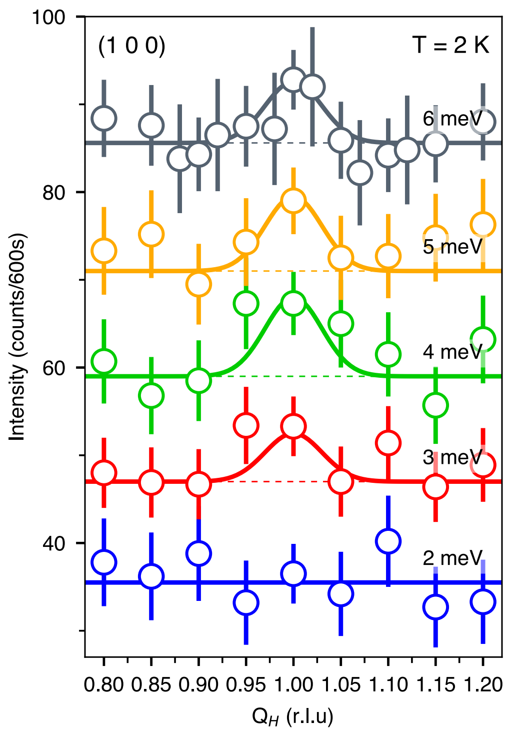
Sr_2IrO_4 has recently received special attention due to its close resemblance to the un-doped high-T_C cuprates in terms of structural, electronic, and magnetic aspects [1]. We have measured the spin-wave dispersion of Sr_2IrO_4 using the resonant inelastic x-ray scattering (RIXS) technique, which revealed a magnon branch with a bandwidth of ~200 meV [2]. The RIXS technique however, does not currently have the energy resolution to resolve the magnitude of the out-of-plane magnon gap, which could reveal potential deviations from 2D Heisenberg physics and may have important implications for the recently hidden symmetry breaking revealed by optical second-harmonic generation [3].

Setup

The cold neutron triple axis spectrometer Thales provides the required low energy S(Q,w) range, along with a high energy resolution and low background with the beryllium filter option. Combined, these factors made it possible to resolve the out-of-plane gap of Sr_2IrO_4. Thales was setup in a constant k_F = 1.55A $Å^{-1}$ configuration. The sample was aligned in the (H0L) scattering plane in order to access the magnetic zone centre (π,π) at (10L). A large array of Sr2IrO4 crystals was co-aligned for the experiment with a mass ~1g.

Results

Due to the small magnetic moment and neutron absorption from Ir-ions, very long count times were required (at least 60 minutes per point) in order to resolve the magnon branch. Constant-E Q_H scans were conducted at (100) and (102) at energies from 1 meV up to 6 meV. The primary result at the (100) is shown in the figure. While the data is noisy, preliminary analysis indicates an out-of-plane gap on the order of 2-3 meV. This feature is also present at the (102) position, which is expected as the magnon does not strongly disperse along the L direction. Measurements were conducted at T=2K and 300K (above T_N=240K) to ensure the magnetic origin of the signal.



Outlook

Thorough analysis is currently underway, with a particular focus upon the resolution ellipsoid, to ensure an accurate determination of the gap energy. This data, combined with other techniques such as Raman spectroscopy and RIXS will enable a full understanding of the magnetic excitation spectrum of Sr_2IrO_4.

References

[1] Rau, J. G., Kin-Ho Lee, E. & Kee, H.-Y. Ann. Rev. Cond. Matt. 7, 2.1-2.27 (2016).
[2] Kim, J. et al. PRL 108, 177003 (2012).
[3] Zhao, L. et al. Nature Phys. 12, 32-36 (2016).