Experimental report

15/09/2016

Proposal: **5-42-427**

Council: 4/2016

Title: Search for anapoles in 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
D7	14	10	01/09/2016	11/09/2016

Abstract:

Layered 5d transition iridium oxides have attracted huge interest due to unconventional Mott insulating states induced by strong spin-orbit coupling and the possible proximity with the physics of high-temperature superconductivity in cuprates. Among all the iridates studied, Sr_2IrO_4 has been the most extensively investigated. Recently, a global symmetry breaking in Sr_2IrO_4 has been reported using spatially resolved optical second harmonic generation measurements as well as forbidden Bragg peaks were observed in neutron diffraction. This broken symmetry cannot be explained by neither structural distortions nor by the antiferromagnetic spin order. Instead, it is argued to be caused by a loop-current order similar to the one observed in superconducting cuprates. Therefore we here propose to evidence the existence of the loop current phase using polarised neutron scattering. We consider that D7 with polarization analysis is the most relevant to achieve our goal and request 14 days of beam time.

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Search for anapoles in Sr_2IrO_4

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The proposed experiment aims to confirm the existence of the loop current phase in Sr_2IrO_4 using polarized neutron scattering. The magnetic scattering from the loop current ordered state is expected to appear on top of nuclear peaks. We have measured temperature dependence of non-spin-flip (NSF) and spin-flip (SF) intensities from 100 to 300 K at (112) and (116) Bragg peaks. For a reference, (004) peak and graphite (002) have been examined. Assuming a stable flipping ratio (FR=NSF/SF) that originates from neutron polarization leakage, one can extract a magnetic signal by a decrease of FR. However, the FR usually shows a drift in temperature, so temperature dependent bare FR0(T) is obtained from the reference.

In figure 1, the NSF and SF intensities were shown as well as FR(T), measured at the (112) Bragg peak. The FR for the P//z polarization increases at 100 K by ~10% at 300 K, while one for other polarizations are rather flat. In figure 2, the same measurement on graphite (002) shows a similar slope in temperature for all polarizations. By taking the bare $FR_0(T)$ with this slope, a pure polarization leakage $NSF/FR_0(T)$ is calculated. An additional SF intensity depart from it represents the emergent magnetic signal. Here we have evidenced magnetic transition around 250 K mainly on the P//x and y polarizations.

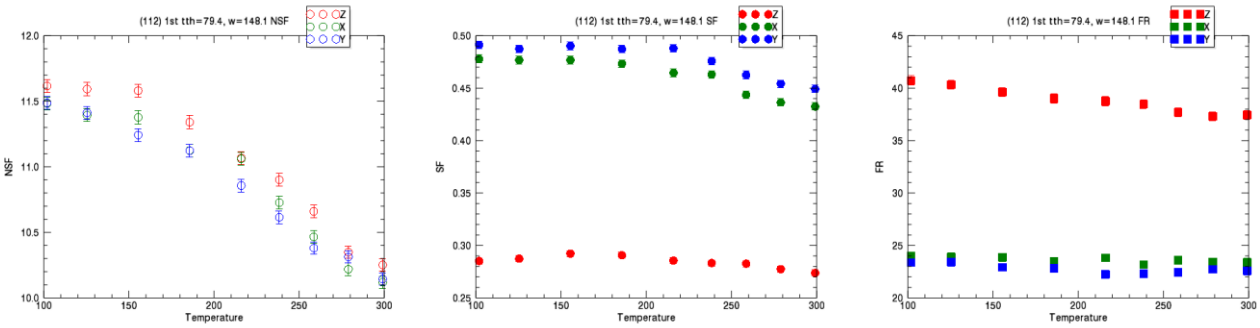

Figure 1. Temperature dependence of NSF, SF intensities and FR(T) measured at the (112) peak.

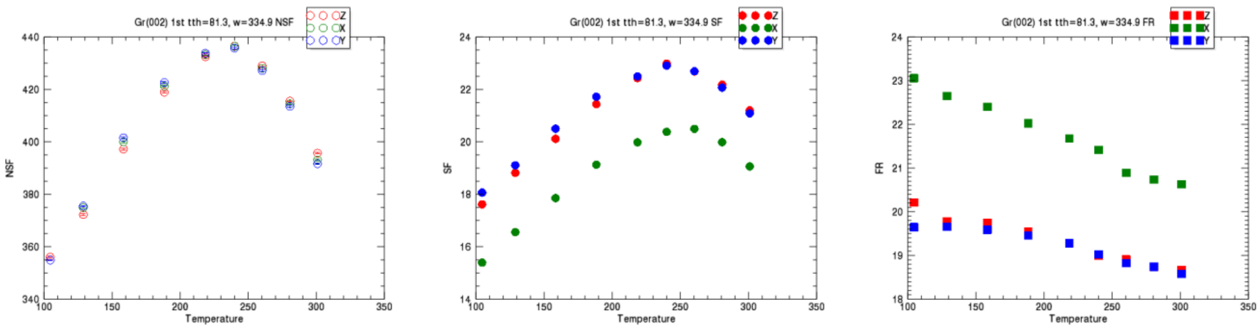

Figure 2. Temperature dependence of NSF, SF intensities and FR(T) measured for the graphite (002). The bare $FR_0(T)$ with a slope is determined.

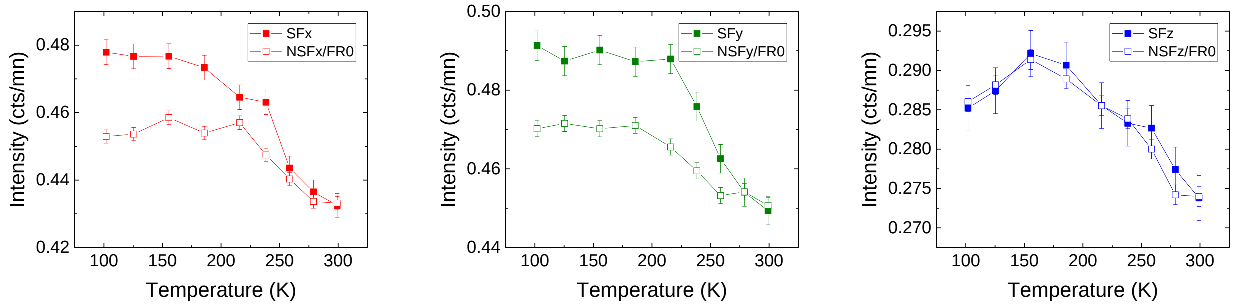

Figure 3. Thermal evolution of SF and NSF/FR_0(T) for P//x, y and z polarization.

This analysis is highly dependent to determination of the bare FR_0(T). Further detailed and careful analysis will be done.

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