Experimental report

29/08/2017

Proposal: **4-02-471** **Council:** 4/2016

Title: Field dependence of spin excitations in superoxygenated LCO+O

Research area: Physics

This proposal is a new proposal

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Samples: La2CuO4+y

Instrument	Requested days	Allocated days	From	To
THALES	4	4	03/10/2016	07/10/2016

Abstract:

The mechanism responsible for high-temperature superconductivity (SC) in cuprates is still under intense debate. The incommensurate antiferromagnetic order (IC AFM) and excitations which can be observed by neutron scattering seem to be connected to superconductivity. One consequence of this interplay is the opening of a spin gap at the superconducting transition temperature, an effect observed in YBa2Cu3O6+x and La2-xSrxCuO4. Applying a magnetic field is usually found to enhance the static order, as well inducing in-gap states.

In a recent experiment on oxygen-doped La2CuO4+y we found that the magnetic field seems to have the opposite effect, i.e. it removes low-lying states. However, we need to measure more energy transfers with better statistics to obtain publication quality evidence for these unusual results.

This experiment will serve an important task in order to understand the fundamental influence of superoxygenation on the magnetic phase both in LCO+O itself but also as a basis for understanding the Sr/O co-doped system and its electronic phase separation

Report of neutron scattering exp. on ThALES on magnetic excitations in LCO+O in a magnetic field

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1 Introduction

This experiment was performed at ThALES at ILL at Monday 3/10 2016 to Friday 7/10 2016. Present were Sonja Holm, Tim Tejsner, Kim Lefmann as well as Paul Steffens and Martin Böhm (instrument responsible).

The experiment is a continuation of the experiments performed at IN12 in 2013, at FLEXX in 2015 and ThALES at 2015. At FLEXX we found that a magnetic field suppresses intensity at low energy, contrary to expectations. The aim of this experiment was to confirm this finding. The proposal number is 4-02-471_162.

We have roughly 3.44 g of sample in the beam; the same as was used in the previous ThALES experiment.

2 Problems

There were several issues throughout the experiment, preventing us from getting optimal results.

Due to the magnet quenching more than once we only went to 10 T instead of 12 as in the FLEXX experiment. Also the T sensor was quite far away from the sample, so we went to 50 K instead of 45 K for measurements in the normal state, to be certain the sample was completely out of the SC phase.

The velocity selector malfunctioned several times, the A3P motor did not work (so we had to rotate the magnet along with the sample), there was a He leak in the magnet, and the slits had to be set manually.

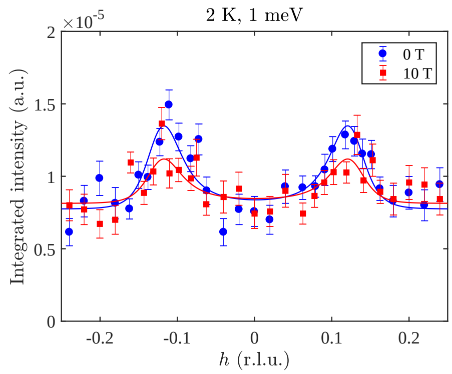

Figure 1: The IC peak 2 K, 1 meV, comparing with and without 10 T magnetic field. The magnetic field surprisingly reduces the intensity.

3 Data

The elastic data showed very large and fluctuating background due to the problems mentioned above.

The inelastic data on the other hand were fairly good. An example of the data is shown in Fig. 1.

The magnetic field suppresses the intensity at low energies. At higher energies (2.5 meV) the magnetic field seems to induce signal. This could indicate a phase separation where the SC phase behaves as seen elsewhere in an applied field, while an applied field introduces a gap in the non-SC phase.

4 Conclusion

Despite the problems mentioned, we managed to get useful data, although the number of points measured was reduced. The magnetic field suppresses the scattering at low energies. In other words, the gap decreases with application of a magnetic field. This, again, is unexpected, as the opposite is seen in e.g. LSCO with $x = 0.12$ [1], $x = 0.145$ [2], $x = 0.16$ [3], $x = 0.18$ [4].

References

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