Experimental report

16/02/2021

Proposal: **4-02-563**

Council: 4/2019

Title: Orientation determination of dynamic stripes in superconducting LCO+Oby means of polarized scattering

Research area: Physics

This proposal is a continuation of INTER-389

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Samples: La(2) Cu O(4+y)

Instrument	Requested days	Allocated days	From	To
THALES	5	4	16/01/2020	20/01/2020

Abstract:

Previous research from our group revealed a discontinuity of the magnetic fluctuations dispersion in oxygen doped LCO+O, in the limit of vanishing energy transfer. This result was interpreted as an electronic phase separation into two phases, one containing the static stripes, and the associated fluctuations which were not measured, and the second containing the observed magnetic fluctuations. One characteristic that would support this would be a different orientation of the two types of magnetic modulations. In order to answer this question we have already performed polarized neutron scattering on this sample and were able to determine the orientation of the elastic signal. We now propose a method of determining the orientation of the spin fluctuations in the same sample.

Orientation determination of dynamic stripes in superconducting LCO+O by means of polarized scattering, on Thales

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The aim of the experiment is to study the polarization of the dynamic magnetic stripes in a superconducting oxygen doped LCO+O single crystal. In this very same sample it was previously observed that the dynamic stripes do not disperse towards the static ones in the limit of vanishing energy transfer, pointing to a different origin of the two types of magnetic stripes.

Results

To access the precise orientation of the magnetic moments in static and dynamic magnetic stripes, measurements have been performed in three different spin configurations of the incoming neutron beam. First, the neutron polarisation was chosen parallel to the scattering vector $\boldsymbol{Q}$, defined as the x-direction in the following. In this set-up, we performed scans in both the spin flip (SF) and the non-spin-flip (NSF) configurations. Afterwards, only the SF channel was measured with the neutron spin aligned along the y and z-directions, z being out of the scattering plane. This XYZ polarisation analysis allowed us to determine the contribution of different components of the magnetic order in the sample.

In the elastic channel, Fig. 1(b), we observe a lack of intensity in the S∥y spin flip channel and equal intensity in the other two SF channels. This provides definite evidence that the spin structure in the elastic channel resides in the a-b plane. Taking into account the twinning pattern of our sample we were able to prove that the LCO+O system hosts charge stripes along both the tetragonal a and b axis.

The inelastic polarised data of Fig. 1(a) shows scattering intensity in all spin channels. This means that there is an out-of-plane spin component to the scattering signal, which is expected both in the case of isotropic spin fluctuations, and in the limit of purely transverse fluctuations connected to the static SDW signal. By analysing the ratio of intensity in all three channels, we were able to confirm that, out of these two limiting cases, it is more likely that the sample exhibits isotropic fluctuations. More details can be found in our publication: Phys. Rev. B 103, 045138 (2021).

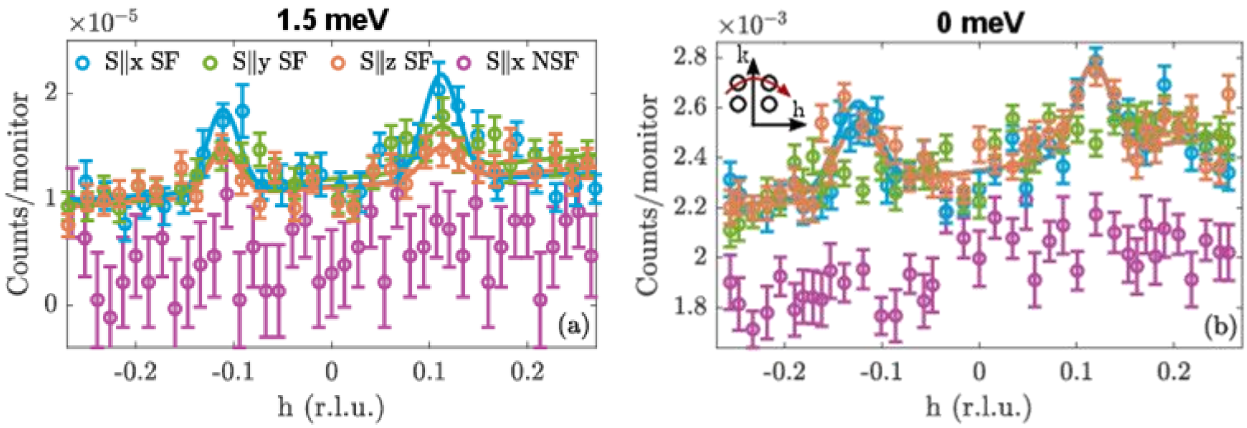

Fig. 1 (a) Inelastic constant energy scan ($\hbar\omega$ = 1.5 meV) and **(b)** elastic scans collected in the superconducting phase (30 K and 5 K respectively) in spin-flip (SF), with 3 spin configurations, and non-spin-flip (NSF) mode. The scan direction is represented in the inset of subplot (b). In panel (a) the NSF data are displaced by a factor -0.7×10^{-5} for better visualisation. S denotes the incoming neutron beam spin direction. The solid lines are Gaussian fits to the raw data.