Experimental report

31/08/2022

Proposal: **5-41-1159** **Council:** 4/2021

Title: Investigation of the static magnetic stripes under uniaxial pressure in LBCO in the enhanced Tc -regime

Research area: Physics

This proposal is a new proposal

Main proposer: **Machteld KAMMINGA**

Experimental team: Machteld KAMMINGA
Kim LEFMANN
Kristine KRIGHAAR
Lise SANDBERG
Pascale Petronella DEEN

Local contacts: Martin BOEHM

Samples: La(2-x)Ba(x)CuO4, x=0.095
La(2-x)Ba(x)CuO4, x=0.11

Instrument	Requested days	Allocated days	From	To
THALES	5	5	01/10/2021	06/10/2021

Abstract:

There is a large current interest in the relation between disorder and Tc in cuprate superconductors. It is proposed that Tc enhancements can be generated by distortion of the orthogonal stripes in LBCO (La2-xBaxCuO4), re-establishing the Josephson coupling between the layers and hence its 3D superconductivity. A recent study on LBCO (x = 0.115) showed a very large increase in 3D Tc by applying a uniaxial stress of 0.1 GPa in the Cu-O plane. We propose a detailed analysis of the static stripes as a function of temperature and pressure on our LBCO single crystals (x = 0.095 and 0.11). With the high flux of the cold neutron triple-axis spectrometer Thales, we hypothesize that changes in elastic scattering could well be observed. With our custom-build pressure cell, suitable for uniaxial pressures up to 1 GPa, we apply a pressure along the tetragonal [1 1 0] direction, previously shown to be the optimal direction to improve Tc in a related system. This allows for simultaneously probing the (±¿ 1±¿ 0) spin order peaks. We expect to observe a reduction in the elastic signal as a function of pressure, directly proving the hypothesis of a trade-off between the spin density wave and Tc.

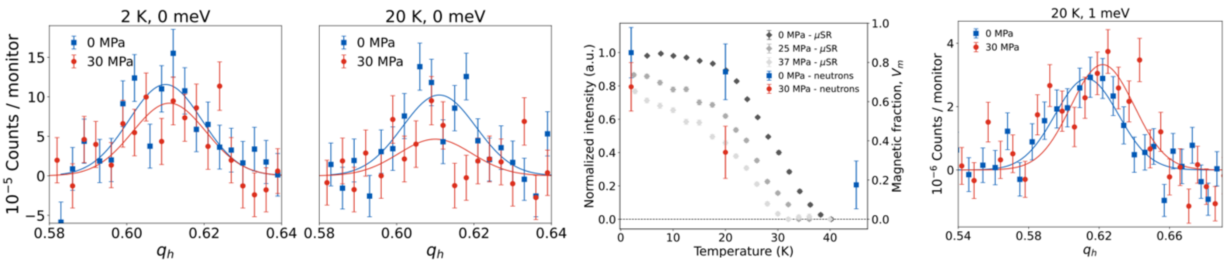
Experimental report: Investigation of the static magnetic stripes under uniaxial pressure in LBCO in the enhanced Tc - regime

Experiment ID: 5-41-1159

Authors: Machteld E. Kamminga, Kristine M. L. Krighaar, Kim Lefmann

A recent study on disorder-enhanced T_c in LBCO (x = 0.115) focused on the competing interaction between uniform and striped SC states[1]. In this study, the authors observed a very large increase in 3D T_c, from ~10 to 32 K, by applying a uniaxial stress of as little as 0.1 GPa in the Cu-O plane. This is understood to be due to a frustration in the orthogonal stripe order that is in between the Cu-O plane, that happens under uniaxial stress. This frustration in turn enhances the Josephson coupling between the planes and hence superconductivity.

We proposed a detailed analysis of the static stripes as a function of temperature and pressure on our LBCO single crystals of x = 0.115 (close to the 1/8 anomaly), making use of the high neutron flux of the cold neutron triple-axis spectrometer Thales.



A B C D

Measurements were performed at 0 MPa and at 30 MPa uniaxial pressure in our own pressure cell. We measured at the incommensurate magnetic stripe (0.615 0.5 0) in the tetragonal orientation of the coper oxygen planes. In the elastic measurements, on figures A and B we were able to observe a decrease in the amplitude of the signal that corresponds to the decrease observed for magnetic volume fraction upon uniaxial stress, studied with μSR, showed on figure C.

We further measured the magnetic stripes inelastically at 1 meV energy transfer. Here we also observed a change in the magnetic stripe signal upon applied uniaxial stress as is seen in figure D. However, the inelastic intensity increased, in contrast to a decrease that would follow an opening of a spin gap, naively expected when superconductivity is enhanced.

In conclusion the experiment was successful as we were able to observe changes to the magnetic stripe signals, both elastically and inelastically, under very difficult experimental conditions.

A preprint on this work can be found on arXiv:2203.00558

[1] Z . Guguchia et al., PRL, 125, 097005 (2020)