Experimental report

13/02/2017

Proposal: **INTER-357** **Council:** 10/2016

Title: Internal time on IN8

Research area:

This proposal is a new proposal

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Samples: La(1.93)Sr(0.07)CuO(4.14)

Instrument	Requested days	Allocated days	From	To
IN8	4	4	03/02/2017	07/02/2017

Abstract:

Phonon Anomaly in $La_{1.94}Sr_{0.06}CuO_{4+y}$ at IN8

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1 Introduction

Previously, an anomaly in the bond-stretching phonon at at 70 meV has been observed in optimally doped $La_{2-x}Sr_xCuO_4$ (LSCO)[PFH+14]. In this experiment, we repeat the experiment for over-stochiometric $La_{1.94}Sr_{0.06}CuO_{4+y}$ (LSCO+O) by the use of inelastic neutron scattering. We find evidence that the bond-stretching phonon anomaly resembles that of the optimally doped LSCO.

2 Experiment

The sample used in the experiment is an over-stochiometric $La_{1.94}Sr_{0.06}CuO_{4+y}$ single crystal of roughly 2 grams. The crystal lattice is orthorhombic at low temperatures and the lattice parameters used at 10 K were $a = 5.34$, $b = 5.356$, $c = 13.1$. The sample is aligned in the a-b plane.

The experiment was performed at IN8, ILL. The instrument was configured with Cu002 and Si311 monochromators depending on the q-range. we used a Pg002 Analyzer. There was no collimation and k_f was fixed at 2.661 $Å^{-1}$. After mounting the sample and checking alignment, we cooled from 300 K - 100 K with a rate of 1 K/min (Fast mode ON, timeout 12 minutes, 10 K steps). We subsequently cooled to 10K in one step with Fast Mode ON.

The bond-strething phonon is expected to be polarized in the (h h 0) direction in orthorhombic notation[1]. The dispersion was measured with energy-scans in the 65-95 meV range. With the Cu002 monochromator we measured points from (2.5 2.5 0) to (4.3 4.3 0) and with Si311 we measured points from (4.5 4.5 0) to (5 5 0).

3 Results

Due to a significant amount of spuriouns in the measurements, the data from (2.5 2.5 0) to (4.3 4.3 0) was either contaminated or very weak. The data obtained with the Si311 monochromator from (4.5 4.5 0) to (5 5 0) was an improvment, but there are still issues with spuriouns. To isolate the phonon, we compared the data with the value of M2 (the monitor after the sample, but before the analyser). The results are shown in Figure 1. The dispersion and linewidth are shown in Figure 2 along the results from [PFH+14].

References

[PFH+14] S. R. Park, T. Fukuda, A. Hamann, D. Lamago, L. Pintschovius, M. Fujita, K. Yamada, and D. Reznik. Evidence for a charge collective mode associated with superconductivity in copper oxides from neutron and x-ray scattering measurements of La2-xSrxCuO4. *Physical Review B*, 89(2):020506, January 2014.

[1] Note that [PFH+14] uses tetragonal notation where the direction is (h 0 0).

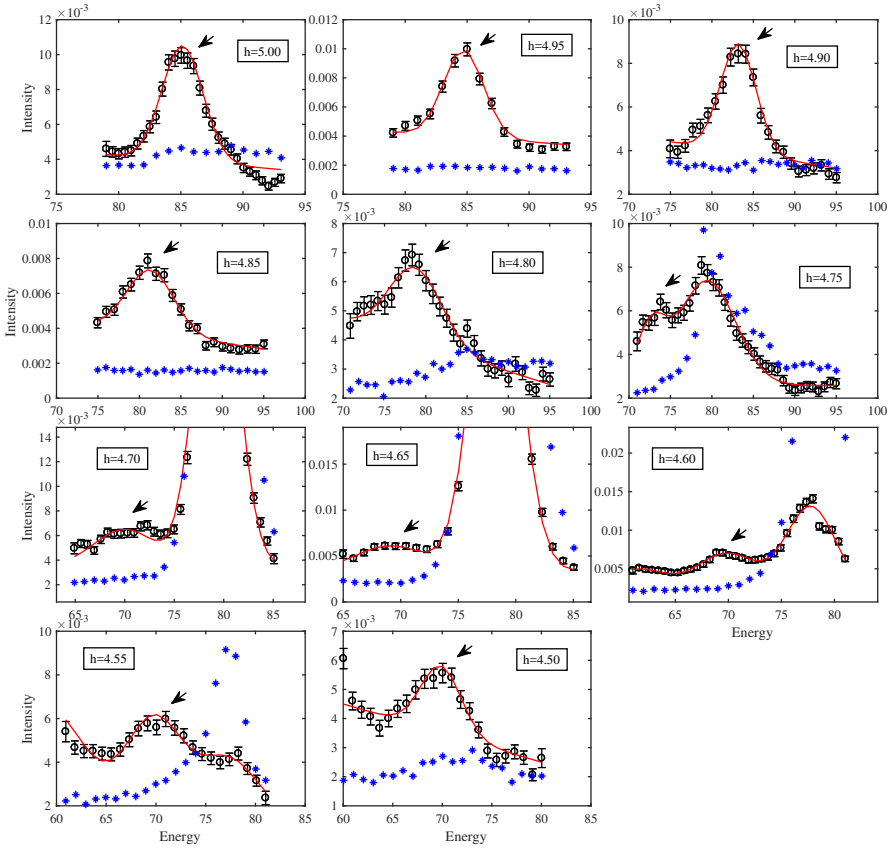

Figure 1: INS data and fits used to find the dispersion. The blue stars are the M2 values. The solid lines are fits of one or two Gaussians with a linear background. The arrows indicate the position of the phonon peak. Instrument resolution is not included in the fits at this moment.

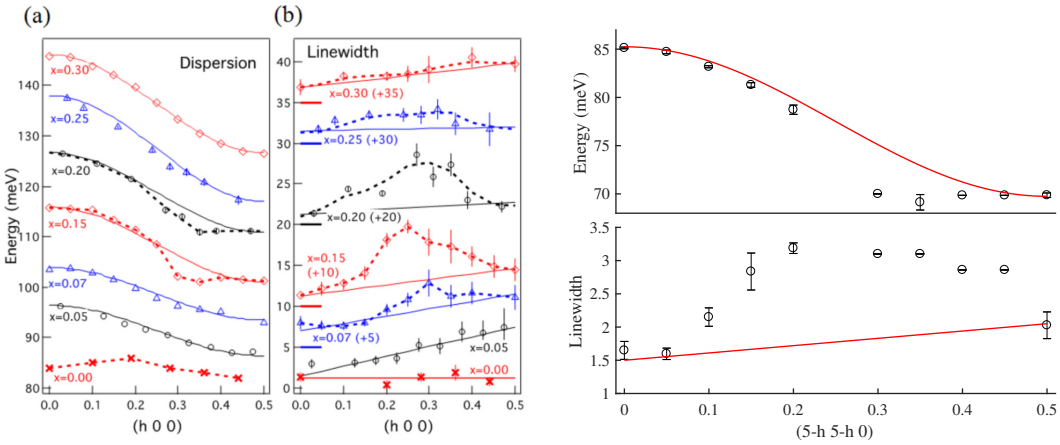

Figure 2: **Left**: Dispersion and linewidth in $La_{2-x}Sr_xCuO_4$ as a function of x from [PFH+14]. **Right**: Dispersion and linewidth from this experiment obtained from fits. The solid lines in both plots are cosines for the dispersion and a straight line for the linewidth.