



	Experiment title: Soft phonon modes in $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$	Experiment number: HC-1119
Beamline: ID28	Date of experiment: from: 13/11/2013 to: 19/11/2013	Date of report: 01/09/2014
Shifts: 18	Local contact(s): Tom FORREST	<i>Received at ESRF:</i>

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Report:

Charge density wave (CDW) order has been observed in the pseudogap (PG) regime of a number of underdoped high- T_c cuprate (HTC) superconductors [1-5]. CDW order is often associated with soft phonon modes [6] and this behaviour has recently been confirmed in the $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ (YBCO) HTC system by IXS [7,8].

Most recently, CDW order has also been detected in the $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ (LSCO) HTC system [5]. In experiment HC1119 we aimed to observe the the softening and broadening of the acoustic phonons in LSCO near the CDW ordering wavevector. This had already been seen in YBCO and would provide evidence of a common mechanism behind the CDW formation in the cuprates.

We collected inelastic X-ray scans between $-5 < \hbar\omega < 20$ meV using the Si (999) ($E_i=17.9$ keV) setup at a number of reciprocal space positions, mainly focusing around the CDW ordering wavevector $\delta_{\text{CDW}}=0.23$. The BZ investigated was chosen around the $\mathbf{Q}=(2.23 \ 0 \ 5.5)$ position as it had been shown that the CDW structure factor was strong in this area [5]. Data were collected between $30 < T < 300$ K.

Figure 1 shows the results of the temperature dependence of the phonon spectrum. The data have been fitted to a damped harmonic oscillator lineshape. On cooling, the phonon at the CDW wavevector $\delta_{\text{CDW}}=0.23$ shows pronounced broadening and softening in energy below 150 K. No such effect was observed for the nearby $\delta \neq \delta_{\text{CDW}}=0.20$. The current measured effect appears to be much stronger than in YBCO [7,8].

In YBCO, the phonon at δ_{CDW} is seen to dramatically soften below the superconducting T_c and then harden once again [8]. In the present experiment, we were unable to reach the low temperatures below $T_c \approx 30$ K to investigate this effect in LSCO, because the second (thermal) shield was not available for the CCR and the sample was therefore exposed to 300 K radiation.

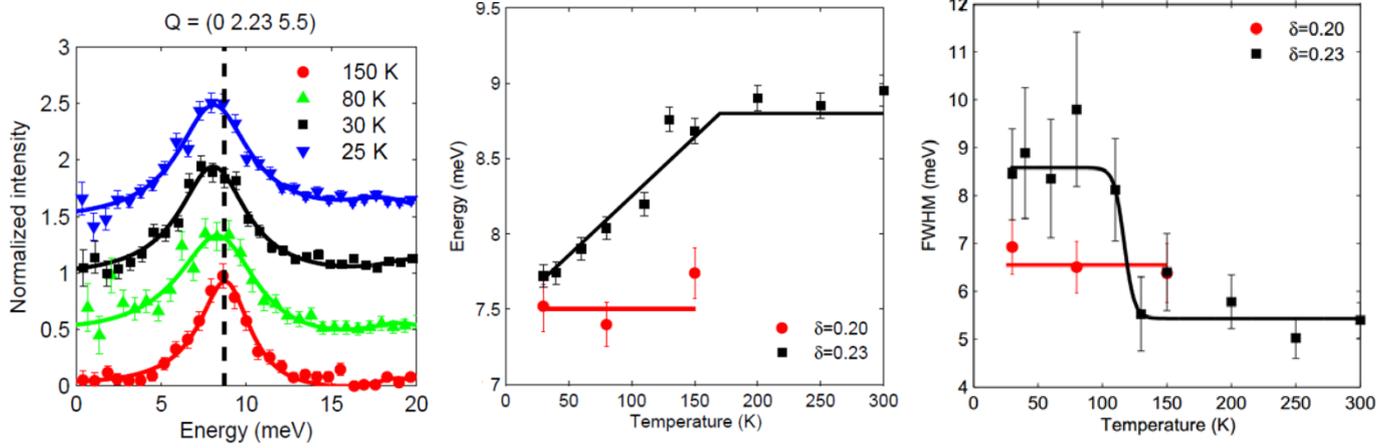


Fig. 1 Temperature dependant softening of the acoustic phonon mode in LSCO at the CDW ordering vector $q_{\text{CDW}}=(0.23, 0, 5.5)$. No softening was detected at $q=(0.20, 0, 5.5)$.

References

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