Experimental report

01/03/2019

Proposal: DIR-140 **Council:** 10/2014

Title: Temperature dependence of magneticexcitations in cobaltates

Research area: Physics

This proposal is a new proposal

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Samples: La2CoO4

Instrument	Requested days	Allocated days	From	To
IN8	2	2	04/08/2015	06/08/2015

Abstract:

Temperature dependence of magnetic excitations in cotaltates

Hourglass shaped magnetic excitations observed in an insulating cobaltate $La_{2-x}Sr_xCoO_4$ system has attracted considerable attention recently [1, 2]. Our previous studies on $La_{1.6}Sr_{0.4}CoO_4$ showed an hourglass shaped magnetic excitations without evidence of charge stripe ordered phases. A novel nano phase separation scenario, which consists of La_2CoO_4-like islands and $La_{1.5}Sr_{0.5}CoO_4$-like islands was able to explain the emergence of hourglass shaped excitations in the $La_{2-x}Sr_xCoO_4$ system. In a very recent experiment on the IN8 spectrometer, we have measured the temperature dependence of the hourglass spectrum in $La_{1.63}Sr_{0.38}CoO_4$ up to high temperatures (~300 K).

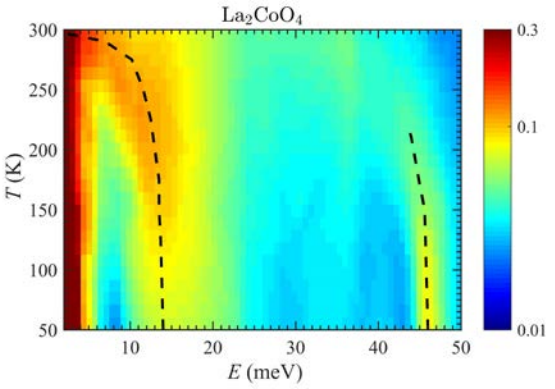

Fig. 1 Inelastic neutron intensity map for La_2CoO_4 measured on IN8 spectrometer with constant Q = (1.5 1.5 0).

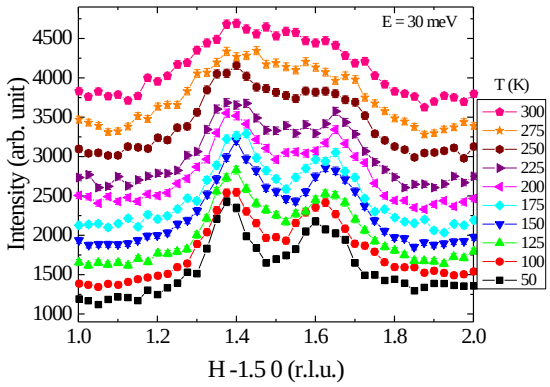

Fig. 2 Constant energy scans along the (H -1.5 0) direction for La_2CoO_4 at various temperatures. The curves have been shifted for clarity.

Although the magnetic excitations on the undoped parent compound La_2CoO_4 has been reported [3], very few information about the temperature dependence is available.

In order to study the temperature dependence of the magnetic excitations in La_2CoO_4 in more detail, we have performed inelastic neutron scattering on our high quality La_2CoO_4 single crystal with T_N ~ 280 K. The Cu monochromator and PG analyzer were doubly focused and one PG filter was mounted behind the sample. The final neutron wave vector was fixed to k_f = 4.1 $Å^{-1}$. The measurements were performed in a constant Q = (1.5 1.5 0) mode with energy scans from 70 to 2 meV, and the sample was cooled down to 50 K by an orange cryostat. Fig. 1 shows the color-contour plot of the corresponding neutron scattering intensities in energy-temperature space. Two gaps with distinct energies can be observed at 50 K with

excitation energies of about 15 and 46 meV, which correspond to the in-plane and out-of-plane anisotropy gaps, respectively. Both energy gaps shift towards lower energy with increasing temperature. Especially, the low energy gap seems to close above 250 K.

Moreover, we also performed constant energy scans at E = 30 meV along (H -1.5 0) direction, as shown in Fig. 2. The quantitative analyses of the peak intensity, peak shift and peak width are shown in Fig. 3 to compare with that of the $La_{1.63}Sr_{0.38}CoO_4$ sample.

References:

[1] A.T. Boothroyd et al., Nature **471**, 341 (2011)

[2] Y. Drees et al., Nature Communications **4**, 2449 (2013)

[3] P. Babkevich et al., Phys. Rev. B **82**, 184425 (2010)

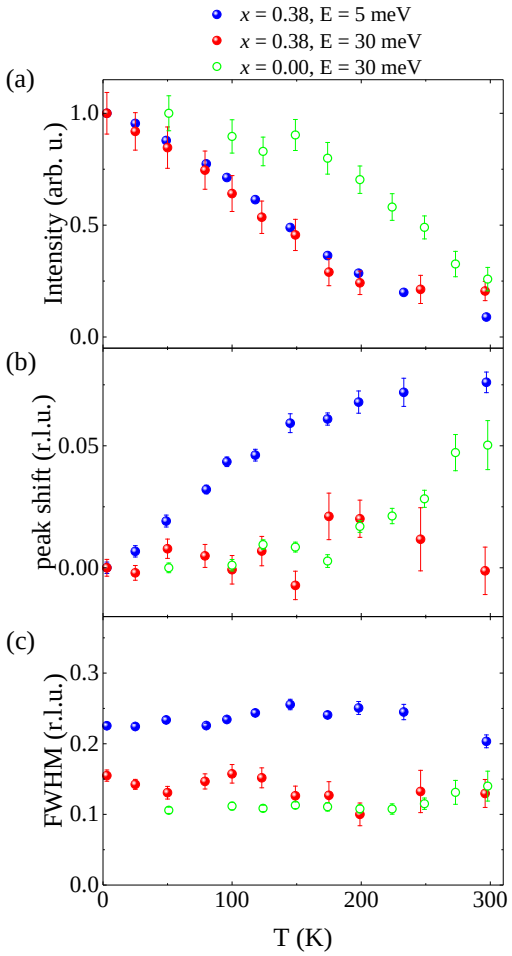

Fig. 3 For high-energy (red) and low-energy (blue) excitations in $La_{1.62}Sr_{0.38}CoO_4$ (a) the integrated peak intensities corrected for Bose factor and magnetic form factor, (b) the peak positional shifts and (c) the peak widths are shown. Additionally, the fitting values for the corresponding scan at 30 meV in the La_2CoO_4 reference sample are shown.