Supplementary Materials for:
Formation of Incommensurate Charge Density Waves in Cuprates

(Dated: August 28, 2019)

I. CURVE FITTING

Here we present the fitting of the RIXS momentum scans integrated in an energy window of ±100 meV around $E_{\text{loss}} = 0$ meV. The spectra are fitted by two Lorentzian squared functions plus a linear background:

$$I = c_0 + c_1 * x + P_{\mathrm{I}}^1 \left[\frac{1}{1 + \left(\frac{x - P_{\text{pos}}^1}{P_{\text{wid}}^1} \right)^2} \right]^2 + P_{\mathrm{I}}^2 \left[\frac{1}{1 + \left(\frac{x - P_{\text{pos}}^2}{P_{\text{wid}}^2} \right)^2} \right]^2 , \tag{1}$$

where P_{I}, P_{pos} and P_{wid} represent peak intensity, position and width, respectively. Superscripts 1 and 2 differentiate the lCDW and pCDW peak. The linear term $c_0 + c_1 * x$ is used to account for the background. We chose the Lorentzian squared function on a phenomenological basis as it reproduces the observed peak shape better than other functions such as Lorentizian or Gaussian lineshapes[1].

We start by fitting the pCDW peak at high temperature and set P_I^2 to be zero. Below the lCDW transition temperature, the integrated intensity has three contributions: lCDW, pCDW and a linear background. As shown in Fig. 3 of the main text, within experimental uncertainties, the shape of the broad intensity (that including both the pCDW peak and linear background) is nearly constant. We thus fix the fitting parameters of the pCDW and linear background in Eq. 1. Here the fixed fitting parameters are from data that just above the lCDW transition temperature. Figure S1 shows the fitted RIXS intensity near the lCDW critical temperature along the H direction.

The volume of CDW is estimated by the integrated intensity defined as:

$$I_{\text{int}} = P_{\mathrm{I}} * \text{HWHM}^2 \tag{2}$$

where $\text{HWHM} = \sqrt{\sqrt{2} - 1} * P_{\text{wid}}$ is the half-width-at-half-maximum.

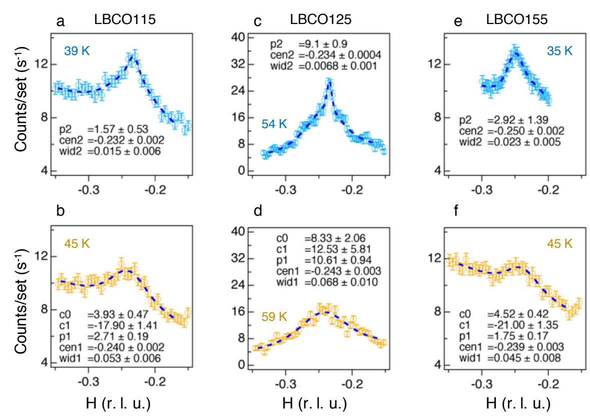

Figure S1. **Curve fitting**. (a) and (b) show the fitted LBCO115 RIXS data slightly below (cyan) and above (yellow) the lCDW critical temperature, respectively. The same plots for LBCO125 and LBCO155 are shown in (c),(d) and (e),(f) respectively.

[1] H. Miao, J. Lorenzana, G. Seibold, Y. Y. Peng, A. Amorese, F. Yakhou-Harris, K. Kummer, N. B. Brookes, R. M. Konik, V. Thampy, G. D. Gu, G. Ghiringhelli, L. Braicovich, and M. P. M. Dean, Proceedings of the National Academy of Sciences **114**, 12430 (2017), https://www.pnas.org/content/114/47/12430.full.pdf.

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