EUROPEAN SYNCHROTRON RADIATION FACILITY

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ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office via the User Portal:

https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do

Reports supporting requests for additional beam time

Reports can be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Probing the doping evolution of the mysterious zone-center excitations in the $La_2Ce_xCuO_4$ electron-doped cuprate.	**Experiment number**: HC-2392
Beamline: ID 32	**Date of experiment**: from: 26 April 2017 to: 02 May 2017	**Date of report**:
Shifts: 18	**Local contact(s)**: Kurt Kummer	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

* Dr. Wei-Sheng Lee, SLAC National Accelerator Lab., Menlo Park, USA

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Report:

During this beamtime, we performed high-resolution resonant inelastic x-ray scattering (RIXS) measurements at the Cu L_3-edge on electron-doped cuprate, $La_2Ce_xCuO_4$ (LCCO). Samples of doping concentration of x = 0.08, 0.13, and 0.175 were measured to track the evolution of the zone-center excitations in the phase diagram. In addition, we have also utilized the polarimeter to analyzer the polarization of scatterred light.

We have obtained high quality spectra for all the samples. Zone center excitations were observed in all of them. The zone center excitations heav been previously reported in another electron-doped compounds $Nd_{2-x}Ce_xCuO_4$ (NCCO) [1, 2]. Our results on LCCO unambiguiously established that the existence of the zone center excitations is universal in the electron-doped cuprates. Importantly, we have confirmed the surprising l-dependence discovered in our previous beamtime. We have obtained results for samples of other doping concentrations. These data will allow us to analyze the doping dependence.

To gain further insight into the nature of these excitations, we tuilized the polarimeter to analyze the polarization of the scatering light. We obtained polarization-resolved RIXS spectrum at two momentum positions, (0.045, 0, 1) and (0.095, 0, 1.65), respectively. As an example, Fig. (b) shows the polarization-resolved RIXS spectra taken at (0,045, 0, 1). We found that the zone center excitation is purely in the parallel polarization chanel (i.e. the σσ channel in the figure), indicating that these modes are pure charge excitations; Thus, it crucially connected to the coherent charge dynamics in the electron-deoped cuprates.

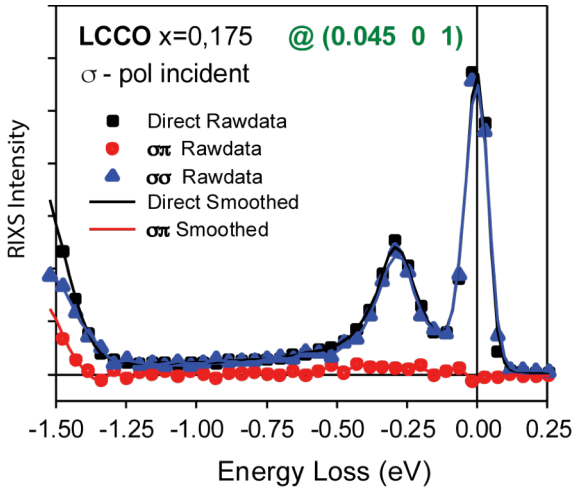

Figure 1. Polarization-resolved RIXS spectra at (0,045, 0, 1) taken with an incident x-ray with σ-polarization. The excittaions is essentially in the parallel polarization channel, suggesting that it is a pure charge excitations.

In summary, we have obtained new important results consistent with the framework of the initial proposal. The *l*-dependence and the collective charge nature of the zone center excitaions are important results, which deserve to be published soon. Currenlty, we are working on finalizing the data analysis, constructing a theoretical model, and preparing a manuscript to publish these results.

Reference:

[1] W. S. Lee *et al.,* Asymmetry of collective excitations in electron- and hole-doped cuprate superconductors. *Nature Phys*. **10**, 883 (2014).

[2] K Ishii *et al.*, High-energy spin and charge excitations in electron-doped copper oxide superconductors, *Nature Commun.* **5,** 3714 (2013).