ESRF	**Experiment title: resonant inelastic x-ray scattering (RIXS) with momentum and polarization resolution on high-temperature cuprate superconductors**	**Experiment number**: HE- 3857
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Names and affiliations of applicants (* indicates experimentalists):

M. Hashimoto*1, G. Ghiringhelli*2, W.-S. Lee*3, G. Dellea*2, A. Amorese*2, C. Mazzoli*2, K. Kummer*4, N. B. Brookes*4, B. Moritz3, Y.Yoshida*5, H. Eisaki*5, Z. Hussain*6, T. P. Devereaux3, Z.-X. Shen*37 and L. Braicovich*2

1 Stanford Synchrotron Radiation Lightsource, SLAC National Accelerator Laboratory, 2575, Sand Hill Road, Menlo Park, California 94025, USA; 2 CNR-SPIN and Dipartimento di Fisica, Politecnico di Milano, Piazza Leonardo da Vinci 32, I-20133 Milano, Italy; 3 Stanford Institute for Materials and Energy Sciences, SLAC National Accelerator Laboratory, 2575 Sand Hill Road, Menlo Park, CA 94025, USA; 4 European Synchrotron Radiation Facility (ESRF), BP 220, F-38043 Grenoble Cedex, France; 5 Nanoelectronics Research Institute, AIST, Ibaraki 305-8568, Japan; 6 Advanced Light Source, Lawrence Berkeley National Lab, Berkeley, CA 94720, USA; 7 Geballe Laboratory for Advanced Materials, Departments of Physics and Applied Physics, Stanford University, CA 94305, USA

Report:

Experiment

We performed a resonant inelastic x-ray scattering (RIXS) experiment with polarization on nearly optimally-doped single-layer high-temperature (*T*c) cuprates $Bi_2Sr_2CuO_{6+\delta}$ (Bi2201) and double-layer cuprates $Bi_{1.5}Pb_{0.6}Sr_{1.54}Cu_2O_{8+\delta}$ (Bi2212). The aim was to discover an evidence of the charge ordering for the pseudogap phase by looking for the resonance of the quasi-elastic peak in momentum-transfer space, which has been recently found in another high-*T*c compound $YBa_2Cu_3O_{6+\delta}$ (YBCO). Strongly correlated electron systems often show complex phase diagram which are important to understand the emergent phenomena in the system such as high-*T*c superconductivity. Among them, the pseudogap phase, which exists in the cuprate phase diagram above *T*c, has been the most mysterious one and its role for superconductivity is still elusive. Our goal was to search for evidence of translational symmetry breaking that can be related to the mysterious pseudogap. If successful, the results can not only determine the nature of pseudogap state, but also reconcile the results with other experimental observations such as ARPES, STM and INS as well as transport properties. We have measured Bi2201 and Bi2212 with both vertical and horizontal polarizations for both positive and negative momentum transfer around Γ along the CuO bond direction and CuO bond diagonal direction to detect a signal of charge density wave (CDW). The measurement temperatures were well below Tc and around Tc to observe the suppression of the CDW signal below Tc due to competition between the CDW and superconductivity. We particularly focused on the momentum range around q = 0.25, where we found a CDW feature.

Results

Fig. 1 summarizes the obtained result from this beamtime. The beamtime was successful and we obtained good dataset of Bi2212 and Bi2201. In Bi2201 along the Cu-O bond diagonal cut ((110) cut), in addition to the paramagnon dispersion which is close to zero energy loss at Γ and ~-0.3 eV at the zone boundary, we

also found a signature of super lattice modulation of the BiO layers, which is at q ~ 0.22, consistent with previous scattering studies. Along Cu-O bond direction, the paramagnon dispersion is dominant, and it is consistent with other cuprates mostly in the underdoped region. In Bi2212, in addition to these signatures, we found a clear signature of CDW in the quasi-elastic signal (zero-energy loss) around momentum transfer q~0.25. The CDW feature has been observed by scattering experiments in the underdoped cuprates, and has been a very important topic in the field in recent years. Our experiment revealed for the first time that such a CDW feature is present at least up to the optimal-doping. Also such a CDW feature has not been observed in Bi-based cuprates. This suggests that the CDW feature is more universal phenomenon in the cuprates, possibly important for the mechanism of high-Tc, and related with the pseudogap physics.

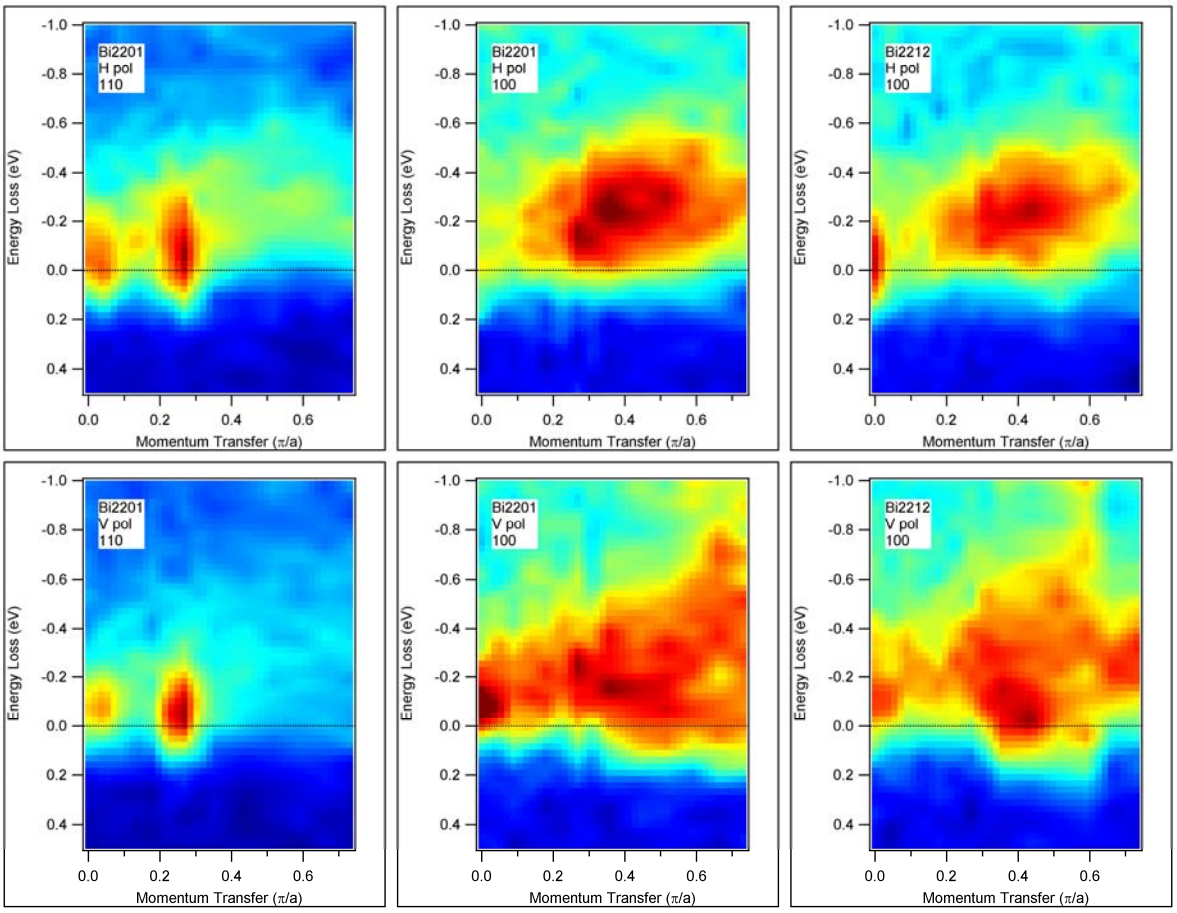

Fig. 1 Low-energy RIXS intensity map taken at T~50K along the Cu-O bond diagonal and bond directions with π and σ polarizations, respectively, for Bi2201 and Bi2212. The data contain information about the paramagnon dispersion, phonon, elastic intensities. The quasi-elastic signal was analyzed carafully to examine the existence and temperature dependnece of the CDW in these system.