Resonant inelastic X-ray scattering from Hg-based cuprate superconductors

Jason N. Hancock[1)], Guillaume Chabot-Couture[2)], Martin Greven[1,2)], Kenji Ishii[3)], Jun'ichiro Mizuki[3)]
[1)]Geballe Lab for Advanced Materials and Stanford Synchrotron Radiation Laboratory, [2)]Stanford University, [3)]JAEA

Abstract: We attempted an investigation of the symmetry sensitivity of the RIXS cross section (in analogy to the Raman cross section) by performing high-resolution measurements of the Mott insulating La_2CuO_4 in several carefully chosen scattering geometries. The particular geometries chosen were not possible from a single slab of material, and a complex faceting scheme was adopted. La_2CuO_4 was chosen over Hg1201 for this complex preparation procedure, and good results were achieved, which highlight the symmetry selective Raman effect.

Keywords: Mott insulator, RIXS, symmetry

Recent work on the theory of resonant inelastic X-ray scattering (RIXS) [1,2] have suggested that important information can be gleaned from detailed analysis of the polarization state of the incident and scattered beam relative to the crystalline axes of the sample under study. Such an analysis can in principle lead to symmetry selective probing of charge excitations.

This symmetry-selective power has been developed at length in the context of conventional laser Raman scattering, where combined polarization filtering of the incident and scattered beam can enhance or suppress the acceptance of Raman transitions of particular symmetry. RIXS, which is frequently described as Raman scattering at finite momentum transfer, in principle has a similar power, which has not yet been fully exploited. Our recent beam run was an attempt to perform symmetry selective measurements of the charge-transfer excitations in a charge transfer insulator La_2CuO_4.

Several difficulties naturally arose in exploring the symmetry selective power of RIXS. First, unlike conventional laser Raman, polarization of the scattered photon was not possible because the current count rate is prohibitively low (<10photons/sec) that polarization filtering would essentially extinguish the signal. Fortunately, the incident beam is naturally polarized by the vertical jaw undulator. In order to compare the signal content of several Raman channel acceptances, we faceted a large crystal in a fairly complex manner, revealing 5 very different crystal planes to scattering experiments. Because a large crystal (5x5x5mm) was needed, $La_{2-x}Sr_xCuO_4$ was chosen. Furthermore La_2CuO_4 was chosen because it is well known [3-5] that the energy loss features are sharply defined, assisting in the symmetry assignment.

The results of the run were profitable, showing systematics correlation of channel suppression and features of the energy loss spectra. These data show agreeable overlap with the limited results of laser Raman spectroscopy, and suggest for the first time symmetry assignment of the charge-transfer excitation above 1eV in a correlated insulating cuprate.

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