



Experiment title: Anisotropic local atomic correlations in Bi2212 high Tc superconductor: A polarized x-ray absorption study at the Cu K-edge

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HE-732

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Report:

The aim of these series of experiments is to get insight into the quadrupole transition in a system having square planar geometry. This proposal was meant to follow the last experiments in which we had shown, for the first time, the experimental observation of the k-dependence of the $1s \rightarrow 3d_{x^2-y^2}$ transition probability in the $\text{Bi}_2\text{Sr}_2\text{Cu}_2\text{O}_{8+\delta}$ (Bi2212) superconductor as a model compound. Indeed the outcome was a result of several experiments performed using different geometry for the in-plane polarized Cu K-edge absorption spectra pointing to the physics of the Cu $1s \rightarrow 3d_{x^2-y^2}$ quadrupole transition.

During the allocated beamtime for the experiment we have repeated more experiments on the Bi2212 superconductor at the optimum doping and extended the work on an underdoped system. The work was further extended to other cuprates and choice for this has been the $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ (LSCO) system. Preliminary analysis of the comparative work suggests non-negligible differences between the quadrupole oscillation amplitude. The details are still to be uncovered by further analysis but the results indicate a close relationship between the disorder created by the doping and the quadrupole transition. In addition, the residual pre-peak intensity in the Cu K-edge spectra, when the polarization of the electric vector (E) of the

synchrotron beam is parallel to the Cu-O-Cu bonds shows appreciable change with doping. We have shown the experimental geometry and the representative absorption spectra measured in the two extreme polarization where quadrupole transition is expected to be present and absent respectively (Fig. 1). The inset of the figure shows quadrupole oscillation observed in the Bi2212 system observed in the grazing incidence geometry. We have not observed any quadrupole contribution, evidenced by the oscillations of the peak intensity, in the normal incidence geometry.

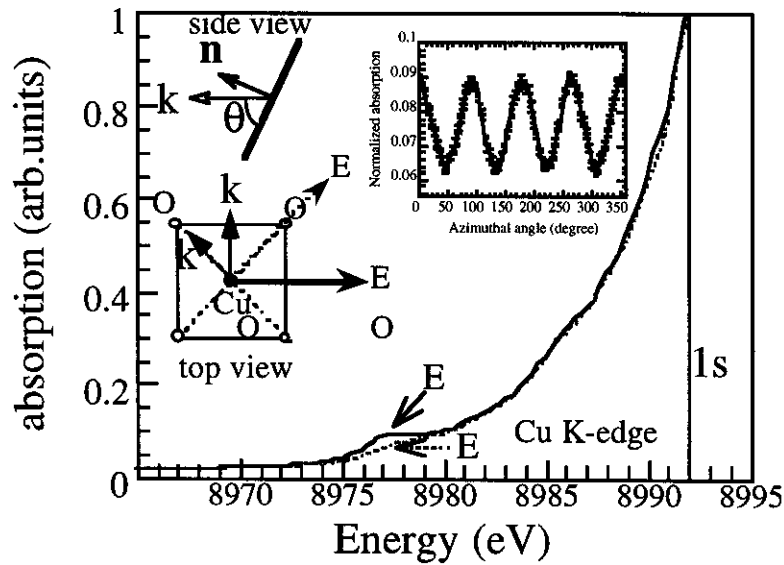


Fig.1. Cu K-edge absorption spectra in the vicinity of the Cu 1s threshold measured in different experimental geometry (see the top view and side view of the geometry shown in the figure). The quadrupole contribution is evident. The quadrupole oscillations were measured by monitoring its intensity as a function of azimuthal rotation. An example of the quadrupole oscillations is shown as inset.

In summary, we have studied quadrupole transition in the superconducting cuprates. The doping dependence of the quadrupole transition has been carried out. We have measured optimally doped and underdoped Bi2212 superconductor and compared the results with an optimally doped LSCO superconductor. The details are being analysed, however, the preliminary outcome is encouraging, suggesting a particular way to explore local lattice effects in complex systems such as cuprate superconductors. The outcome of the experiment is to be modelled with theoretical calculations to have further insight into the physics of quadrupole transitions in the systems with square planar geometry.