



	Experiment title: Determination of the static and dynamic Jahn-Teller distortions of the MnO ₆ octahedra at TC in giant magnetoresistive Al _x A _{1-x} MnO ₃ manganites	Experiment number: HS-44
Beamline:	Date of experiment: from: 23 Oct 1996 to: 27 Oct. 1996	Date of report: 31.0898
Shifts: 12	Local contact(s): Adriano Filipponi	<i>Received at ESRF:</i> 02 SEP. 1998

Names and affiliations of applicants (* indicates experimentalists):

*Paolo Radaelli I.L.L

A. Bianconi, Università di Roma "La Sapienza"

*A. Lanzara, Università di Roma "La Sapienza"

*N.L. Saini, Università di Roma "La Sapienza"

*F. Natali, Università di Roma "La Sapienza"

*M. Brunelli, Università di Roma "La Sapienza"

Report:

There is a growing evidence for polarons in doped manganese-oxide perovskites, showing giant-magneto resistance (GMR) effects. There are several studies made on a wide range of doping range of manganites. One of the most interesting system is the La_{0.75}Ca_{0.25}MnO₃ which shows strong GMR effects with metal insulator transition around 240K. A simultaneous charge, spin lattice ordering is found by diffraction techniques.

During the allocated time for the work, we have exploited high intensity of ESRF and fluorescence detection to investigate the quantitative distortions in wide temperature range across the metal-insulator transition in the system. The present work is motivated to provide a quantitative measure of the JT polaronic distortion of the MnO₆ octahedra and the probability of the JT distorted and undistorted Mn sites in a wide temperature range covering the metal-insulator phase transition of the La_{0.75}Ca_{0.25}MnO₃ system.

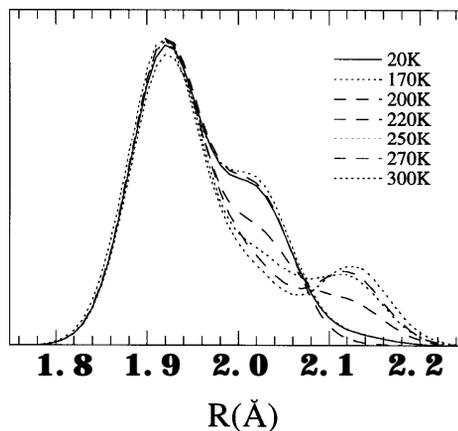
The Mn K-edge x-ray absorption measurements were made on a powder of La_{0.75}Ca_{0.25}MnO₃ synthesised by the solid state reaction method. The sample shows GMR transition at T_c-240 K

The EXAFS spectra with high signal to noise ratio upto high momentum transfer

($Q=2k_{\text{max}}=38\text{\AA}^{-1}$) recorded at the ESRF made us to obtain a quantitative information about the polaronic distortions. The outcome of the present work is that the giant-magneto resistance (GMR) transition is accompanied by a transition from a delocalized large polaronic phase at low temperature to the high temperature phase where small polarons covers 50% of Mn sites.

The temperature dependent absorption measurements were performed on the beam-line BM29 at the ESRF. The sample was placed in a closed-cycle two stage cryostat and the temperature was monitored with an accuracy of $\pm 1\text{K}$. The spectra were recorded by detecting the fluorescence yield using 13 Ge element solid state detector. Several scans were collected at each temperature to ensure a true estimation of the systematic errors.

To summarize, we have provided a quantitative characterisation of the MnO_6 octahedra of the LCMO system. We have found that the metallic state of the LCMO system is characterised by a homogeneously distributed large polarons characterised by small local distortions (AJT-like) of octahedra, while the insulating state is characterized by a small polaronic state in which the AJT-like and highly distorted RJT-like octahedra coexists. The local structural changes across the GMR transition is evident in the Fig.



The results of the experiment have been published in the following papers:

[1] *Anomalous Jahn-Teller distortions in $\text{La}_{0.75}\text{Ca}_{0.25}\text{MnO}_3$ system: An x-ray absorption study* M. Brunelli, A. Lanzara, N.L. Saini, A. Bianconi and A. Valletta, P.G. Radaelli **J. Superconductivity** **10**, 315318 (1997).

[2] *From Manganites to cuprates: A comparative study of the local lattice instability* A. Lanzara, N.L. Saini, M. Brunelli, F. Natali and A. Bianconi, P.G. Radaelli

Z. Phys. B **104**, 699-703 (1997)

Crossover from Large to Small Polarons across the Metal-Insulator Transition in Manganites A. Lanzara, N.L. Saini, M. Brunelli, F. Natali, A. Bianconi, P.G. Radaelli, S.-W. Cheong **Phys. Rev. Lett.** **81**, 878-881 (1998).