ESRF	**Experiment title:** Unravelling phonon and magnon excitations in La1.2 Sr1.8Mn2O7 near the metal-insulator transition	**Experiment number:** HS3202
Beamline: ID28	**Date of experiment:** from: 4.12.2006 to: 11.12.2006	**Date of report:** 31.3.2008
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Report:

Introduction: The current interest in the bilayer compound $La_{2-2x}Sr_{1+2x}Mn_2O_7$ arises from the recent discovery of the colossal magnetoresistance (CMR) in these systems. $La_{1.8}Sr_{1.2}Mn_2O_7$ exhibits further remarkable magnetic and electronic properties, e.g., a transition from a ferromagnetic metal (low T) to a paramagnetic insulator (high T) with $T_c \approx 120\,K$ [1].

The microscopic mechanism of the CMR effect is not fully understood as as well as the electronic, magnetic, defect and lattice properties which are interwoven, e.g., the number of observed phonons depends on the doping level. Further, the lattice degrees of freedom interact strongly with the magnons at higher momentum transfers. A strong coupling of acoustic and optic phonons with the acoustic spin-wave branch has already been observed by INS. One of the major problems is the contamination of the magnetic signal by phonons. As the phonon dispersion in this system is mostly unknown knowledge of the wavevector dependence of lattice excitations would give an indirect information on coupling mechanisms.

Experiment:

The inelastic X-ray scattering experiment has been performed at the beamline ID28 at the ESRF, Grenoble. The sample, a $La_{1.2}Sr_{1.65}Ca_{0.15}Mn_2O_7$ single crystal, has been mounted in the [$\xi\xi$0]-[00ξ] scattering plane. Scans were taken at room temperature as well as at 50 K using a cryostat. At room temperature the lattice constants result in $a = 3.877$ and $c = 20.105$ Å. $La_{1.2}Sr_{1.8}Mn_2O_7$ shows tetragonal symmetry I4/mmm (space group # 139).

With the Si(11,11,11) reflection the experimental resolution resulted in 1.5 meV.

Results:

Inelastic scans were taken in $[\xi\xi 0]$ as well as in $[00\xi]$ direction at room temperature and at 50 K. Scans in longitudinal and transverse geometry were, where possible, followed up to about 40 meV. The present bilayer compound can be described in a 24 atomic as well as in a 12 atomic unit cell maintaining the same symmetry group. The following figures show the results along the main symmetry directions for a notation in the 12 atomic unit cell.

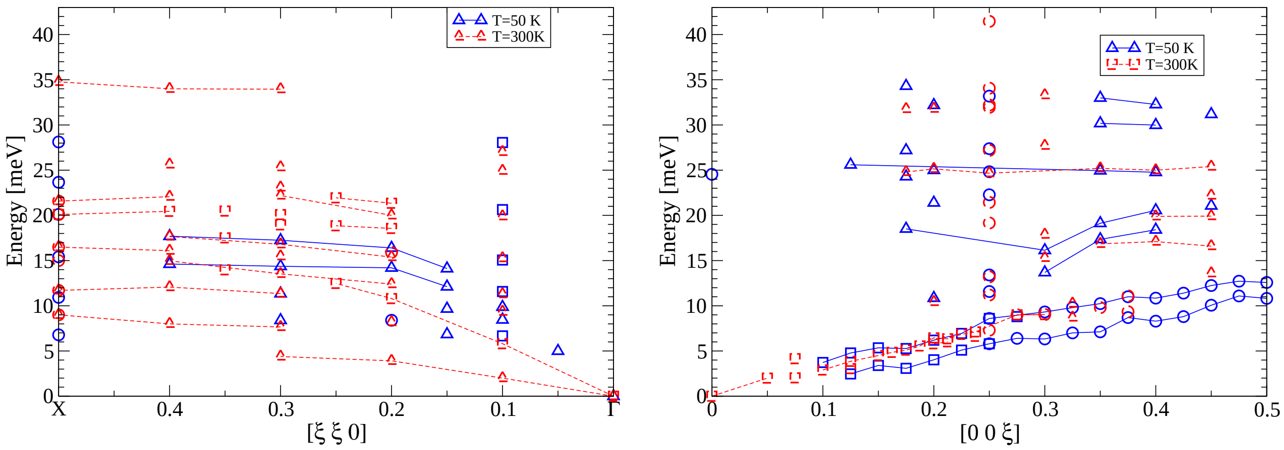

Figure: Low energy phonon dispersion along the [ξξ0] and [00ξ] direction. Triangles refer to measurements in longitudinal, squares to transverse polarization. Circles denote unspecified polarization. Shown are data for 50 K (solid line, in blue) and at room temperature (broken line, in red). The lines are guide to the eye and connect scans measured in the same Brillouin zone.

Especially along the $[00\xi]$ direction the transverse acoustic branches could be followed up to the zone boundary for 50 K. In $[\xi\xi 0]$ direction more scans were taken at room temperature.

In the higher energy region it was more difficult to follow and unravel the closer lying optic phonon branches.

No general shift in frequency could be found between the data at 50 K and room temperature. Also, at room temperature the excitations experience some broadening and, e.g., the two transverse acoustic branches in $[00\xi]$ direction could not be resolved. The acoustic branches reach an energy at the zone boundary of about 10 meV. The magnon dispersion reaches up to 50 meV and cuts in this way through the acoustic as well as the optic branches.