EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office via the User Portal:

https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do

Reports supporting requests for additional beam time

Reports can be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Magnon-phonon coupling in the Heisenberg triangular lattice antiferromagnet $LiCrO_2$	**Experiment number**: HC-2198
Beamline: ID28	**Date of experiment**: from: 28.10.2015 to: 03.11.2015	**Date of report**: 29.02.2016
Shifts: 18	**Local contact(s)**: Thanh-Tra NGUYEN	*Received at ESRF:*

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Abstract

We measured inelastic X-ray scattering on the triangular lattice antiferromagnet (TLA) $LiCrO_2$. We observed a large change of the phonon spectrum from 300 K down to 5 K. The changes are attributed to the magnon phonon interaction present in the system.

Experiment

We aligned our sample in the (*H,H,L*) plane to access both the triangular (*H,K,0*) plane and the perpendicular direction. This particular choice of orientation is also due to the shape of the crystal which is plate like in the *ab*-plane, with this orientation we could optimise the location of the beam spot on the sample. In order to measure the phonon spectrum with high enough X-ray flux, we chose the λ=0.6968 Å using the Si(9,9,9) reflection of the main-monochromator, which provided an overall energy resolution of 3.0 meV full-width-half maximum. The beam size was about 50x50 μm^2 which we positioned on the sample surface where the incoherent scattering was the weakest to reduce background, see Fig. 1. The momentum resolution was set to 0.3 (horizontal) x 0.9 (vertical) nm^{-2}. Energy transfer scans were performed at constant momentum transfer (Q), selected by appropriate choices of scattering angle and sample orientation. The maximum scattering angle in this setup was limited to 48°, which restricted us in reciprocal space to $H \lesssim 1.5$ along the ***Q***=(*H,H,0*) direction in the triangular plane. The analyzer efficiencies and energy resolution was determined during calibration prior to our experiment. The sample was aligned in the scattering plane on the (0,0,6) and (1,1,0) Bragg peaks. The temperature was controlled by a closed cycle refrigerator with a Joule-Thomson stage to reach 7.1 K.

Results

At 295 K we observed acoustic phonons at zone boundary energies of 30.8(4) and 34.6(2) meV and an optical phonon mode at 59.2(1) meV at ***Q***=(1.5,1.5,0), in good agreement with our previous ab initio phonon calculation, see Fig. 3. Upon cooling the sample, the optical phonon mode was continuously shifting upwards in energy while the lower acoustic phonons decrease in intensity enormously almost disappearing at 7.1 K, see Fig. 2a. Beside we observe a new excitation appearing at 7.9(7) meV at 100 K and increasing in energy up to 10.3(2) meV at 7.1 K. We attribute these large changes to the magnon phonon coupling and the new peak around 10 meV to a magnon mode that strongly mixes with the lower longitudinal acoustic phonon mode.

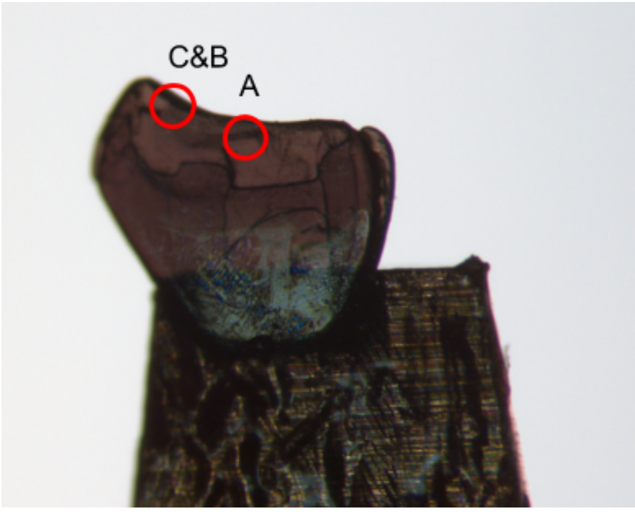

Fig. 1. Sample orientation showing the beam position, where all data was measured on spot A.

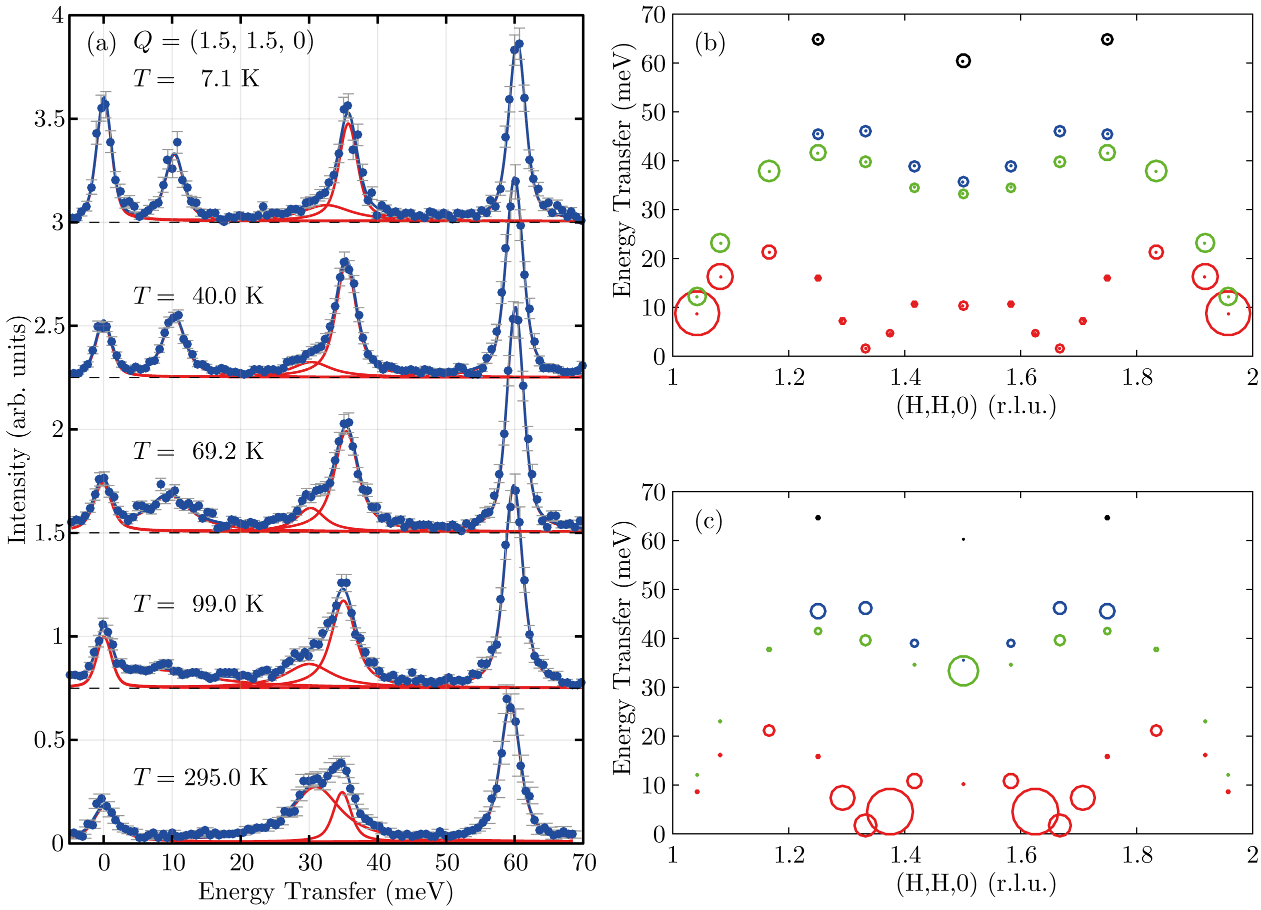

Fig. 2. (a) Temperature dependence of the IXS signal of $LiCrO_2$ measured on ID28 at $\boldsymbol{Q}$ = (1.5,1.5,0) (blue lines denote the fit using the instrumental resolution profile). Note the temperature dependence of the excitations at 10 and 30 meV. The peak around 10 meV was identified as a magnon by INS. (b) Dispersion of the excitations found by IXS at T = 7.1 K, the area of the circles is proportional to the quasiparticle peak intensity, while radius of the circles on (c) are proportional to the intrinsic line width of the excitations. Note the roton minimum in the dispersion at H = 1.5, E ~ 10 meV.

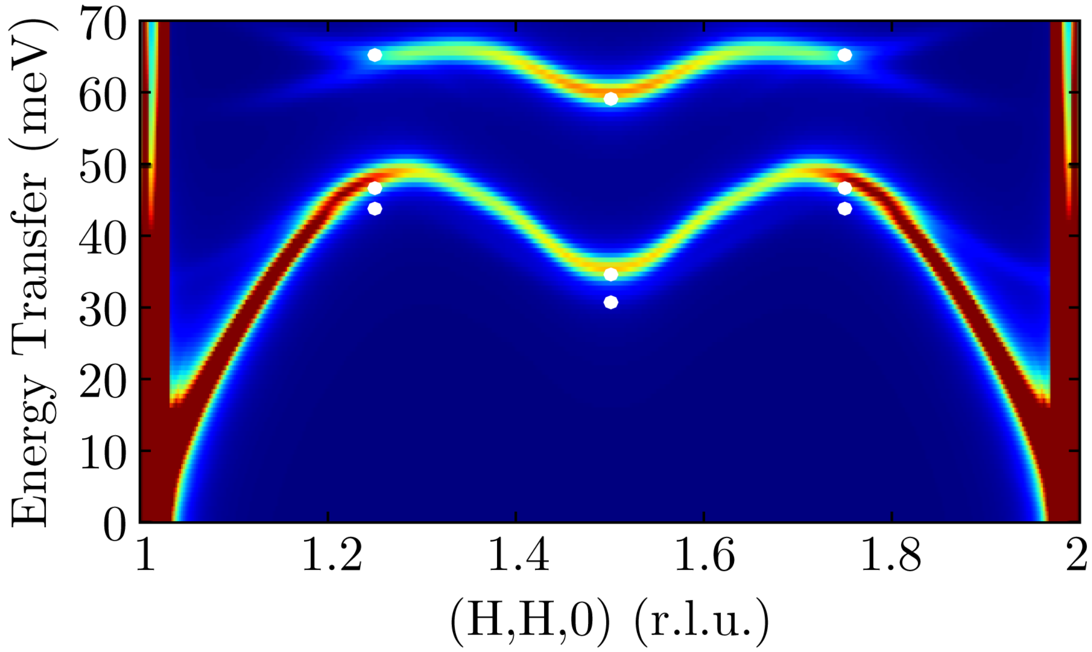

Fig. 3. Phonon spectrum calculated using VASP ab initio code and the color plot was simulated using the AB2TDS code developed at ESRF. The phonon lines are convoluted with the instrumental energy resolution. White circles denote the experimentally found quasiparticle peaks at 295 K symmetrized around the *H*=1.5.