実験報告書様式（一般利用課題・成果公開利用）

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Experimental Report (CROSS TOKAI / J-PARC)	承認日 Date of Approval 2013/07/19 承認者 Approver Ryoichi Kajimoto 提出日 Date of Report 2013/07/20
課題番号 Project No. 2012B0153 実験課題名 Title of experiment Magnetic excitations and phonons in spin-charge coupled $LuFe_2O_4$ 実験責任者名 Name of principal investigator Manuel Angst 所属 Affiliation Forschungszentrum Jülich GmbH	装置責任者 Name of Instrument scientist Ryoichi Kajimoto 装置名 Name of Instrument/（BL No.） BL-1 実施日 Date of Experiment Jan 30-Feb 8 2013

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

Lutetium Ferrite, $LuFe_2O_4$, single crystal 1.4 g

2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

The sample to be studied had first been oriented and characterized by polarized neutron diffraction at DNS (FRMII), with clear magnetic Bragg peaks being observed at 200 K very similar to previously investigated (much smaller) crystals. For the 4SEASONS experiment the sample was remounted on a sample holder with much less Al, to minimize background, such that (HHL) is the scattering plane. The mounted sample was then put in an Al can flushed and back-filled with He, and attached to the cryofurnace, allowing to reach the three target temperatures of the experiment (the empty can was measured also to subtract its contribution). Given the multiple-incident energy feature we chose a setting with energies 11, 18, 35, and 96 meV. For each temperature we measured a 120° slice in omega, which proved sufficient to reach all regions of interest in q-E space. We used 1° -steps and 15 min counting per step. In the pre-analysis during the experiment lack of intensity (especially in the high-E region) was identified, and we chose 290 K to measure again in order to double the statistics. Post-experiment analysis was hampered by software installation problems and is thus still not complete (e.g. results below are without background subtraction).

2. 実験方法及び結果（つづき） Experimental method and results (continued)

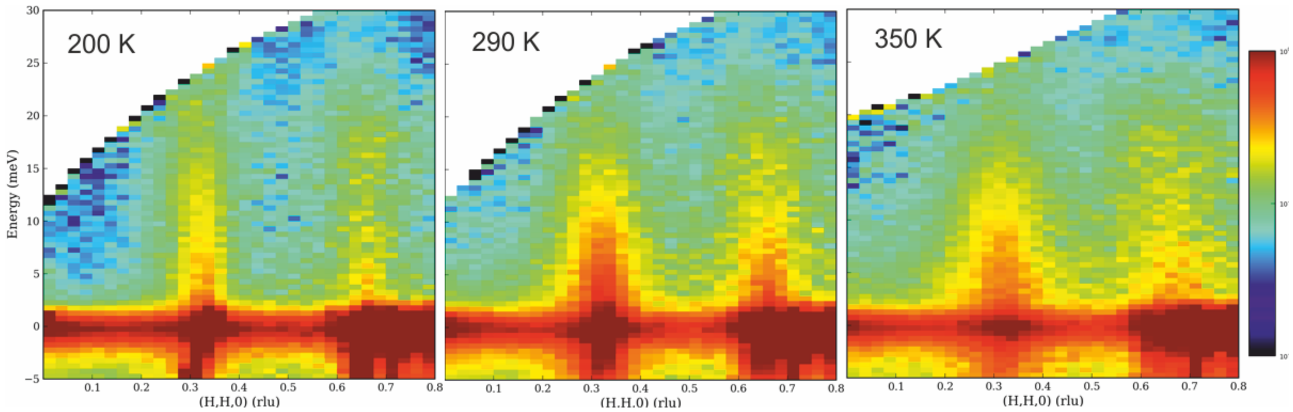

Fig. 1. Scattered Intensity as a function of (HH0) and energy transfer for incident neutron energy 35 meV. The data have been integrated along (H,-H,0) from -0.15 to 0.15 and along (00L) from 0 to 6. The results for three temperatures are shown: 200 K (left), 290 K (middle), and 350 K (right). The elastic intensity at H~0.7 is heavily affected by an Al powder line.

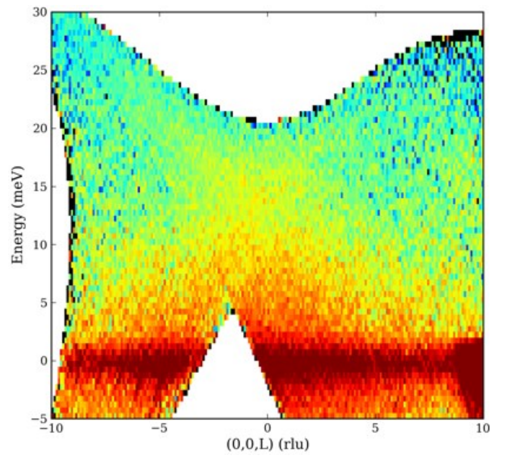

Fig. 2: As Fig. 1 left, except that Intensity vs E and (00L) is shown, integrated in (HH0) from 0.2 to 0.4.

The strongest feature observed is shown in Figs. 1 and 2, inelastic intensity above (1/3,1/3,L) superstructure peaks. In diffraction experiments, superstructure peaks due to CO appear at (1/3,1/3,n/2) below 320 K, which is replaced by diffuse (1/3,1/3,L) rods at higher T. The increased elastic intensity is also visible in Fig. 1, but interestingly there is also increased inelastic intensity. In polarized neutron diffraction, there is also diffuse magnetic intensity at (1/3,1/3,L), replaced by magnetic Bragg peaks at (1/3,1/3,n) and (1/3,1/3,n/2) below 240 K. Below this temperature, inelastic intensity is significantly decreased (Fig. 1 left). We interpret this as magnetic moments starting to fluctuate when the magnetic phase is left, resulting in intensity shifting from elastic to inelastic. This interpretation is in line with short-range correlations seen by neutron diffraction while no static magnetism is seen by Mössbauer spectroscopy. In contrast to a previous report on powder inelastic scattering we see no indications of a spin gap of several meV, which is surprising given the Ising anisotropy. There is a practically vertical in-plane dispersion of inelastic intensity above superstructure peaks. In the out-of-plane direction (Fig. 2) the inelastic intensity looks “diffuse” with no dispersions resolvable (Fig. 2). In part, this is likely due to the long c-axis (25 A) increasing the requirement for q-resolution. We plan to further investigate the features described above with a triple-axis spectrometer with polarization analysis to clearly separate magnetic and non-magnetic contributions and resolve out-of-plane dispersion. Further in-depth analysis of all the data gathered is also planned once we have a stable-running software installation on our cluster computers.