

Triple-Axis Spectrometer (UNIDAS)



Instrument Parameters

Beam tube:	4H4 radial Ø 4"
Monochromators:	pyrolytic graphite (002), vertical focusing
Analyzers:	pyrolytic graphite (002), focusing germanium (111)
Filter:	pyrolytic graphite, for incident and/or final beam
Collimators:	15' ... 60' (Rutherford collimators)
Angular range - Monochromator: - Scattering angle: - Analyzer: - Sample:	$12.5^\circ \leq \Theta_M \leq 60^\circ$ $-90^\circ \leq \Phi \leq 130^\circ$ $-75^\circ \leq \Theta_A \leq 75^\circ$ (with different configurations) $-180^\circ \leq \psi \leq 180^\circ$ $-180^\circ \leq \chi \leq 180^\circ$ (with Eulerian cradle) $-180^\circ \leq \varphi \leq 180^\circ$
Beam size at specimen:	35 x 90 mm ²
Neutron flux at sample position:	typically 5×10^6 n/cm ² s
Incident:	$0.8 \text{ \AA} \leq \lambda \leq 4 \text{ \AA}$
Energy transfer:	$0.02 \text{ meV} \leq \hbar\omega \leq 80 \text{ meV}$
Momentum transfer:	$0.05 \text{ \AA}^{-1} \leq Q \leq 10 \text{ \AA}^{-1}$
Detector:	³ He (8 bar)
Background:	≤ 2 cnts/min
Time resolution for stroboscopic experiments:	2 ms ≤ Δt ≤ 200 s
Sample environment:	goniometer, ±20° tilt; Eulerian cradle; 2 closed-cycle cryostats (10 K ≤ T ≤ 300 K); 2 bath cryostats (4 K ≤ T ≤ 300 K); 2 standard furnaces (300 K ≤ T ≤ 1100 K); 1 special furnace (500 K ≤ T ≤ 1800 K); 2 four-circle furnaces (300 K ≤ T ≤ 1300 K) ; furnace for uniaxial (periodic) pressure; automatic temperature control

Instrument Responsible

Dr. Andreas Hoser

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Experimental Report of Neutron Scattering Experiments at the FRJ-2 Reactor

Proposal number:	UDS-04-013		
Experiment title:	Magnetic Excitations in nanocrystalline Tb		
Dates of experiment:	8-18 March 2005	Date of report:	24 May 2005
Experimental team: Names	Addresses		
O. Moze, C. Vecchini Andreas Hoser	Physics Dept, Modena University, Italy Forschungszentrum Juelich, Germany		
Local Contact:	Andreas Hoser		

Experimental report text body

Recent measurements by SANS (Weissmüller et al, Phys. Rev. B 69, 054402 [2004]) were performed for the first time on the nanocrystalline hard magnet Tb. Two important parameters used in modelling the magnetic behaviour in this material, and indeed in understanding the nature of the large magnetic anisotropy in nanocrystalline Tb are the spin-wave stiffness constant D and the spin-wave gap Δ , which reflects dipolar and anisotropy contributions. We have recently re-attempted to measure the spin wave excitations in a 1 gm sample of nanocrystalline Tb with a grain size of 13 nm. Inelastic scans were performed at different temperatures in the ferromagnetic region ($T_c=226K$). Previously performed scans at PSI (Switzerland) on the Triple-Axis Spectrometer TASP, gave evidence of the probable presence of an inelastic peak at about 1.8 THz at 200K. The measurements were performed in the fixed initial energy mode ($K_i=2.67 \text{ \AA}^{-1}$) with energy transfer up to 2.85 THz. Initial diffraction scans were done in order to center scans around the (101) reflection, which is the strongest magnetic and nuclear Bragg peak (Fig. 1). This position was chosen because of the high magnetic scattering intensity and much lower background and small angle scattering than in the forward direction. Due to the low intensity of the inelastic magnetic signal, the measurement time was necessarily very long. Measurements at 200K did not show any intrinsic inelastic peak but showed the presence of 2 Bragg spurion peaks due to analyzer and monochromator reflections at 2 THz and 2.7 THz. The first one appears to be very broad for a Bragg spurion. Measurements at 150K showed the presence of the 2 spurions, always at 2 THz and 2.7 THz and of one inelastic peak at 2.1 THz. This peak has an intensity of about 90 counts on top of the background and a width of 0.2 THz as shown in Fig. 2. Further measurements at 50K evidenced the absence of that peak, that, in our opinion, has moved outside the energy range investigated (Fig. 3) and confirmed the position of the first spurion at 2 THz. In light of the scans at 50K and 150K, we think that the intrinsic inelastic peak at 200K could have moved inside the spurion, broadening it and slightly moving from its original position due to the convolution of the two (Fig. 4).

Further measurements with different temperatures choices and different incoming neutron energies are very desirable. This will allow tracking of the inelastic signal over a wider temperature range. These measurements are also *pioneering* in the sense that they demonstrate what can be done with *neutrons on rather small nanocrystalline samples*.

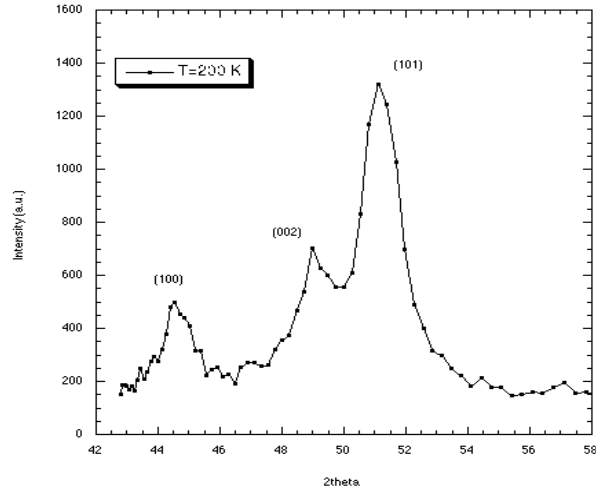


Fig. 1 Elastic scan for nano Tb at T=200K

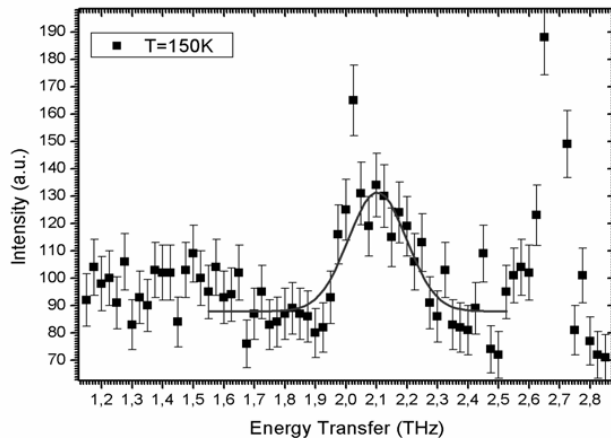


Fig. 2 Zoom of the inelastic peak for nano Tb at T=150K

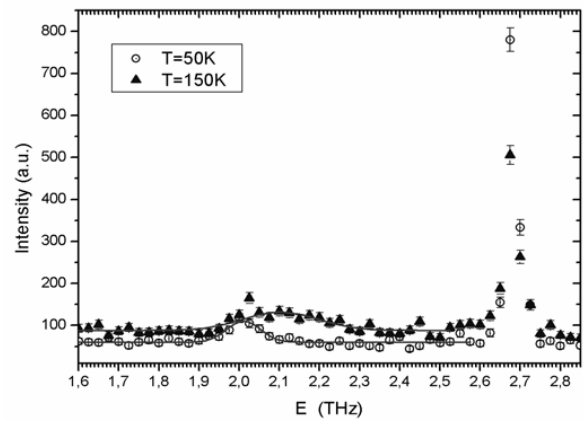


Fig. 3 Inelastic and spurion peaks for nano Tb at T=150K and T=50K

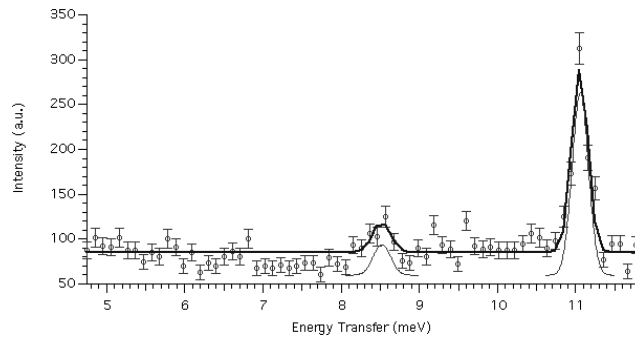


Fig. 4 Inelastic peak convoluted with the spurion at (8.8meV) and



Experimental Report
of Neutron Scattering Experiments
at the FRJ-2 Reactor

Proposal number:	UDS-05-004		
Experiment title:	Diffuse scattering in magnetite, and its relationship with anharmonic phonon effects		
Dates of experiment:	01.11.05 – 14.11.05	Date of report:	06.06.06
Experimental team: Names	Addresses		
Peter Mitchell Joe Hargreaves Geetha Balakrishnan	School of Physics & Astronomy, University of Manchester, M13 9PL, UK School of Physics & Astronomy, University of Manchester, M13 9PL, UK Department of Physics, University of Warwick, CV4 7AL, UK		
Local Contact:	Andreas Hoser		

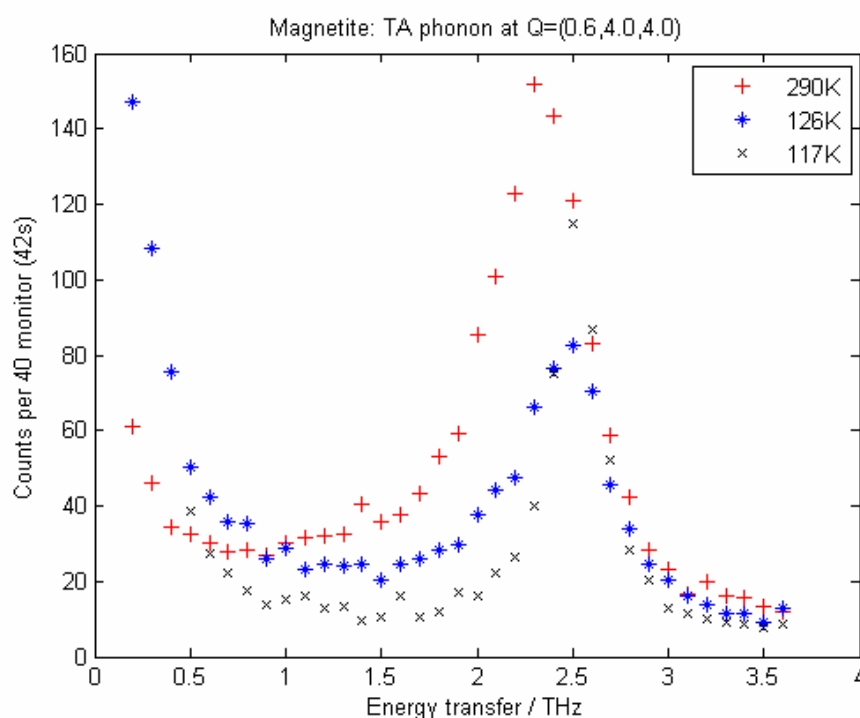
Experimental report text body

Magnetite is perhaps the magnetic material which has been used over the longest period in history. Lodestone, naturally occurring Fe_3O_4 , is ferrimagnetic at room temperature, and when magnetised can be used in navigation. However, an understanding of the material in detail still seems elusive. A model, which seemed to explain both the magnetic and other properties, which involved Fe^{2+} and Fe^{3+} ions occupying various sites [1], is now not tenable in the light of a range of evidence [2].

In addition to the paramagnetic to ferrimagnetic transition at 848K, there is a first order structural transition at T_V , which is about 120K, the so-called Verwey transition. The most striking change at this point is that the electrical conductivity falls by a factor of 100 or so. It has been called a metal-insulator transition, but in reality it is a transition between two different semiconducting states. The resistivity decreases as the temperature increases in both phases. Structurally, magnetite is a cubic inverse spinel above T_V , and below T_V the structure is still not completely known, but it is known to be monoclinic [3]. The magnetism is not significantly affected by the transition.

We have grown several large artificial crystals by the floating zone method at Warwick. They show the Verwey transition at about 121K, which indicates both high (metallic) purity and good stoichiometry (i.e. a very low level of oxygen defects). The crystal we have used in this experiment is a single crystal of 3.7cm^3 , which is several times larger than crystals used in earlier inelastic scattering studies [4,5,6].

In this experiment, we measured the transverse acoustic phonons at selected wavevectors in the [100], [110] and [111] directions at room temperature, and just above T_V . At room temperature, the phonons become very broad, with a large intensity between the “phonon frequency” and zero, as the zone boundary is approached in the [100] and [110] directions, while they remain good normal modes in the [111]. This is in contrast to the previous phonon measurements [7], where “the observed peak widths could in most cases be accounted for by instrumental widths”. This broadening may signal the anharmonicity we seek. It remains down to just above T_V , while the quasi-elastic scattering grows at those wavevectors where the phonons also show anharmonic effects. Below T_V , the phonon becomes sharper again and the intensity between it and zero disappears (see figure).



It was not possible, in the time available for this experiment, to measure the diffuse quasi-elastic scattering as proposed. At all wavevectors where the phonon broadening was seen, there was also strong quasi-elastic diffuse scattering.

The observations of significant phonon broadening achieved in this experiment encouraged the performance of further experiments to characterise these effects in quantitative detail as a function of wavevector and temperature.

References

- 1 Verwey E J W, Haayman P W and Romeijn C W, J Chem Phys **15** 181, 1947
- 2 Garcia J and Subias G, J Phys: Condensed Matter **16** R145, 2004
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- 4 Fuji Y, Shirane G and Yamada Y, Phys Rev **B11** 2036, 1975
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Experimental Report of Neutron Scattering Experiments at the FRJ-2 Reactor

Proposal number:	UDS-05-005		
Experiment title:	Magnetic Excitations in nanocrystalline Tb		
Dates of experiment:	08.03. – 18.03.2005	Date of report:	21.06.2006
Experimental team: Names	Addresses		
O. Moze, C. Vecchini Andreas Hoser	Physics Dept, Modena University, Italy Institut für Festkörperforschung, Forschungszentrum Jülich, Germany		
Local Contact:	Andreas Hoser		

Experimental report text body

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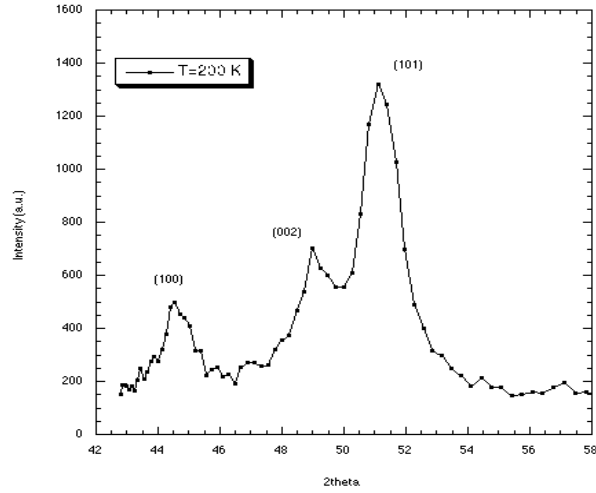


Fig. 1 Elastic scan for nano Tb at T=200K

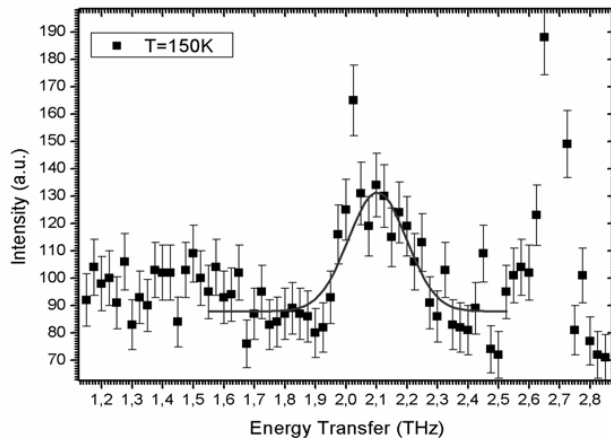


Fig. 2 Zoom of the inelastic peak for nano Tb at T=150K

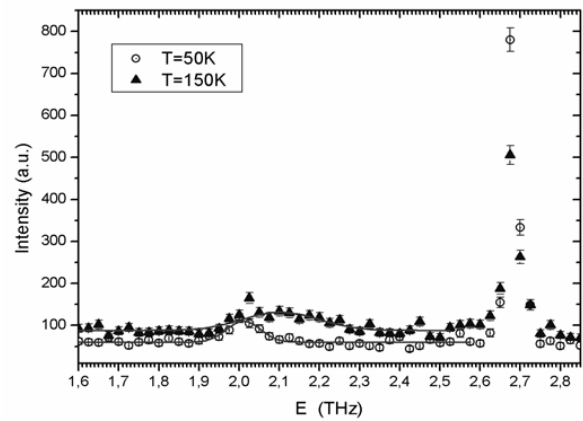


Fig. 3 Inelastic and spurion peaks for nano Tb at T=150K and T=50K

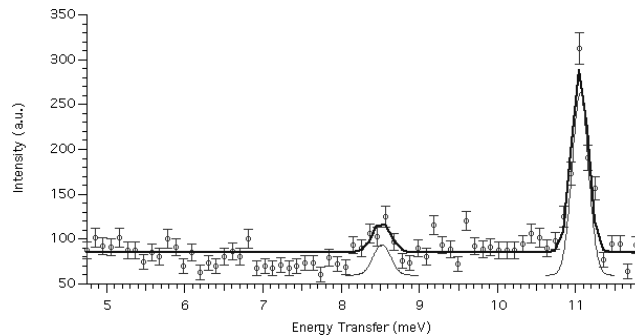


Fig. 4 Inelastic peak convoluted with the spurion at (8.8meV) and



Experimental Report of Neutron Scattering Experiments at the FRJ-2 Reactor

Proposal number:	UDS-05-006		
Experiment title:	Crystal field effects in ErAl_2		
Dates of experiment:	30.08. – 04.09.2005 30.10. – 02.11.2005	Date of report:	02.06.2006
Experimental team: Names	Addresses		
U. Köbler A. Hoser	Institut für Festkörperforschung, Forschungszentrum Jülich Institut für Kristallographie, RWTH-Aachen		
Local Contact:	Dr. A. Hoser		

Experimental report text body

ErAl_2 is a metallic ferromagnet with cubic MgCu_2 structure and a Curie temperature of $T_C=13.6$ K [1]. The effective Bohr magneton number evaluated from the paramagnetic Curie-Weiss susceptibility is $\mu_{\text{eff}}=9.4\mu_B$. This value is consistent with the theoretical value for the free Er^{3+} ion of $\mu_{\text{eff}}=9.58\mu_B$. The observed saturation magnetic moment of $7.4\mu_B$ is considerably smaller than the theoretical free ion value. For the Er^{3+} ion with configuration $4f_{15/2}$ and $g=6/5$ a theoretical saturation moment of $9\mu_B$ results. The reduced moment is indicative of crystal field effects.

As we have shown recently [2,3] the dynamics of the magnetic order parameter shows universality at the stable fixed point $T=0$. This means that saturation of the magnetic order parameter for $T \rightarrow 0$ is according to a single power function of absolute temperature. The universal exponent ε depends on the number of relevant states $N=2J+1$ per magnetic particle. In isotropic (cubic) magnets $\varepsilon=9/2$ for an odd number of states ($J=\text{integer}$) and $\varepsilon=2$ for an even number of states ($J=\text{half-integer}$). This empirical systematic allows one to determine how many states of the free ion are relevant in the ordered state for $T \rightarrow 0$.

Universality is a consequence of the continuous symmetry of the dynamics in the long range ordered state. Note that the order parameter is located at the Brillouin zone centre. On the other hand, the crystal electric field is a phenomenon on the length scale of the inter-atomic distance. Crystal field effects, therefore, are located at the Brillouin zone boundary. As a consequence, crystal field effects are, in a first approximation, not relevant for the dynamics of the order parameter. This is the case if the crystal field splitting is much smaller than the exchange interaction. A non relevant crystal field is noticed by a saturation moment that conforms to the free ion value. This is realized in the ferromagnetic heavy Rare Earth (RE) elements [3].

In the REAl_2 alloys the crystal field is relevant and the saturation moment is reduced with respect to the free ion

value. In contrast to the crystal field splitting of the isolated single ion, reduction of the saturation moment in the ordered state is not a continuous process as a function of decreasing temperature but occurs as discrete crossover events. At a crossover the number of relevant states is reduced by one, i.e. the effective spin is reduced by $\Delta J=1/2$. In other words, at a crossover the universality class changes from $\varepsilon=9/2$ to $\varepsilon=2$ or vice versa.

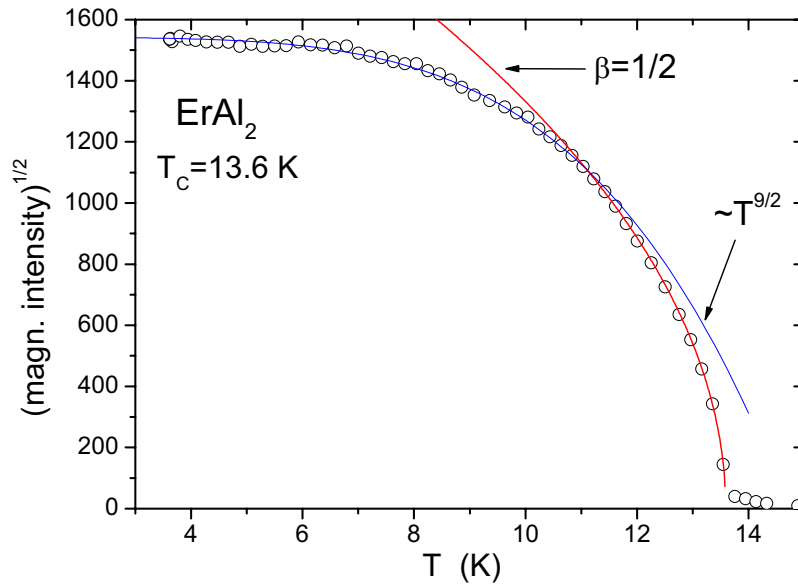
We have performed neutron scattering measurements on an ErAl_2 single crystal in zero magnetic field. Note that magnetic saturation, i.e. removal of the magnetic domains can change the universality class. The macroscopic magnetization therefore can give a different result than the zero-field measurement.

Fig. 1 shows the result for the magnetization as a function of temperature. These data are the square root of the (200) diffraction intensity after subtraction of the nuclear intensity. It can be seen that the exponent for $T \rightarrow 0$ is $\varepsilon=9/2$ but the critical exponent β for $T \rightarrow T_c$ is $\beta=1/2$. Note that the two exponents give a fairly complete description of the temperature dependence of the spontaneous magnetization [4].

The exponent $\varepsilon=9/2$ indicates that the spin is integer. Practically the spin can be only $J=6$ instead of $J=15/2$. The number of states therefore is reduced from $N=16$ to $N=13$, i.e. by $\Delta N=3$. With $J=6$ and $g=6/5$ a saturation moment of $7.2\mu_B$ is calculated in good agreement with the observed moment of $7.4\mu_B$.

The fitted mean field exponent $\beta=1/2$ is indicative of a half-integer spin. It is reasonable to assume that the spin has the full value of $J=15/2$ in the critical range. This assumption is consistent with the large pre-factor of the $(T_c-T)^{1/2}$ power function. Normally the critical power function has an extrapolated value for $T \rightarrow 0$ that is larger by a factor of ~ 1.3 compared to the saturation value of the order parameter. The fitted critical power function is larger by a factor of ~ 1.65 for $T \rightarrow 0$ compared to the order parameter. This is consistent with $J=15/2$.

We consider the result obtained on ErAl_2 as consistent with our proposition that in the ordered state the effect of a relevant crystal field is to reduce the number of states, N . A strong crystal field reduces the number of states by more than $\Delta N=1$. On the other hand, a non relevant crystal field leaves the number of states unchanged. Each reduction of the number of states gives rise to a crossover phenomenon, i.e. to a change of the universal exponent ε from $\varepsilon=9/2$ to $\varepsilon=2$ or vice versa. In other words, the crystal electric field has to be treated in a fundamentally different way under the continuous symmetry of the long range ordered state compared to the isolated and non interacting ion.



- [1] K.H.J. Buschow, Rep. Prog. Phys. 42 (1979) 1373.
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- [3] U. Köbler, A. Hoser, J. Magn. Magn. Mater. 299 (2006) 145.
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Experimental Report
of Neutron Scattering Experiments
at the FRJ-2 Reactor

Proposal number:	UDS-05-007		
Experiment title:	Searching for phonon-like magnetic excitations in ErAl_2		
Dates of experiment:	12.01.-14.02.2006 16.02.-26.02.2006	Date of report:	06.06.2006
Experimental team: Names	Addresses		
A. Hoser U. Köbler	Institut für Kristallographie, RWTH- Aachen Institut für Festkörperforschung, Forschungszentrum Jülich		
Local Contact:	A. Hoser		

Experimental report text body

In recent analyses of the specific heat of magnetic and non magnetic materials we have observed that the universal exponents for $T \rightarrow 0$ are commonly identical for magnetic and non magnetic materials [1]. As is well known, $T=0$ is a stable fixed point [2]. At those points universality is observed. This means that spontaneous magnetization, specific heat etc. follow exact power functions of absolute temperature over a large temperature range [3]. The standard behaviour for the lattice heat capacity is given by the famous T^3 power function according to the Debye model. Universality is clearly revealed by the fact that the T^3 dependence is confirmed for many solids with different chemical compositions and lattice symmetries. However, two more universality classes represented by T^2 and T^4 functions have also been identified empirically [1].

In order to demonstrate that the Debye T^3 function holds also in magnetic materials we show in Fig.1 heat capacity data for ferromagnetic cobalt. It can be seen, that the T^3 function of the lattice heat capacity holds exactly over a large temperature range. Beyond the T^3 function crossover to a linear temperature dependence follows. This crossover is observed in all magnetic and non magnetic solids [1].

Speaking in terms of renormalization group theory we have to conclude that the magnetic heat capacity is not relevant. This means that the observed universal exponent ($\varepsilon=3$) is defined by the lattice and that the magnetic heat capacity must be contained in the pre-factor of the T^3 function. Note that the zero field spontaneous magnetization of cobalt follows $T^{3/2}$ function for $T \rightarrow 0$ [4]. We should note that the specific heat of ferromagnetic GdMg also shows T^3 function for $T \rightarrow 0$ but the spontaneous magnetization saturates according to T^2 function.

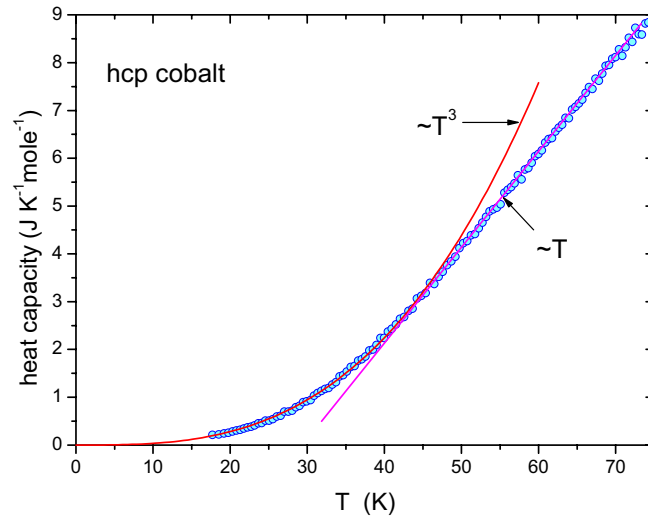


Fig. 1

From the identical exponents for the heat capacity of magnetic and non magnetic solids we have to conclude that phonons are more important than magnons. As a conclusion, it can be expected that the phonon spectra are somehow different above and below the magnetic ordering temperature. Ferromagnetic ErAl_2 with $T_C=13.6$ K is a good candidate to test this. We have measured transversal acoustic phonon modes at 3.4K and at 19K, i.e. below and above Curie temperature. We observe no change in the dispersion curve except reduction of phonon intensities above T_C according to thermal depopulation of ground state.

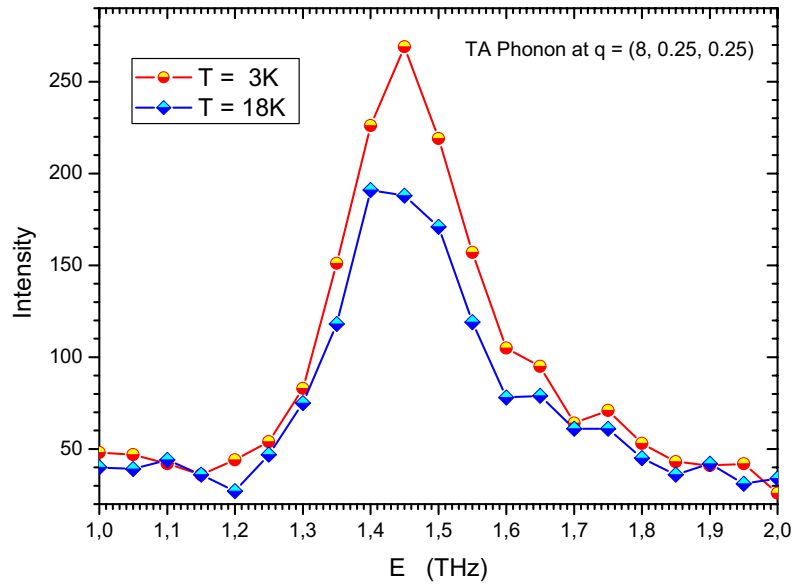


Fig. 2

- [1] U. Köbler, M. Kawakami, W. Schnelle, Physica B 367 (2005) 255.
- [2] K.G. Wilson, J. Kogut, Phys. Reports 12C (1974) 75.
- [3] U. Köbler, A. Hoser, Physica B 362 (2005) 295.
- [4] U. Köbler, A. Hoser, J.-U. Hoffmann, C. Thomas, Solid State Commun. 137 (2006) 301.



Experimental Report
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Proposal number:	UDS-05-008		
Experiment title:	Diffuse scattering in magnetite, and its relationship with anharmonic phonon effects		
Dates of experiment:	05.12.2005 – 19.12.2005	Date of report:	06.06.2006
Experimental team: Names	Addresses		
Peter Mitchell Joe Hargreaves Geetha Balakrishnan	School of Physics & Astronomy, University of Manchester, M13 9PL, UK School of Physics & Astronomy, University of Manchester, M13 9PL, UK Department of Physics, University of Warwick, CV4 7AL, UK		
Local Contact:	Andreas Hoser		

Experimental report text body

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In addition to the paramagnetic to ferrimagnetic transition at 848K, there is a first order structural transition at T_V , which is about 120K, the so-called Verwey transition. The most striking change at this point is that the electrical conductivity falls by a factor of 100 or so. It has been called a metal-insulator transition, but in reality it is a transition between two different semiconducting states. The resistivity decreases as the temperature increases in both phases. Structurally, magnetite is a cubic inverse spinel above T_V , and below T_V the structure is still not completely known, but it is known to be monoclinic [3]. The magnetism is not significantly affected by the transition.

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We planned to complete this investigation of the various phonon modes near T_V in an attempt to link the quasi-elastic diffuse scattering to specific phonon anharmonic effects. We measured the phonon broadening effects as a function of wavevector (see figures 1 and 2), at room temperature and just above and just below T_V .

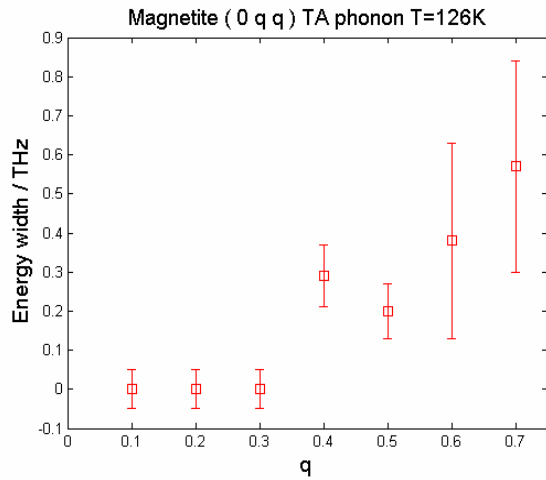


Fig 1: phonon width at 126K in [011]

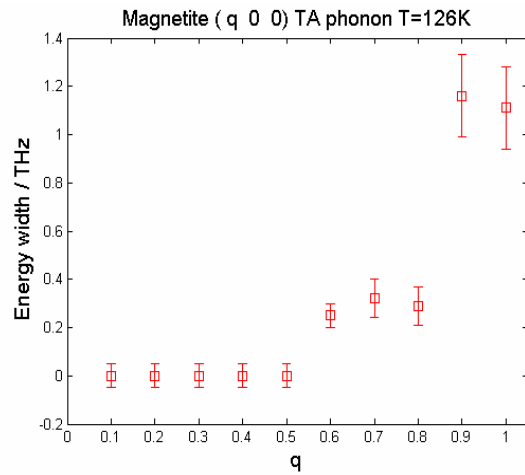


Fig 2 phonon width at 126K in [100]

We also made measurements of the quasi-elastic diffuse scattering in the cubic phase just above, and just below, T_V , in several zones in order to establish the dependence on the magnitude of the wavevector transfer. These measurements are complicated by the appearance of many new Bragg peaks in the low temperature phase. Analysis of the quasi-elastic diffuse scattering is continuing. One early conclusion we arrived at by examining a limited subset of the data, namely that the diffuse quasi-elastic scattering correlates exactly with the wavevectors where significant phonon broadening is observed, is not upheld by more detailed examination of all of the data.

These observations of the phonon linewidths are consistent with the following model for the Verwey transition. The state above the transition may be considered as a classic semiconductor with a certain band gap (around 200meV estimated from photoemission [7], or 110meV from the gradient of the conductivity-temperature curves [8]). Below it might also be a semiconductor with a wider band gap (around 300meV from photoemission [7], or 270meV from the conductivity-temperature curves [8]). In this case, the structural transition is driven by the gain in electronic energy as the band-gap widens. This model would imply anharmonic vibrational effects which would grow as the temperature is lowered towards the transition, because of the electronic energy gain from the lattice distortion. The reduction in energy which is eventually realised at the transition would gradually favour small distortions from the cubic structure equilibrium atom positions, and so would generate an anharmonic potential. This is observable as the broadening of the phonon modes which has been observed.

References

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- 2 Garcia J and Subias G, J Phys: Condensed Matter **16** R145, 2004
- 3 Wright J P, Attfield J P and Radaelli P G, Phys Rev **B66** 214422, 2002
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- 8 Data taken from Miles P A, Westphal W B and von Hippel A, Rev Mod Phys **29** 279, 1957



Experimental Report
of Neutron Scattering Experiments
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Proposal number:	UDS-06-001		
Experiment title:	Influence of hydrogen uptake on spin-density wave magnetism in Cr/V multilayers		
Dates of experiment:	07.04. – 02.05.2006	Date of report:	1 June 2006
Experimental team: Names	Addresses		
Gregor Nowak Arndt Remhof	Institut für Festkörperphysik / Experimentalphysik Ruhr-Universität Bochum 44780 Bochum Germany		
Local Contact:	Dr. Andreas Hoser		

Experimental report text body

The spin-density wave (SDW) state in thin Cr films is known to be under influence of contaminations, dimensionality (film thickness) and proximity effects from neighboring layers [1]. As the SDW is completely suppressed in $\text{Cr}_{1-x}\text{V}_x$ alloys for $x > 0.04$, we investigated the dependence on the SDW state in thick Cr layers sandwiched between thin V films [2,3] and in epitaxial Cr/V multilayers [4]. An unpredicted strong and long-range effect on the polarization, period, and the Néel temperature of the SDW in rather thick Cr films was found. The magnetic phase diagram of the multilayers turned out to be rather complex. For Cr layers thinner than 120 Å the samples behave paramagnetic. At this thickness a commensurate SDW originates and as Cr thickness increases further a fraction of incommensurate SDW appears and expands. Finally the SDW becomes completely incommensurate. The Néel temperature of the incommensurate SDW scales with Cr thickness as well. V is known to dissolve considerable amounts of hydrogen, resulting in lattice expansion and in a modified electronic band structure. This ability has been employed to tailor the magnetic properties of H-loaded Fe/V [5,6] heterostructures.

In the present experiment we investigated the influence of H loading in a $[\text{Cr}(500\text{ML})/\text{V}(14\text{ML})]_{*4}$ superlattice. The epitaxial sample was prepared by conventional dc sputtering in ultra high vacuum (UHV) onto polished MgO (001) substrate ($20 \times 20 \times 0.5 \text{ mm}^3$). Details of the sample preparation and the SDW state of the H-free sample may be found in [4]. For the H-loading experiments, the cryostat was connected to a gas loading system, consisting of two capacitance manoscopes to enable gas-independent pressure measurements and a vacuum leak valve to allow precise adjustment of the H pressure. As *in-situ* experiments were not possible, the different loading and unloading kinetics of the sample were exploited. First, the sample was exposed to a hydrogen pressure of 100 mbar up to 1000 mbar. At this pressures H saturation of the sample is reached quite quickly. After a 30 minutes the sample is cooled in the H atmosphere below 230K. At this temperature the unloading is suppressed and the H motion within the sample is frozen. Subsequently the cryostat is evacuated

down to the 10^{-7} mbar regime before the begin of the experiment. From a previous experiment we know that the sample is in the incommensurate SDW state at low temperatures. At 220K the commensurate phase occurs. Both phases coexist than until 250K. Above 250K only the commensurate phase is seen. Figure 1 shows a temperature series of the 100 mbar hydrogen loaded sample. First we notice that even at the lowest measured temperature (20K) we found after H-loading up to 1000mbar enhance intensity around the position of the commensurate SDW.

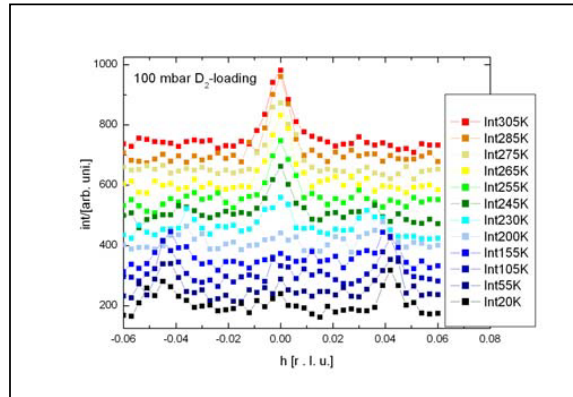


Fig.1

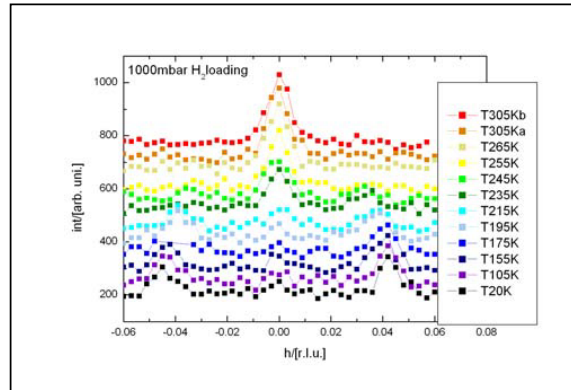


Fig.2

Neutron scattering scans taken in the L direction around the Cr(010) reflection in the H-loaded state ($p_{H_2}=100\text{mbar}$ (left) and $p_{H_2}=1000\text{mbar}$ (right)) to explore the SDW polarization. Scans recorded at different temperatures are depicted with an offset in the vertical direction for clarity. The incommensurate phase can be identified by the two satellite reflections at $L=\pm 0.04$, while the reflection at $L=0$ is indicative for the commensurate phase.

The temperature at which the incommensurate SDW state is completely suppressed, indicated by the depression of the Bragg-reflection satellites, is 10-20 K lower for the hydrogen loaded state as for the virgin state. Additionally, small volume fractions of the hydrogen loaded sample are in the commensurate phase even at low temperatures (20K). This has not been observed for the pristine sample. Obviously the presence of hydrogen in the V layers favors the commensurate SDW state within the adjacent Cr layers. The differences observed for the 100mbar loading and for the 1000 mbar loading are rather small, suggesting that saturation is already achieved at 100 mbar.

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