| ESRF | **Experiment title:** High energy non-resonant X-ray magnetic scattering from $EuAs_3$ | **Experiment number:** HE054 |
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| **Beamline:** ID15A | **Date of experiment:** from: 3. 12. 1996 to: 10. 12. 1996 | **Date of report:** January, 1997 |
| **Shifts:** *18* | **Local contact(s):** K.-D. LISS | *Received at ESRF:* 27 FEV. 1997 |


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**Report:**

Semimetallic $EuAs_3$ exhibits unusual magnetic properties not expected for a spherically symmetric S-state $Eu^{2+}$ ion. This compound orders at $T_N \approx 11$ K to an incommensurate sine-wave phase which undergoes an incommensurate-commensurate lock-in phase transition at $T_L \approx 10$ K [l]. The magnetic (H-T) and (P-T) phase diagrams are very complex containing several commensurate and helimagnetic phases **[2,3].**

We have investigated non-resonant high energy X-ray magnetic scattering from $EuAs_3$ in the antiferromagnetic phase by using an X-ray energy of 104 keV on the high energy beam line ID15A of the European synchrotron Radiation Facility. A single crystal of $EuAs_3$ of size $5x1x0.7\ mm^3$ with a mosaic spread of about 0.02" was for the present investigation. The monoclinic b-axis of the crystal was fixed parallel to the w-axis of the diffractometer. We have performed the experiment in the three-axis mode using oxygen precipitated Si( 111) monochromator and analyzer crystals with mosaic spreads of about 5 arc seconds. The use of high energy enabled us to use a conventional helium cryostat with an aluminium tail without the use of any special windows.

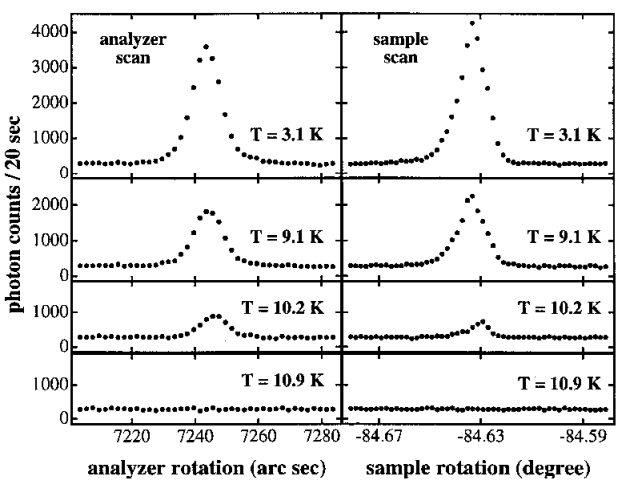


*Figure 1 – Analyzer and sample rotation scans of the 3,0,3/2 magnetic reflection at several temperatures*

Search for magnetic reflections at low temperatures readily revealed magnetic intensities in the antiferromagnetic phase corresponding to the propagation vector k = (-1,0,1/2). We obtained a signal to background ratio of about 10:1 for the magnetic Bragg peak at Q = (3,0,3/2) and a maximum count rate of about 200 counts/second at T = 3.1 K. Fig. **1** shows the analyzer and the sample rotation scans of the 3,0,3/2 magnetic reflection at

several temperatures. Fig. 2 shows the temperature dependence of the intensity of the 3,0,3/2 magnetic reflection which decreases with increasing temperature. The intensity of this reflection drops abruptly to zero at the commensurate-incommensurate lock-in phase transition temperature $T_L$ = 10.3 K We have measured the intensities of several magnetic reflections from the antiferromagnetic phase and have compared them with those calculated from the magnetic structure model derived from the neutron diffraction investigations. The observed and the calculated intensities agree well within the experimental accuracy. We have also measured the temperature variation of the relative change in the interatomic spacing Ad/d (Fig. **3)** corresponding to the -6,0,6 charge reflection which shows a thermal expansion anomaly due to the magnetoelastic effects at the magnetic phase transition. For this measurements we used perfect Si(351) monochromator and analyzer crystals. Since the angular position of the -6,0,6 reflection changes by a few arc seconds only at the phase transition we employed an interferometric method to monitor the angles and measure them [4]. The monochromator, the sample and the analyzer had coarse rotation stages for alignment and setup, and piezoelectric fine rotation stages. The readout of the actual setting was done by optical interferometers. The precision of the angular setting was about 0.1 arc second.

The present results demonstrate that the high energy non-resonant X-ray magnetic scattering is a possible complimentary technique for investigating static magnetic properties of materials. Unlike the medium energy resonance X-ray magnetic scattering, the high energy X-ray magnetic scattering probes the bulk material and the magnetic structure factors determined from this technique yield the spin moment S of the magnetic ions. So this technique, when combined with neutron diffraction which measures the total 2S+L moment, can yield individual values of S and L. We have also demonstrated that due to the superior Q resolution the magnetoelastic effects accompanying magnetic phase transitions can be conveniently investigated by this technique.

References:


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[3] T. Chattopadhyay and P.J. Brown, Phys. Rev. B 41,4358 (1990)

[4] P. Sourtti and T. Tschentscher, Rev. Sci. Instr. 66. **1798 (19950**


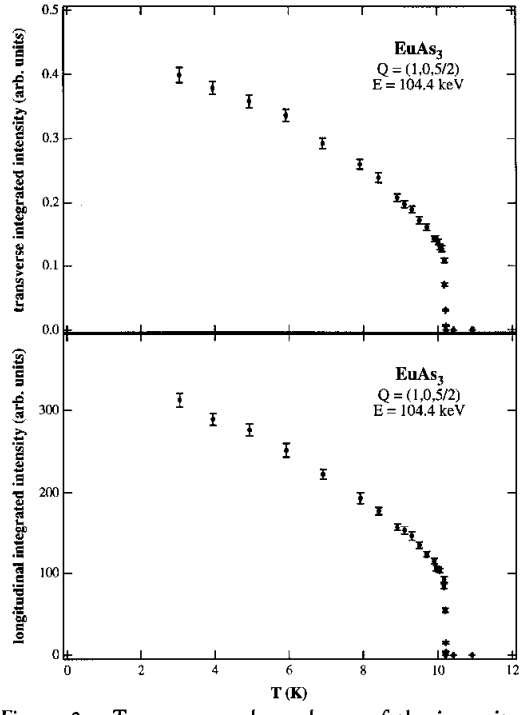


*Figure 2 – Temperature dependence of the intensity of the 3,0,3/2 magnetic reflection. The intensity of this reflection decreases continuously with increasing temperature and drops abruptly to zero at the commensurate-incommensurate lock-in phase transition $T_L$ = 10.3 K.*

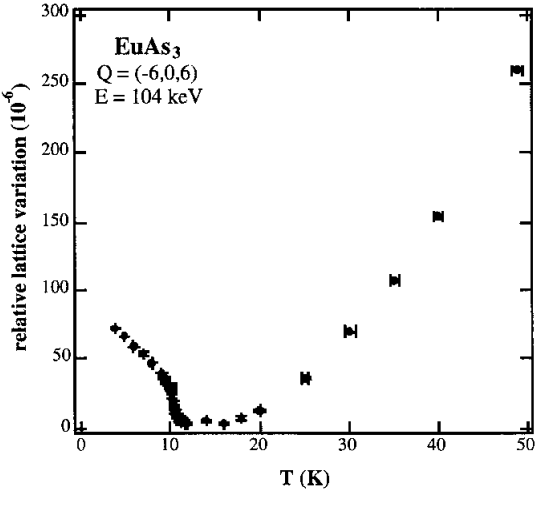


*Figure 3 – Temperature variation of the relative change in the interatomic spacing Δd/d corresponding to the -6,0,6 charge reflection which shows a thermal expansion anomaly due to the magnetoelastic effects at the magnetic phase transition.*