LOW TEMPERATURE MAGNETOSTRICTION OF HEAVY FERMION YbAgGe

G.M. Schmiedeshoff (Occidental College, Physics); S.W. Tozer (NHMFL); T.P. Murphy (NHMFL); S.T. Hannahs (NHMFL); E.C. Palm (NHMFL); S.L. Bud’ko (Iowa State, Ames Laboratory); and P.C. Canfield (Iowa State, Ames Laboratory)

Introduction

Hexagonal YbAgGe is a moderately enhanced heavy fermion compound with two antiferromagnetic phase transitions near 1.0 and 0.6 K in zero field, a Kondo temperature of about 25 K, and a crystal field splitting of 60-100 K. Earlier work suggests that the application of magnetic fields tunes YbAgGe through an anisotropic quantum critical point near 4.5 and 8.0 T for fields in the basal plane and along the c-axis respectively [1-3].

Experimental

Our sample was a single crystal of YbAgGe with dimensions of 1.88 mm along the c-axis and 1.49 mm between the hexagonal “flats” bounding the basal plane along the [120] direction. The dilation $\Delta L$ was measured along both of these axes, with the field parallel to both of these axes, in various combinations. The isothermal magnetostriction $\Delta L/L$ was measured with a titanium capacitive dilatometer [4]; the sample was affixed to the dilatometer with Duco cement. The sample and dilatometer were immersed in the mixture of a dilution refrigerator, this arrangement provides excellent thermal contact to the sample but makes temperature dependent measurements challenging because of the large thermal expansion of the liquid helium itself. The magnetic fields were generated by a superconducting magnet. The top-loading probe on which the dilatometer and sample were mounted permitted in situ rotation.

Results and Discussion

The linear magnetostriction at 30 mK with fields applied in the basal plane is shown in Fig. 1. Features associated with the rich magnetic phase diagram of YbAgGe (and difficult to see in the figure) are observed at fields in good agreement with earlier work [1-3].

Figure 1: The linear magnetostriction of YbAgGe with $\Delta L$ measured along [120] and parallel to H (red line), with $\Delta L$ measured along [120] and perpendicular to H (black line), and with $\Delta L$ measured along [001] and perpendicular to H (blue line).

We rotated the dilatometer in situ at a temperature of 50 mK and in a magnetic field of 9 T while measuring $\Delta L$ along [120]. The dilatometer was aligned in such a way that the sample rotated over 180° about its c-axis (sweeping the field about the basal plane). We observed a four-fold anisotropy of the magnetostrictive response, consistent with a magnetically isotropic basal plane. Subsequent work will focus on a thermodynamic analysis of the features in the magnetostriction and on the influence of the quantum critical point.

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References