PULSE-ECHO MEASUREMENTS OF THE FIELD DEPENDENT ELASTIC MODULI OF THE HEAVY FERMION YbAgGe

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Introduction

Magnetization, resistivity, heat capacity and Hall effect measurements showed that the heavy fermion YbAgGe exhibits a field induced quantum phase transition (QPT)[1] and offers fertile ground for quantum critical point (QCP) research.
In our previous report we presented preliminary measurements[1] of the elastic moduli as a function of temperature and magnetic field. We used the Resonant Ultrasound Spectroscopy (RUS) technique and we found that the field and temperature dependence of the elastic moduli allow us the estimate the QCP of correlated electron systems. Here we report preliminary measurements of the elastic moduli as a function of magnetic field using the pulse-echo technique.

Experimental

We performed pulse-echo measurements[2] on a single YbAgGe crystal at temperatures ranging from 4K to300mK and magnetic field up to 12T in the 15T-superconducting magnet at NHMFL-LANL. The crystal was oriented with the ab-direction parallel to the magnetic field. In brief, the sample was glued to the transducer and a short pulse of ultrasound was generated and propagated through the sample. The round trip travel time was measured. Knowing the travel and the length of the sample, the sound speed and the elastic modulus in a specific direction can be determined.

Results and Discussion

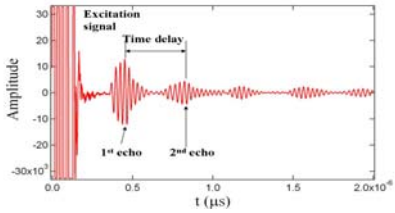

Figure 1 shows the signal measured in the Pulse-echo technique. The time delay between the 1st and 2nd echo is given by $T=T_0 + \Delta t = 2L/v + \phi/2\pi f$, where L is the length of the specimen, v the sound speed and Δt correction term[2]. The elastic modulus is related to the sound speed as follows: $c_{11}=v^2 \rho$, where ρ is the density of the material.

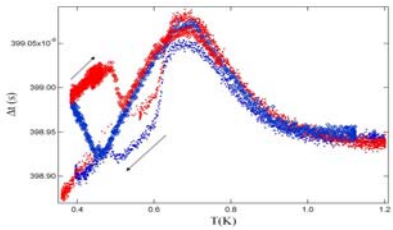

Figure 2: The time delay versus temperature and magnetic field (B=0T closed squares and B=1T open squares). Two phase transitions are observed. A second order transition at T~0.7K is present at zero magnetic field as well as at B=1T. A first order, magnetic transition, at a lower temperature is clearly seen at B=1T. The width of the hysteresis increases with the magnetic field.

Conclusions

We used the Pulse echo method to determine the elastic modulus c_{11} for YbAgGe as a function of T and B. The pulse-echo method has the advantage that allows a continuous sweep of the variables (magnetic field and temperature) and therefore a complete mapping of the T-H phase diagram is possible in a short length of time.

Acknowledgements

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References

[1] Mihut, I. et al., NHMFL Research Reports, (2005), and references therein.
[2] Pantea, C. et al., Rev. Sci. Instrum. **76**, 114902 (2006).