Ultrasonic Probe of Quantum Oscillations in GdSi

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Introduction

Rare-earth intermetallic compound GdSi possesses an incommensurate antiferromagnetic ground state. The magnetic structure is a result of a cooperative interaction between nested itinerant electronic spins and localized Gd 4*f* moments, where the nesting wave vector determines the ordering vector and the interaction of local moments provides the itinerant electrons the coupling strength for nesting. Under magnetic field, GdSi remains antiferromagnetic until above 21 Tesla (at low temperatures) when it eventually is induced into a ferromagnetic state.

We already studied the phase diagram [1] and Fermi surface of GdSi. For studying the Fermi surface we used two techniques namely the magnetoresistance and magnetization measurements. Both techniques allow to observe and analyze quantum oscillations and then to make conclusions about the topology of the Fermi surface.

Experimental Results and Discussion

In this project we used the pulse-echo ultrasound technique for studying GdSi. Measurements were performed in magnetic fields of up to 18 T in ^{3}He cryostat (SCM2) in the temperature range 0.3 – 10 K. Ultrasound wave with frequency 30 MHz propagated along b-axis of GdSi aligned parallel the magnetic field. The influence of magnetic field on attenuation and velocity of the ultrasound wave is presented in Figs. 1 and 2, respectively. A rich pattern of quantum oscillations is observed in low magnetic fields and is more pronounced on the ultrasound velocity curves. A very strong effect of magnetic field on both the attenuation and velocity is clearly seen in the fields above 16 T, i.e. when the field is approaching the transition value.

The most interesting extension of this research would be measurement of angular dependence of the quantum oscillations in ferromagnetic phase of GdSi.

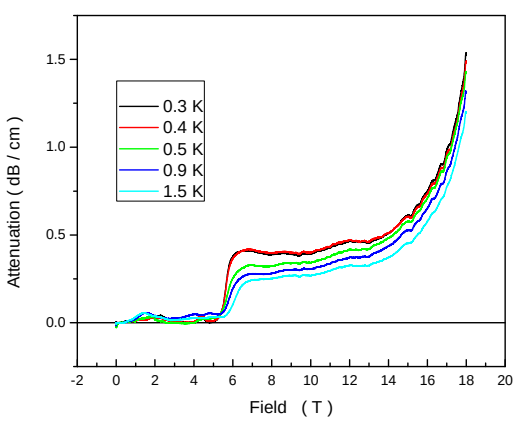

Fig.1 Magnetic field dependence of ultrasound attenuation in GdSi at various temperatures.

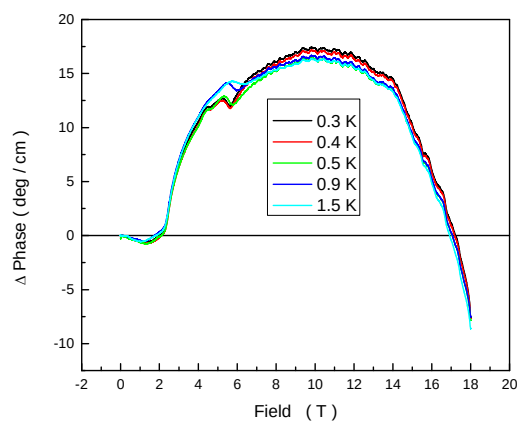

Fig. 2 Magnetic field dependence of ultrasound wave phase change in GdSi at various temperatures.

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References

[1] Feng, Y., *et al*., Phys. Rev. B, **88**, 134404 (2013).