ANGLE-DEPENDENT MAGNETOACOUSTIC PHENOMENA IN Sr_2RuO_4

A. Suslov, O. Svitelskiy, E. Palm, T. Murphy, X. Zhang, J. Crow (NHMFL); D. Shulyatev (NHMFL; Moscow Institute of Steel and Alloys, Moscow, Russia)

Introduction

Development of the pulse-echo technique at the Tallahassee DC field facility a few years ago has offered the opportunity to measure attenuation and velocity of ultrasound in solids at high magnetic fields [1]. Recent improvement of this technique allows one to investigate anisotropy of magnetoacoustic phenomena while the orientation of a sample is changing continuously respect to the magnetic field. This technique has been tested the on layered superconductor Sr_2RuO_4 in dilution and He^3 cryostats (SCM1 and SCM2 systems, respectively) at temperatures down to 45mK and in fields of up to 18 T.

Experiment and Discussion

We studied the longitudinal (c_{11}) ultrasound (f = 30-350 MHz) mode propagated in the *ab*-plane of Sr_2RuO_4. The ultrasound velocity and attenuation were measured while samples were rotated at constant magnetic field. The rotation axis was parallel to the (100) crystallographic direction and, therefore, the magnetic field always was perpendicular to the sound wavevector *q*. When the angle ϕ between the magnetic field and the *c*-axis of the crystal was small, quantum oscillations were seen on the angle dependence of the velocity (Fig. 1) and attenuation. At the angles larger than 35° (not shown) the oscillations disappeared. These measurements allowed us to choose any specific orientation of the magnetic field in the *bc*-plane of Sr_2RuO_4 with the precision of about 1^O and to do field sweeps at the selected points. Also one of our samples was studied in 33 T resistive magnet at temperatures down to 0.5 K (Fig. 2) at $\phi = 0^O$. The three frequencies of quantum oscillations F_α = 3.02 kT, F_β = 12.74kT and F_β = 18.44kT as well as the effective masses m_α = 3.2 and m_β = 5.5 extracted from the field sweep at $\phi=0^O$ are associated with the α, β, and γ sheets of the Sr_2RuO_4 Fermi surface and perfectly agree with the known values [2]. We were unable to calculate m_γ, due to small amplitude of the oscillations related to γ sheet. All three dHvA frequencies follow the $1/\cos\phi$ law (Fig. 2; inset) as expected for the cylindrical Fermi surfaces. The angular dependence of the oscillation amplitudes are associated with the shape of the Fermi surface and layered structure of Sr_2RuO_4. For instance, the disappearance of the oscillations at the large angles ϕ coincides with a strong anisotropy in the resistivity ρ_c / ρ_a = 4000 [2].

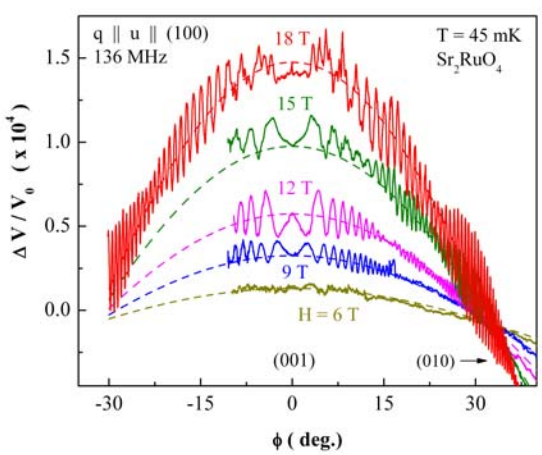

Fig.1. Angular dependence of the ultrasound velocity in Sr_2RuO_4 at different magnetic fields.

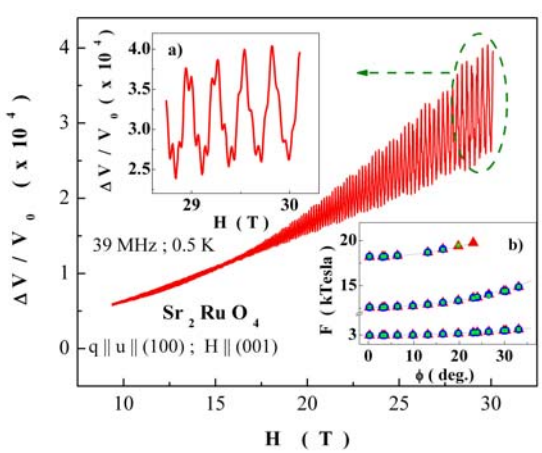

Fig. 2. Magnetic field dependence of the ultrasound velocity in Sr_2RuO_4. Insets: a) High field part of the same curve; b) Angular dependence of the acoustic dHvA frequencies.

References

[1] Feller, J., *et al.*, Phys. Rev. B, **62**, 11538-11544 (2000).
[2] Bergemann, C., *et al.*, Adv. Phys., **52**, 639-725 (2003).