CYCLOTRON RESONANCE IN THE QUASI-1D ORGANIC SUPERCONDUCTOR $(TMTSF)_2ClO_4$

Susumu Takahashi, Cem Kirman, Alexey E. Kovalev and Stephen Hill (University of Florida)

Introduction

There are several theories of unconventional superconductivity in the quasi-one-dimensional (Q1D) Bechgaard salts. To use them it is highly desirable to have detailed information about the Fermi surface (FS) of these metals. To get such information we have studied the magneto-electrodynamics of the layered molecular conductor $(TMTSF)_2ClO_4$ at millimeter-wave frequencies. The high quality data were obtained in the high-field resistive magnets using a cavity perturbation technique. We observed a clear cyclotron resonance (CR) due to electron motion along the Q1D Fermi surface in the studied compound. These phenomena were thoroughly investigated.

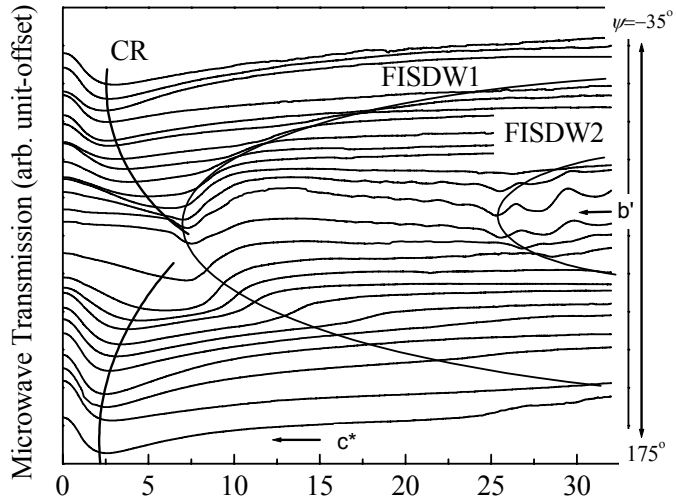

Fig. 1. Angle dependence of the microwave response of $(TMTSF)_2ClO_4$ to high fields.

Experimental

The sample was cooled slowly (< 0.1K/min between 32 K and 17 K) through the anion ordering transition at 24K to obtain the low-temperature metallic state. All data were taken at a temperature of 1.5 - 2.2 K. In order to identify crystal axes, we measured both CR and the field-induced-spin-density-wave phase (FISDW) transition at the same time (See Fig. 1). For this purpose, the experiments were carried out using the 33 T resistive magnets at the NHMFL. The angle dependent study was performed using a specially designed rotating cavity. The details of the cavity are introduced elsewhere.[1]

Results and Discussion

The resonance condition for the Q1D CR is given by,[2]

$$\frac{\nu}{B_{\|}} = \frac{e v_F R_{\|}}{h} \,|\sin(\psi - \psi_o)| \qquad (1)$$

where ν is the microwave frequency, v_F is the Fermi velocity, $B_{\|}$ is the projection of the magnetic field (**B**) onto the plane of the FS, $R_{\|}$ is the projection of the lattice vector associated with the FS corrugation onto the FS, and $(\psi - \psi_o)$ is the angle between $B_{\|}$ (along ψ) and the corrugation axis (along ψ_o); e is the electron charge, and h is the Plank constant. One can, therefore, determine v_F and the direction of the corrugation axis, ψ_o, by studying angle dependent CR. Fig. 1 shows raw experimental data obtained at several different magnetic field orientations. The data were taken by sweeping the magnetic field, whilst maintaining constant frequency, temperature, and field orientation. Clear CRs and FISDW phases are seen in each data set. Because of the angle dependence of FISDW, we identified the corrugation axis along c*. $R_{\|}$ is therefore 13Å. Further Details of these measurements are published elsewhere.[2]

Conclusions

Using this CR technique, we obtained a Fermi velocity, $v_F \sim 10^5$ m/s, for $(TMTSF)_2ClO_4$.

Acknowledgements

This work was supported by the National Science Foundation (DMR 0196461 and 0239481) and by Research Corporation.

References

[1] S. Takahashi, *et al*., to be published in Rev. Sci. Instrum.
[2] S. Takahashi, *et al*., cond-mat/0404545 (2004).