HIGH FIELD TRANSPORT STUDIES OF β'' – (BEDT-TTF)$_4$ [H_3O Ga (C_2O_4)$_3$] CH_2Cl

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We report high field transport measurements on a quasi – 2D organic conductor from the family with general chemical formula β'' – (BEDT-TTF)$_4$ [H_3O M (C_2O_4)$_3$] Y [1, 2], where M is a 3d metallic ion (which can be magnetic), and Y is a interstitial solvent in the anion layer. Many of the isostructural members of this family of organic conductors are superconductors, including some whose anions include a magnetic moment [2]. In the compound discussed here, M is non-magnetic Ga and Y is CH_2Cl_2.

The interlayer resistances of single crystals with typical dimensions 500 x 250 x 100 μm were measured using standard 4 - wire AC lockin techniques. 12.5 μm platinum wires were attached to the most conductive planes of the sample using graphite paint. The sample was placed in a probe with a 2-axis goniometer allowing the sample to be rotated to any orientation with respect to the magnetic field. The experiments were performed in a resistive Bitter magnet at the NHMFL in Tallahassee, in magnetic fields of up to 33 T and at temperatures down to 500 mK.

Figure 1 shows the magnetoresistance for a range of temperatures between 4.2 and 0.5 K, with the magnetic field directed perpendicular to the most conductive plane of the sample. At the lowest temperature studied and at low magnetic fields, two distinct quantum oscillation frequencies (of 15 T and 118 T) can be observed superimposed on a positive background magnetoresistance indicating the existence of two Fermi surface pockets. The nature of the high-frequency oscillation changes significantly above 15 T, the quantum limit for the low-frequency oscillation. It becomes rather non-sinusoidal and its frequency decreases marginally to 113 T. The effective masses were estimated using the 2D Lifshitz-Kosevich formalism. Below 15 T the effective masses are 0.22 ± 0.01 m_e and 0.34 ± 0.02 m_e for the smaller and larger Fermi surface pockets respectively. Above 15 T the effective mass of the large pocket becomes 0.71 ± 0.01 m_e; however, the strong harmonic content of the oscillation in this regime raises questions as to the validity of this mass determination.

As a function of the angle θ between the magnetic field and the normal to the conducting planes, both frequencies follow a 1/cos(θ) dependence (shown in the inset of Figure 1 for the 15 T frequency), indicating that the oscillations originate from a 2D Fermi surface. The high sample resistances and the lack of angle-dependent magnetoresistance oscillations suggest that the interlayer transport in these materials is incoherent.

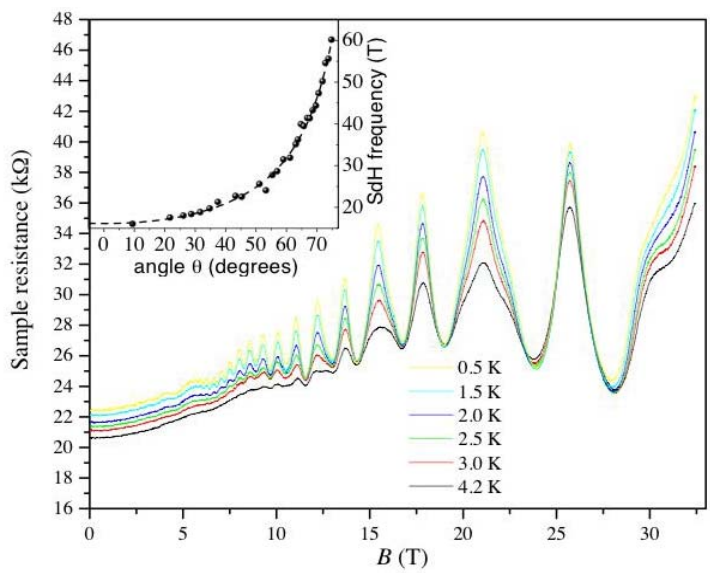

Figure 1: Magnetoresistance for temperatures between 0.5 K and 4.2 K for a magnetic field perpendicular to the conducting plane of the sample. Inset: Angle dependence of the low-frequency quantum oscillation at 0.5 K.

[1] A.I. Coldea *et al*., Phys. Rev. B 69, 085112 (2004).
[2] A.I. Coldea *et al*., submitted to Phys. Rev. B.