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Quantum Effects and Phase Transitions in the High Field Magnetoresistance of the Organic Compound (Tmt5f)₂ClO₄

J. P. Ulmet $^{\rm a}$, P. Auban $^{\rm a}$, S. Askenazy $^{\rm a}$, J. M. Fabre $^{\rm b}$ & P. Delhaes $^{\rm c}$

^a Service CNRS des Champs Magnétiques Intenses, Laboratoire de Physique des Solides, I.N.S.A., 31077, Touiouse-Cedex, France

^b Lab. Chim. Struct. Organ., 34060, Montpellier-Cedex, France

^c Centre de Recherche P. Pascal, 33405, Talence, France

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QUANTUM EFFECTS AND PHASE TRANSITIONS IN THE HIGH FIELD MAGNETORESISTANCE OF THE ORGANIC COMPOUND (TMTSF)₂ClO_b

J.P. ULMET, P. AUBAN and S. ASKENAZY Service CNRS des Champs Magnétiques Intenses, Laboratoire de Physique des Solides, I.N.S.A., 31077 Toulouse-Cedex (France)

J.M. FABRE Lab. Chim. Struct. Organ., 34060 Montpellier-Cedex (France)

P. DELHAES Centre de Recherche P. Pascal, 33405 Talence (France)

Abstract: The transverse magnetoresistance of (TMTSF)₂ClO₄ has been investigated in magnetic fields up to 32 T and temperatures down to 4.2 K, for two cooling rates and different angles between B and the crystalline axis. We observe effects due to the anion ordering and to the metal-spin density wave transition. High field Shubnikov-de-Haas oscillations appear too, giving a fundamental field of 259 ⁺ 10 T around c* axis.

INTRODUCTION

 $(TMTSF)_2CIO_4$ superconductor organic metal at very temperature [1], presents a series of phase transitions such as the anion ordering (dependent on the cooling rate) [2] and the metal to spin density wave transition which is temperature and field dependent Modifications of the electronic states induced by exhibited through transverse magnetoresistance measurements (J//a) carried out from a slowly decreasing pulsed field of 32 T. The observation of Shubnikov-de-Haas oscillations at high field is related to closed orbits on the Fermi surface.

ANION ORDERING

The sharp increasing of Δ 9/90 around 22 K is related to the disorder-order transition of the ClO_{L} anions, which leads to a new

lattice periodicity equal to (a, 2b, c). For B//c* we observe a law of the form $\Delta 9/\% \sim B^{\circ}$:

- above the transition, the same low magnetoresistance both in Q and R states with $\alpha \simeq 2$;
- below the transition, a sharply increasing magnetoresistance in R-state with $\bowtie \simeq 1$; and a weaker increasing magnetoresistance in Q-state with $\bowtie \simeq 1.5$.

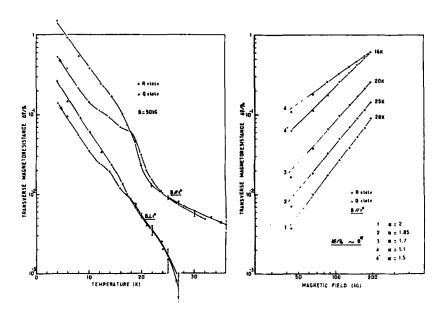


FIGURE 1 Transverse magnetoresistance versus temperature for B/c^* and $B\perp c^*$ and two cooling rates R-state (0.5 K/mn) and Q-state (25 K/mn).

FIGURE 2 Transverse magnetoresistance versus magnetic field for $B//c^*$ and T = 28, 25, 20, 16 K.

METAL TO S.D.W. TRANSITION

The Q-state is metallic down to 3.5 K independently of B. The R-state presents a field induced and temperature-dependent transition towards an insulating state, indicated by a change in the slope

of $\triangle \rho/\rho_0$. Above 6 K., the transition is not well defined and quantum oscillations of the magnetoresistance appear below the corresponding field i.e. in the metallic state contrary to what is generally admitted [4].

SHUBNIKOV-DE-HAAS OSCILLATIONS

Oscillations are directly visible on the magnetoresistance for $B>12\ T$ and temperature up to 10 K. The fundamental field B_F seems to be temperature-independent and its variation versus θ at $T=8\ K$ leads to a cosine type law:

 $1/B_F \simeq .00388 \cos (\theta - 90)^\circ$

For θ = 0°, $B_F \simeq 259 \stackrel{+}{-} 10$ T in good agreement with other results under different conditions [5, 6]. Oscillations progressively decrease in amplitude when B moves away from c* direction and disappear completely around b' direction where open orbits are expected.

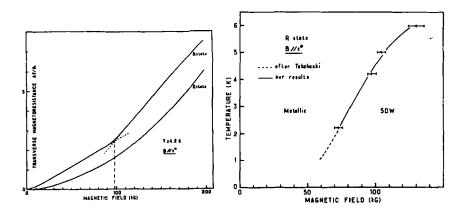


FIGURE 3 Transverse magnetoresistance versus magnetic field (B/c^*) in the two states R and Q at T = 4.2 K.

FIGURE 4 Phase diagram at low temperature.

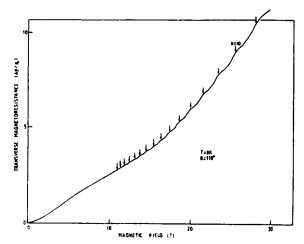
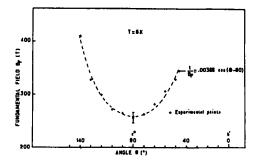


FIGURE 5 Transverse magnetoresistance exhibiting S.d.H. oscillations for T=8 K and $\theta=110^{\circ}$.

FIGURE 6 Angular dependence of the fundamental field B_F for T=8 K, θ = (B,b').



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