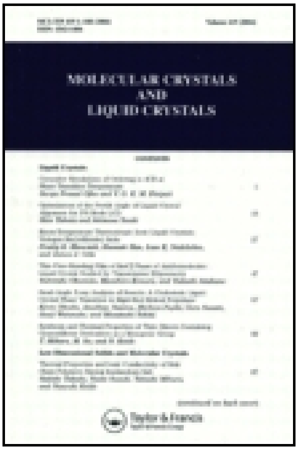

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# Quantum Effects and Phase Transitions in the High Field Magnetoresistance of the Organic Compound $(Tmt5f)_2ClO_4$

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# QUANTUM EFFECTS AND PHASE TRANSITIONS IN THE HIGH FIELD MAGNETORESISTANCE OF THE ORGANIC COMPOUND $(TMTSF)_2ClO_4$

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Abstract : The transverse magnetoresistance of $(TMTSF)_2ClO_4$ 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 $\pm$ 10 T around c* axis.

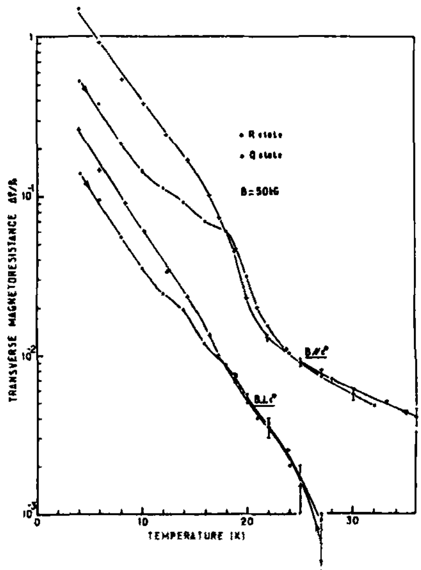
## INTRODUCTION

The organic metal $(TMTSF)_2ClO_4$, superconductor at very low 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 [3]. Modifications of the electronic states induced by these transitions are exhibited through transverse magnetoresistance measurements ($J \parallel a$) carried out from a slowly decreasing pulsed magnetic 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 $\Delta\rho/\rho_0$ around 22 K is related to the disorder-order transition of the $ClO_4$ anions, which leads to a new lattice periodicity equal to (a, 2b, c). For B// c* we observe a law of the form $\Delta \rho/\rho_0 \sim B^{\alpha}$:

- 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 $\alpha \simeq 1$ ; and a weaker increasing magnetoresistance in Q-state with $\alpha \simeq 1.5$.



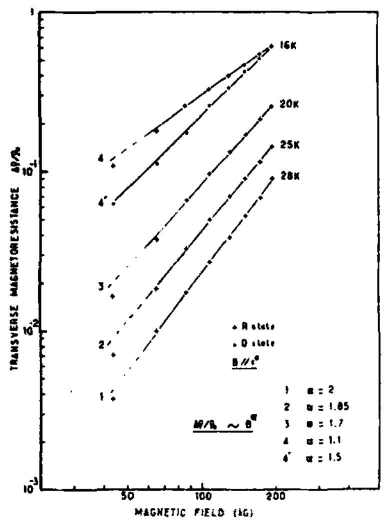




FIGURE 1 Transverse magnetoresistance versus temperature for B//c* and B⊥c* and two cooling rates R-state ( 0.5 K/mn) and Q-state ( 25 K/mn).

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

## METAL TO S.D.W. TRANSITION

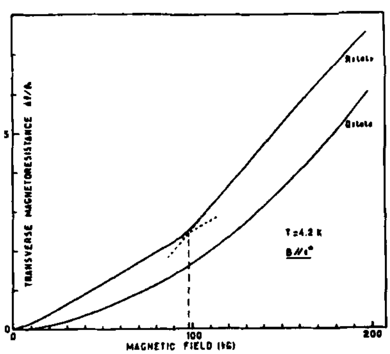
The Q-state is metallic down to 3.5 K independently of B. The R-state presents a field induced and temperature-dependent transition towards an insulating state, indicated by a change in the slope of $\Delta\rho/\rho_0$ . Above 6 K., the transition is not well defined and quantum oscillations of the magnetoresistance 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 $\theta$ at T = 8 K leads to a cosine type law :

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

For $\theta = 0°$, $B_F \simeq 259 \pm 10$ 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.



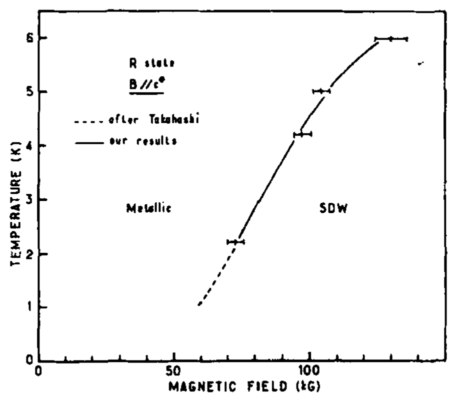




FIGURE 3 Transverse magnetoresistance versus magnetic field (B//c*) in the two states R and Q at T = 4.2 K.

FIGURE 4 Phase diagram at low temperature.

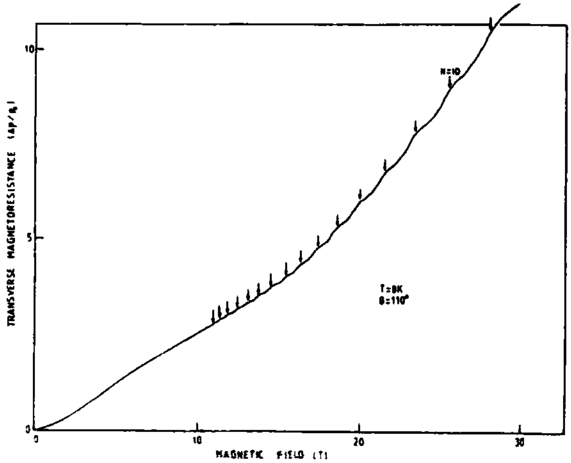


FIGURE 5 Transverse magnetoresistance exhibiting S.d.H. oscillations for T = 8 K and $\theta$ = 110°.

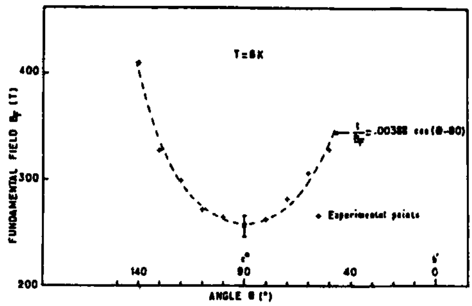


FIGURE 6 Angular dependence of the fundamental field $B_F$ for T=8 K, $\theta$ = (B,b').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