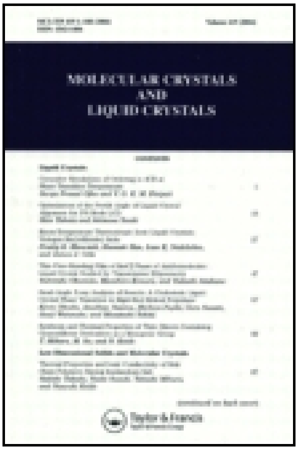

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Electronic States Below 5K in $(TMTSF)_2\ ClO_4$

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ELECTRONIC STATES BELOW 5K IN $(TMTSF)_2\ C\ell O_4$

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Abstract At 0.1 K, in the normal state, the Hall voltage is hole like, its variation versus magnetic field is linear up to 33 kOe. The measured Hall constant, $4\times10^{-9}\ m^3/As$, does not vary between 0.1 and 7 K. In a magnetic field higher than 33 kOe, at low temperature, the magneto transport properties are very dependent on the cooling rate, even when a very low concentration of defects is expected. In standard conditions (4 hours from 30 to 4.2 K) electron like quantized Hall voltage and peaks in magnetoresistance are observed above a threshold field of 41 kOe. At the lowest cooling rate (70 hours from 30 to 4.2 K) strong hole like dips appear in the Hall voltage and the threshold field is 33 kOe. These results are understood within a model associating spin density wave phases and fully occupied Landau levels.

INTRODUCTION

In theses proceedings I develop only the new results specialy prepared for this conference. In the first part, I give an extended abstract of the corresponding part of my communication and I advise you to go to references 1 and 2 to have the results discussed, interpreted and compared with other authors' results; in the second part, I show effects of cooling rate that clearly establish the connection between Hall voltage behaviour and spin density wave phases.

HALL VOLTAGE IN THE STANDARD SLOWLY COOLED STATE

We have studied extensively the Hall voltage in samples cooled in 4 hours from 30 to 4.2 K. Between 7 and 0.1 K, once the superconducting state is destroyed, the relation between Hall voltage and magnetic field is, at first, linear. The sign of the Hall voltage corresponds to holes; the measured Hall constant is 4×10^{-9} m^3/As whereas the calculated value is 3.4×10^{-9} m^3/As[1] . At a threshold field depending on the temperature, the Hall voltage changes sign and its absolute value increases sharply. At 0.1 K, above 40 kOe, the Hall voltage versus magnetic field variation shows plateaus and steps as in Quantum Hall Effects; in our best quality sample the associated magnetoresistance shows sharp peaks just centered on the steps of the Hall voltage (figure 1)[2]. The magnetic field and temperature variation of the Hall voltage plateaus is interpreted as resulting from transitions between spin density wave phases; within each phase the electrical carriers are condensed in fully occupied Landau levels[2,3].

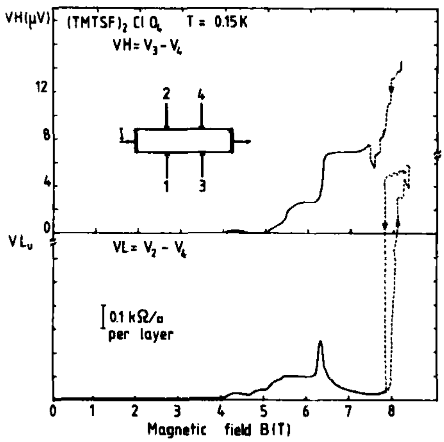

FIGURE 1 Hall voltage VH and magnetoresistance VL versus magnetic field, cooling rate 4 hours from 30 to 4.2 K.

EFFECT OF THE COOLING RATE ON THE LOW TEMPERATURE STATES

My project was to study the influence of the improvement of the anion ordering. The measurements were performed on our best quality sample (see 2) having a resistivity ratio
$(R\ (T = 300,\ H = 0)/R\ (T \to 0,\ H \to 0)) > 1600$.
After each measurement performed at a cooling rate different from our standard (4 hours) I have controlled, in our standard conditions, that the low temperature Hall voltage (VH), up to 70 kOe, remains unchanged.

After a cooling process of 70 hours from 30 to 4.2 K, at 0.1 K, the steps and plateaus pattern was modified as shown in figure 2.

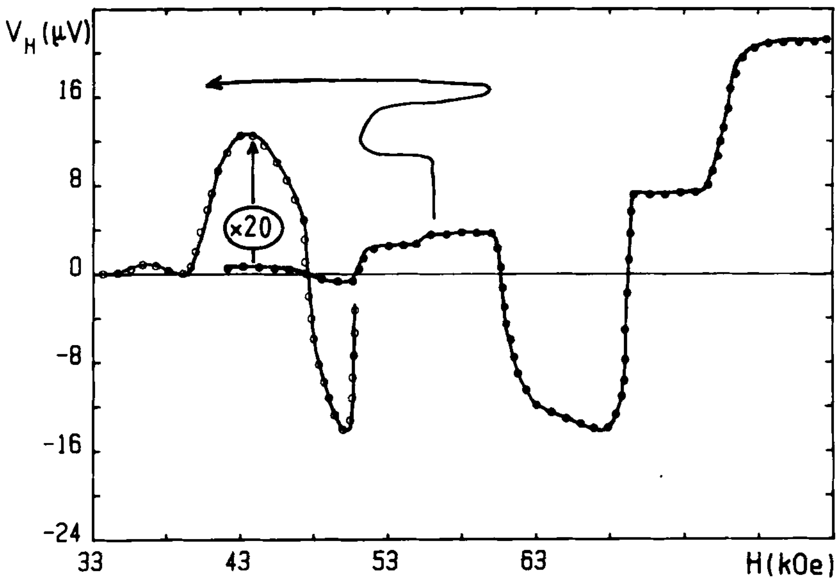

FIGURE 2 Hall voltage VH versus magnetic field at 0.1 K. H// c* 70 hours from 30 to 4.2 K.

The positive plateaus are very well defined, 4 of them are now seen between 53 and 83 kOe, but, in increasing field, the values of VH on the plateaus are like 0.36 / 0.5 / 1 / 2.9. These numbers do not correspond to inverses of successive integers and so, the results cannot be related to standard Quantum Hall Effect (QHE)[2]. Furthermore strong negative dips appear that cannot be understood within QHE. I must draw your attention to the periodicity (one dip, two plateaus) that corresponds to the theory developped by Heritier et al.[3]. The temperature variation of these dips up to 1.5 K [4] is an indication that they are due to a different condensation of the Fermi surface[5]. The first departure from low field behaviour appears at 33 kOe against 41 kOe in standard cooling conditions; a new boundary line has to be drawn in the phase diagram given in ref.1. Strong hysteresis was observed on the highest step (step beginning at 74 kOe, in increasing field, for CR = 70 hours), very much smaller on the others.

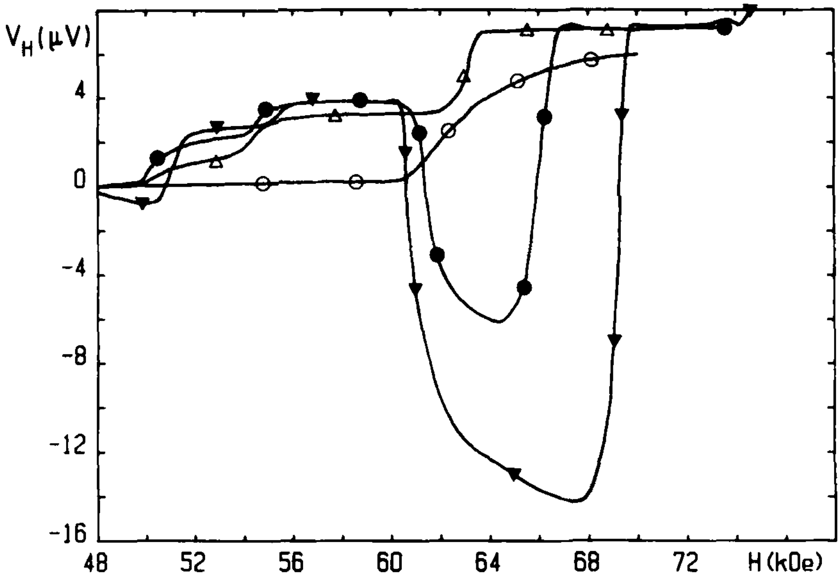

FIGURE 3 Hall voltage versus magnetic field at 0.1 K for various cooling rate from 30 to 4.2 K.
○, △, ●, ▼ respectively 5', 4 h, 10 h, 70 h. H// c^*.

In figure 3 is shown the variation of the Hall voltage versus magnetic field when the cooling rate (CR) is varied from 5' to 70 hours (h). Two main features are seen i) the amplitude of VH on the plateaus varies strongly with CR ii) the very strong dips, with change in sign, are observed only at the lowest CR. VH saturates when CR reaches 4 h and 10 h respectively on the highest and intermediate plateau, whereas the saturation value is not obtained before CR = 70 h on the lowest one. The negative dips in VH are more sensitive to CR than the positive plateaus, this can explain why they have not been observed previously. A small concentration of defects in anion ordering pins the corresponding spin density distortion.

The sensitivity to defects that can only smooth out details of the Fermi surface, is the best proof that spin density wave phases and quantization of the electronic states are associated.

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