Simultaneous ^{77}Se NMR and Electrical Transport Investigation of the Field-Induced Spin Density Wave Phases in the Organic Conductor $(TMTSF)_2ClO_4$

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Introduction

The spin density wave ground state is one of the broken symmetries of low-dimensional metals characterized by a periodic modulation of electronic spins. The quasi-one-dimensional organic conductor $(TMTSF)_2ClO_4$ exhibits a series of field-induced spin density wave (FISDW) phases with the application of magnetic field perpendicular to the a-b plane of the crystal [1]. Since these phase transitions are magnetic and orbital, angular-dependent NMR, correlated with electrical transport data, can give us microscopic insights in this spin system.

Experimental

A single crystal of $(TMTSF)_2ClO_4$, with four-probe gold wire contacts, placed inside a miniature NMR coil was rotated along its most conducting axis at a constant temperature of 1.5K and at a fixed magnetic field of 30 T at the NHMFL magnet cell 7. Corresponding magnetoresistance from 0 to 30 T at different angles were also taken to correlate with the NMR data.

Results and Discussion

The spin dynamics of the different subphases of the field-induced spin density wave (FISDW) ground state in $(TMTSF)_2ClO_4$ was investigated using simultaneous ^{77}Se nuclear magnetic resonance (NMR) and electrical resistivity. In Fig. 1, the metallic and FISDW phases were accessed by rotating the sample along its most conducting axis in a constant magnetic field H and constant temperature. At fixed field of 30 T and constant temperature 1.47K, we report observation of divergence in the spin-lattice relaxation rate $1/T_1$ at angles corresponding to Hperp=Hcosθ~ 6.4T, 15.9T, and 26T FISDW phase transitions. There is a gradual increase in $1/T_1$ in the 2nd-order/FISDW cascade region and a nearly metallic-like behavior deep in the final\reentrant SDW phase is observed [2].

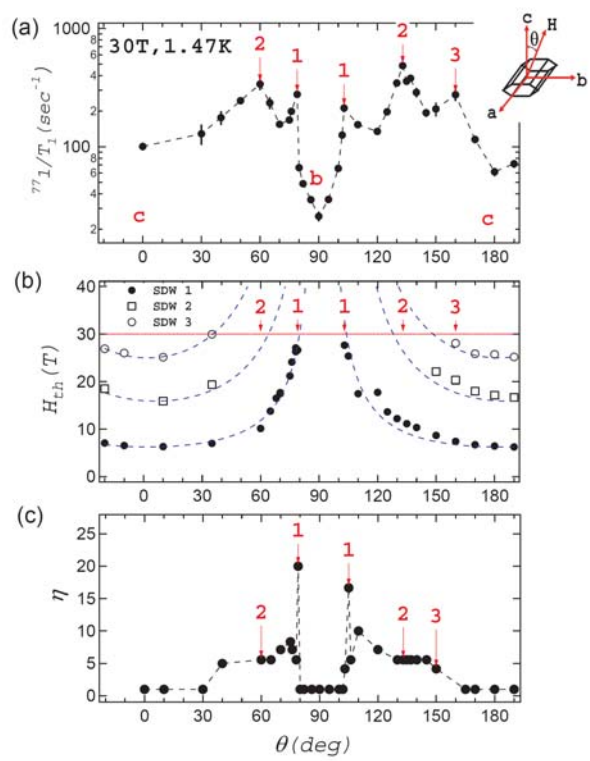

Fig. 1 Simultaneous NMR and electrical transport at 30 T and 1.5 K showing the angular dependencies of the (a) ^{77}Se spin-lattice relaxation rate $1/T_1$, (b) threshold fields, and (c) rf enhancement. The marked arrows 1, 2, 3 correspond to the sharp peaks seen in $^{77}1/T_1$.

Conclusions

We provided microscopic evidence for the phase boundaries in the different FISDW phases of $(TMTSF)_2ClO_4$. There is an intermediate transition at ~15T that is not shown in the current phase diagram of this material.

Acknowledgements

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References

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[2] Lumata, L.L. et. al submitted to PRL (2007)