

GHZ-FREQUENCY MEASUREMENTS OF THE MAGNETOCONDUCTIVITY OF THE CHARGE DENSITY WAVE SYSTEM $\text{Per}_2\text{Pt}(\text{mnt})_2$

R.D. McDonald, N. Harrison, J. Singleton (NHMFL-LANL); A. Ramirez, X. Chi (Bell Laboratories, Lucent Technologies)

The purpose of this experiment was to examine the GHz-frequency conductivity of the Charge Density Wave (CDW) system $\text{Per}_2\text{Pt}(\text{mnt})_2$ in high magnetic field. In principle the high magnetic field response of this material at GHz frequencies should contain contributions from the change in sample conductivity as the CDW gap closes at the Pauli paramagnetic limit and an Electron Paramagnetic Resonance (EPR) signature of the localized Pt spins. The goal of this experiment was to separate the spin-Peierls and CDW contributions to the gap formation.

Low dimensional metals are susceptible to a Peierls distortion at low temperature. This can manifest itself in a variety of forms, for example the spin and charge density wave ground states of one dimensional systems [1]. $\text{Per}_2\text{Pt}(\text{mnt})_2$ is a highly one dimensional organic conductor, with a charge density wave ground state [2]. The energetic stability of the density wave ground state arises from a lattice distortion that induces a gap in electronic dispersion relation at the Fermi energy, thus reducing electronic free energy. Removing states from the Fermi energy results in a significant change in the material's low frequency conductivity. In the extreme case, such as $\text{Per}_2\text{Pt}(\text{mnt})_2$, where all the states at the Fermi energy are removed, the occurrence of the density wave state is accompanied by a metal to insulator transition. CDW formation in $\text{Per}_2\text{Pt}(\text{mnt})_2$ is accompanied by simultaneous dimerization of the Pt spin chains.

The GHz-frequency measurements were performed using a non-metallic resonator to facilitate measurement in pulsed fields of up to 50 T. Figure 1a is a photograph of a $\text{Per}_2\text{Pt}(\text{mnt})_2$ sample loaded into the resonator such that the applied magnetic field is perpendicular to the crystallographic a-direction and the oscillating magnetic field induces currents with components parallel to the a-direction.

In sufficiently high magnetic fields the Zeeman splitting of the electronic energy bands exceeds the magnitude of the density wave gap [2]. In $\text{Per}_2\text{Pt}(\text{mnt})_2$ the gap initially closes at a magnetic field of around 20 T, opening again at a field of around 30 T [2]. At these fields the resistivity is observed to change by several orders of magnitude (see the inset of Figure 1b). Figure 1b shows the magnetic field induced change in conductivity of $\text{Per}_2\text{Pt}(\text{mnt})_2$ measured at GHz-frequencies. The increase in sample conductivity manifests itself as a reduction in transmission through the resonator because the coupling to the microwave resonator is optimized at zero field and at a temperature of 2.8 K the measurement frequency, 58 GHz, is smaller than the gap. The field dependence of the transmission thus mirrors that of the DC resistivity, (compare Figure 1b and its inset). As yet the preliminary results of this investigation show no conclusive signs of high field EPR.

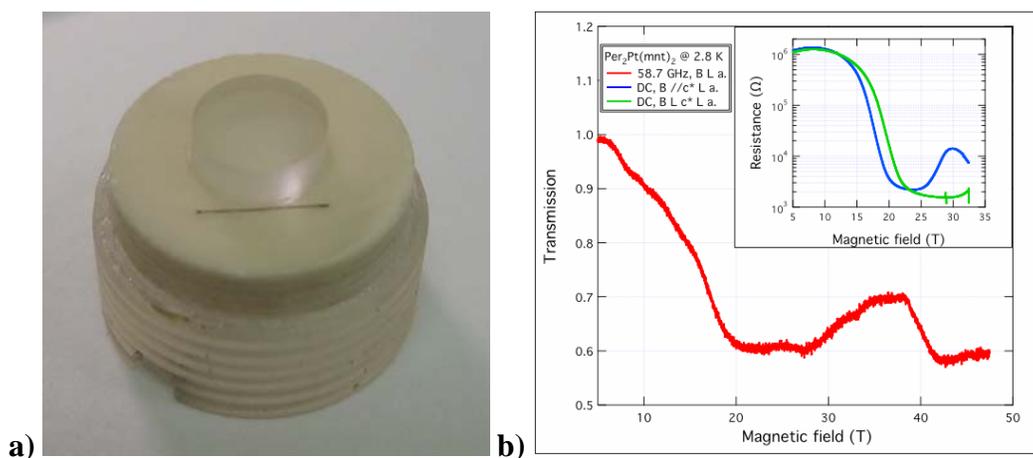


Figure 1a) A $\text{Per}_2\text{Pt}(\text{mnt})_2$ sample loaded into the non-metallic resonator. **b)** The GHz frequency magneto-conductivity of $\text{Per}_2\text{Pt}(\text{mnt})_2$ measured at a temperature of 2.8 K and a frequency of 58.7 GHz with the magnetic field applied in the ac plane. The inset shows the DC resistivity of the same material for comparison.

References

- [1] Gruner, G., Rev. Mod. Phys., **60**, 1129 (1988).
- [2] McDonald, R.D., *et al.*, Phys. Rev. Lett., **94**, 106404 (2005).