MULTI-FUNCTIONAL MOLECULAR MATERIALS COMBINING CHIRALITY AND MAGNETISM

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Introduction, Experiment and Results

In a continuing search for multifunctional crystalline organic materials, salts of TM-ET, an optically-active (chiral) analogue of BEDT-TTF, have been synthesized. The resulting crystals are being studied in DC fields at NHMFL Tallahassee, and in superconducting and pulsed magnets at NHMFL LANL. Of particular note thus far are the chiral (ferro)magnetic salts (TM-ET)$_x$[MnIII(ox)$_2$](CH$_2$Cl)$_2$, which show weak Shubnikov-de Haas oscillations in fields above 15 T (Figure 1). At first sight this is a surprising observation in systems that possess bulk resistivities characteristic of insulators at low temperatures. However, this probably indicates an intrinsic metal/insulator phase coexistence similar to that observed in some β” (BEDT-TTF) salts [1,2] and suspected in κ-phase BEDT-TTF superconductors [2]. The Shubnikov-de Haas oscillations have frequencies in the range 200-300 T (depending on the salt- see Figure 1); in addition, a lower frequency ~40 T may be present. These observations suggest that the Fermi surface of the metallic phase only occupies a small fraction of the Brillouin zone. On the assumption that the magnetoresistance is dominated by the metallic phase, its angle dependence suggests that the metallic layers are decoupled from one another, i.e. that the interlayer transport is incoherent. This may be the reason for the lack of evidence for magneto-chiral anisotropy in the resistivity of these salts. Further studies continue.

Figure 1. Left: typical interlayer magnetoresistance data. Right: the same data with the slowly-varying background subtracted, showing Shubnikov-de Haas oscillations. In this particular salt, the oscillations exhibit a frequency of 215 T (far right).

References