Magnetization of an Unusual Cu(II) Chain Consisting of Alternating Dimers and Trimers

J.L. Manson (Eastern Washington U., Chemistry); J. Singleton (NHMFL-PFF); P.A. Goddard (U. of Warwick, Physics)

Introduction

$[Cu_5(2\text{-}pyO_2)_8(pyz)(H_2O)_2](ClO_4)_2$ features a novel spin-1/2 Cu(II) polymeric chain. $[Cu(2\text{-}pyO_2)_2]$ units are linked through Cu-O bridges to form trimer stacks that are further connected to $[Cu_2(2\text{-}pyO_2)_2(pyz)(H_2O)_2]$ dimers to form a chain. Perchlorate anions occupy interstitial sites. Pyrazine bridges between Cu(II) sites are known to produce antiferromagnetic interactions (J_{AFM}) whereas the intratrimer magnetic couplings are likely to be ferromagnetic (J_F). A third possible exchange interaction is also mediated between dimers and trimers. Competing magnetic interactions of opposing sign can lead to frustrated interactions and exotic field-induced phase transitions. To elucidate these possibilities further, we have conducted magnetization measurements on crushed polycrystalline samples of $[Cu_5(2\text{-}pyO_2)_8(pyz)(H_2O)_2](ClO_4)_2$ down to 0.5 K.

Experimental

Magnetization studies were provided by a 60 T short-pulse magnet located at the Pulsed Field Facility, National High Magnetic Field Laboratory, Los Alamos, NM. The susceptometer was placed within a ^{3}He cryostat providing temperatures down to as low as 0.5 K. The field *B* was measured by integrating the voltage induced in a ten-turn coil calibrated by observing the de Haas–van Alphen oscillations of the belly orbits of the copper coils of the susceptometer.

Results and Discussion

Magnetization (*M*) data (**Figure 1**) reveal intriguing behavior although a clear explanation is not yet available. At the lowest T's, M rises nearly linearly until about 4.3 T where a sharp field-induced phase transition occurs. A second kink follows at 14.6 T which is due to saturation magnetization. As the temperature is warmed, the sharp features disappear and become overtaken by broadened behavior presumably due to spin fluctuations. This is supported by the gradual increase in hysteresis over a broad field range.

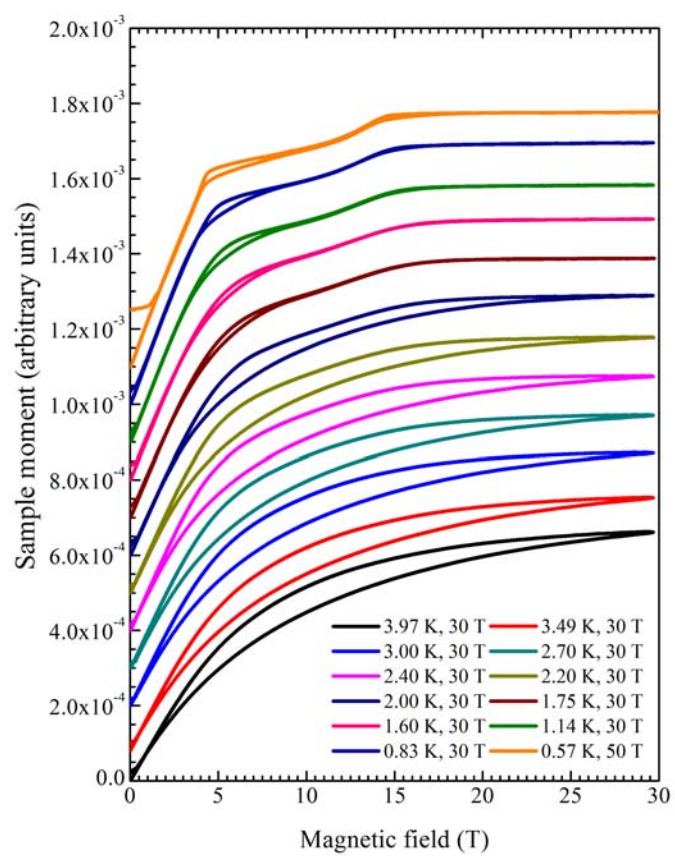

Figure 1. Multi-temperature magnetization data for powdered $[Cu_5(2\text{-}pyO_2)_8(pyz)(H_2O)_2](ClO_4)_2$. Data are vertically offset for clarity.

Conclusions

Complimentary measurements on aligned single crystals will help us understand the nature of the observed field-induced phase transitions. Work is continuing along these lines as well detailed magnetic susceptibility and ESR measurements.

Acknowledgements

Work at EWU was supported by the NSF under Grant No. DMR-1005825 and work at the NHMFL was performed under the auspices of the NSF, the DoE project "Science in 100T," and the State of Florida.

References

[1] J.L. Manson, *et al*., unpublished results.