High-field Magnetization of the *S* = 1/2 Spiral Chain $[Cu(pym)(H_2O)_4]SiF_6$ Up to 85 T

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

Introduction

Recently, $[Cu(pym)(H_2O)_4]SiF_6$ (pym = $N_2C_4H_4$) was synthesized and its crystal structure determined to consist of spiral 1D chains made up of CuO_4N_2 octahedra that are linked by bridging pym ligands [1]. The SiF_6^{2-} anions are situated between the chains which ensure large interchain separations. In spite of the large J_{1D}–value of 42.2 K mediated along the Cu-pym-Cu chains as evidenced by magnetic susceptibility data, μSR measurements did not detect any signature of zero-field long-range magnetic order (LRO) down to 20 mK thus suggesting the ideality of this 1D structural motif. The unique crystal structure provides a playground to further investigate field-induced phenomenon in low-dimensional spin systems as well as those systems composed of spiral magnetic chains. Although the application of a magnetic field can induce unusual phenomena, such as a Luttinger-Liquid (LL) phase [2], appropriate model compounds are still needed to evaluate the thermodynamical behavior and $[Cu(pym)(H_2O)_4]SiF_6$ may be an excellent example.

Experimental

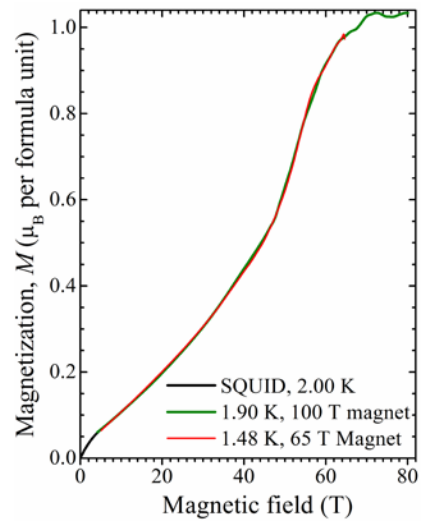
Initial studies were provided by a 65 T short-pulse magnet and fields up to 85 T were obtained using the 100 T multi-shot magnet located at the Pulsed Field Facility, National High Magnetic Field Laboratory, Los Alamos, NM. The susceptometer was placed within a ^{3}He cryostat providing temperatures 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 measurements (***figure***) conducted on a polycrystalline sample of the title complex revealed a B_c of 63.5 T. These data, combined with the J_{1D} determined from the magnetic susceptibility, were used to derive the interchain coupling (J_{pyz}). Using an exchange-only mean-field model for S = 1/2, namely $B_c = k_B(2J_{1D} + 4J_\perp)/g\mu_B$, we obtain $J_\perp$ = 0.4 K which agrees with density-functional theoretical (DFT) calculations. The strong concavity in *M(B)* is also consistent with a predominant 1D magnetic character in this material.

Conclusions

Pulsed-field magnetization data were useful to conclusively establish the saturation field since it is very close to the upper field limit of the 65 T short-pulse magnets. From knowledge of Bc we were able to determine the relative strength of the interchain coupling which further confirm the ideal magnetic-chain nature of the title compound. Future plans entail synthesis and investigation of Zn(II)-doped derivatives to assess the overall effect on the crystal structure and magnetism of the chain for comparison to the pristine undoped sample.



Pulsed-field magnetization data for a polycrystalline sample of 1D $[Cu(pym)(H_2O)_4]SiF_6$.

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*., manuscript in preparation.
[2] Ch. Rüegg, *et al*., *Phys. Rev. Lett*. **2008**, *101*, 247202.