High Field Magnetization of Atacamite $Cu_2Cl(OH)_3$

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Introduction

Band structure calculations [1] suggested that the natural mineral atacamite $Cu_2Cl(OH)_3$ may be the first material representing a seminal model in low-dimensional frustrated magnetism, the S=1/2 sawtooth or delta chain. The model as defined by the Hamiltonian

$$H = \sum_i J_1 \cdot S_i \cdot S_{i+2} + J_2 \cdot (S_i \cdot S_{i+1} + S_{i+1} \cdot S_{i+2}) + h \cdot S_i^z$$

describes a chain of triangles which are magnetically coupled along the chain by J_1, with the triangular coupling J_2 in a magnetic field h (for atacamite: $J_1 \sim 100K$ and $J_2 \sim 30K$). With such couplings, a distinct feature of the sawtooth model, a magnetization plateau at half saturation magnetization [2], might appear. To test this notion, and under consideration of a high field anomaly in the magnetostriction (Fig. 1a) we have carried out pulsed field magnetization measurements for fields aligned along the crystallographic *b* axis (chain direction).

Experimental

Pulsed field experiments on atacamite $Cu_2Cl(OH)_3$ have been carried out using the 65Tesla Multi-Shot magnet for the field B aligned along the crystallographic *b* axis at temperatures down to 0.65.

Results and Discussion

In Fig. 1b we plot the result of the high field magnetization of atacamite $Cu_2Cl(OH)_3$. As predicted, we observe a wide magnetization plateau at half saturation magnetization ($M_{sat} \sim 1\mu_B$). The plateau coincides with the feature previously observed in the magnetostriction (Fig. 1a). From the data we construct the magnetic phase diagram displayed in Fig. 2, including here the antiferromagnetically ordered low-field phase and the field of magnetic saturation at about 80T.

Conclusions

Our study demonstrates that atacamite $Cu_2Cl(OH)_3$ may be considered as the first material matching the S=1/2 sawtooth chain model

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida.

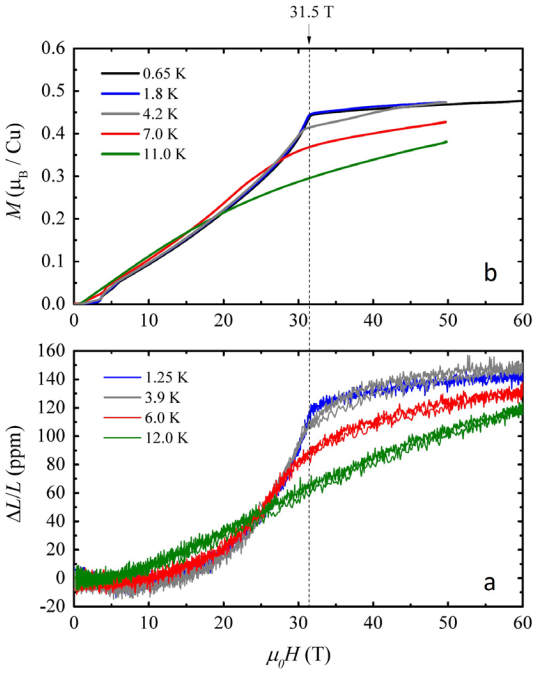

Fig.1 High field magnetostriction (a) and magnetization data for B||*b* axis of atacamite $Cu_2Cl(OH)_3$.

References

[1] Jeschke, H., and Valentí, R., private commun. (2016).
[2] Richter, J., et al., J. Phys.: Cond. Matt. **16**, S779 (2004).

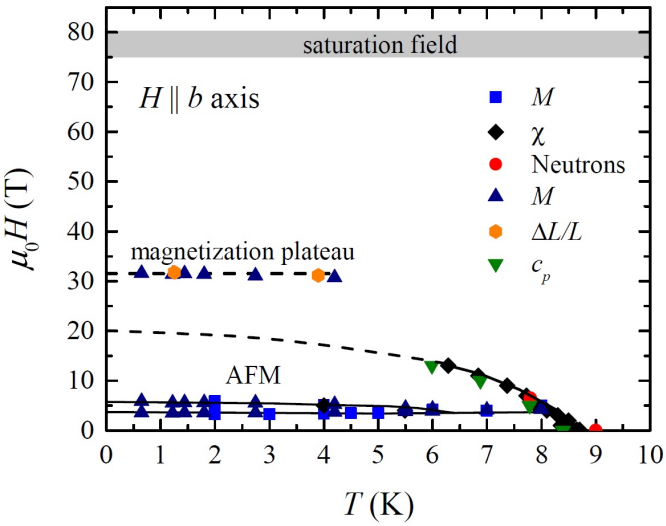

Fig.2 Phase diagram for B||*b* axis of atacamite $Cu_2Cl(OH)_3$.