Transversal Magnetostriction To 60 Tesla In Frustrated Magnet $Srcu_2(BO_3)_2$

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Introduction

Strong geometrical frustration in magnets leads to exotic states such as spin liquids, spin supersolids, and complex magnetic textures. $SrCu_2(BO_3)_2$, a spin-1⁄2 Heisenberg antiferromagnet in the archetypical Shastry–Sutherland lattice, exhibits a rich spectrum of magnetization plateaus and stripe-like magnetic textures in applied fields. The structure of these plateaus is still highly controversial due to the intrinsic complexity associated with frustration and competing length scales. We recently discovered magnetic textures in $SrCu_2(BO_3)_2$ via *c*-axis magnetostriction and magnetocaloric measurements in fields up to 100.75 T. In addition to observing low-field fine structure with unprecedented microstrain resolution, the data also revealed lattice responses at 73.6 T and at 82 T[1]. While these previous results are quite important, they say little about the strain in the Cu-dimer planes when H//*c*-axis, where the magnetic order actually occurs.

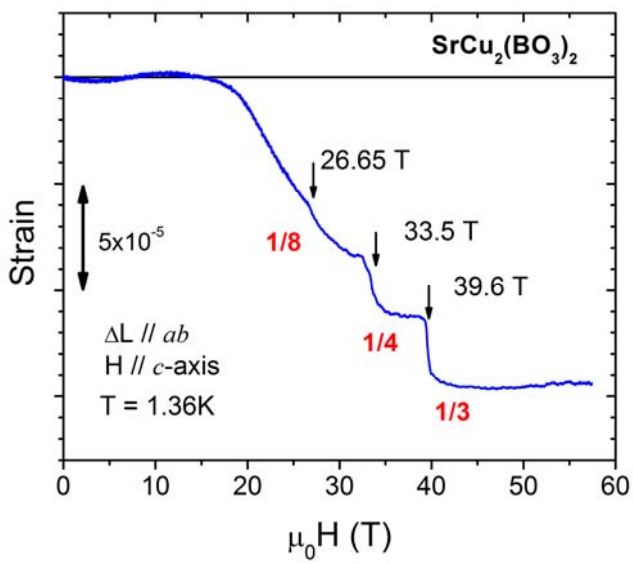

Figure 1. Strain ΔL/L vs. magnetic field in a $SrCu_2(BO_3)_2$ single crystal for ΔL||*ab*-plane while H|| c-axis measured in a 60 T motor-generator-driven long pulse magnet. The main result is the contraction of the magnetic plane upon application of a large magnetic field, as expected. Features at 26.65T, 33.5T, and 39.6 T are attributed to the 1/8, ¼ and 1/3 magnetization plateaus respectively.

Experimental

We measured for the first time the magnetostriction ΔL ⊥ H || *c*-axis of $SrCu_2(BO_3)_2$ single crystals in the NHMFL 60T motor generator-driven long pulse magnet at various temperatures between T = 1.36 K and 20K with the goal of determining the volumetric magnetostriction. We used an optical FBG technique running at 46kHz, with the 125μm optical fiber mounted parallel and perpendicular to the magnet axis.

Results

A reduction of the lattice parameter in the *ab*-plane is observed at the field-induced magnetization plateaus, as predicted by the so-called Goodenough rule that says that 90-degree angles are favored in Cu-O-Cu bonds when
The cu spins are aligned ferromagnetically. Numerical simulations of the lattice parameter changes with magnetic fields are under way.

Acknowledgements

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References

[1] M. Jaime et al., *Proc. Natl. Acad. Sci* **109**, 12404 (2012)