Multiple Magnetic Phases in the Frustrated Spin-dimer Compound $\text{Ba}_3\text{Mn}_2\text{O}_8$

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Introduction

$\text{Ba}_3\text{Mn}_2\text{O}_8$ is a spin-dimer compound based on vertical pairs of $S=1$ 3d$^3$Mn$^{5+}$ ions arranged on a triangular lattice. Antiferromagnetic intradimer exchange leads to a singlet ground state in zero-field, with a gap to excited triplet and quintuplet states. Our experiments at the NHMFL probe the high-field behavior of this system, revealing multiple novel magnetically ordered phases.

Experiments and Results

The phase diagram for temperatures above 0.3 K (figure 1(a) for $H\perp[001]$) has been established via heat capacity, magnetocaloric effect and magnetistriction measurements performed in resistive magnets in cells 12 and 5 respectively. Additional torque magnetometry experiments were also performed down to 25 mK in SCM-1 (Figure 1(b), also for $H\perp[001]$.) Detailed experiments probing the angle-dependence (not shown) indicate a significant anisotropy.

Discussion

The remarkable phase diagram of $\text{Ba}_3\text{Mn}_2\text{O}_8$, and its surprising anisotropy, ultimately arises as a consequence of the competition between the effects of interdimer coupling on a triangular lattice and single ion anisotropy. Details of the resulting magnetic structures are currently being established via additional experiments, but an initial analysis based on a minimal spin Hamiltonian containing all relevant interactions indicates that the ordered phases are novel modulated spiral structures, characterized by multiple order parameters.

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