Monte Carlo simulation on magnetization plateau induced by magnetic field

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Triangular antiferromagnetic system: \( \text{Ca}_3\text{Co}_2\text{O}_6 \)

**Experiment**

Structure character: parallel magnetic chains align along the hexagonal c axis, forming a two-dimensional triangular lattice in the ab plane. The intrachain coupling along c axis is ferromagnetic and the interchain coupling is antiferromagnetic and much weaker.

The steplike magnetization \( M \) plotted against magnetic field \( H \) at low temperature \( T \). As \( T \) falls down into between 10K and 25K, \( M \) presents an \( M_{\text{sat}}/3 \) plateau where \( M_{\text{sat}} \) is the saturated \( M \). As \( T < 10 \text{ K} \), the \( M_{\text{sat}}/3 \) plateau decomposes into three nonzero and equidistant substeps.

**Simulation**

Our simulation results show the different steplike behaviors in different temperature ranges, consistent with experimental observations. The \( M_{\text{sat}}/3 \) plateau at about 10K corresponds to a homogeneous ferrimagnetic ordering. The multiple steps below 10K originate from the inhomogeneous metastable states.

Monoclinic system: \( \text{CoV}_2\text{O}_6 \)

**Experiment**

The monoclinic \( \text{CoV}_2\text{O}_6 \) also shows an \( M_{\text{sat}}/3 \) plateau, but the critical magnetic field for the second jump is about 2 times as large as that for the first one.

**Simulation**

The distorted antiferromagnetic triangular model with anisotropic exchange interactions can well reproduce this stepwise behavior. The \( M_{\text{sat}}/3 \) plateau originates from the same ferrimagnetic state observed in the regular triangular system, but the critical fields show different features due to the frustration relaxed by anisotropy.