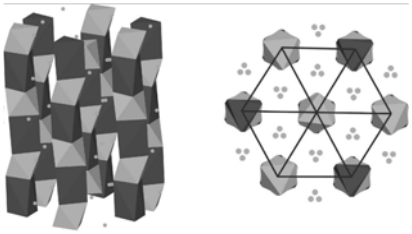
Monte Carlo simulation on magnetization plateau induced by magnetic field

Xiaoyan Yao

Department of Physics, Southeast University, Nanjing, China

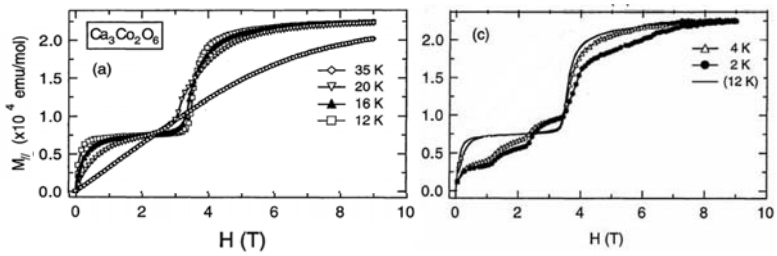
■ Triangular antiferromagnetic system: $Ca_3Co_2O_6$

Experiment



Taken from V. Hardy et al. (2003)

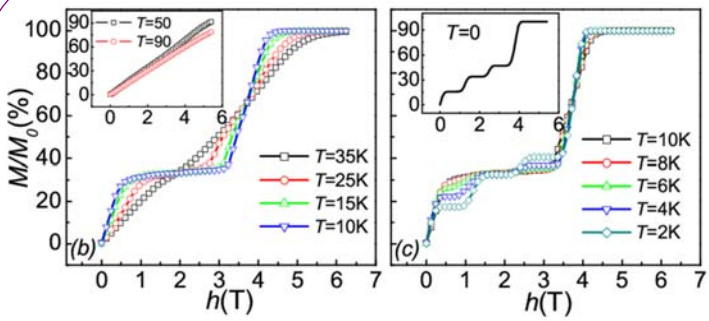
Structure character: parallel magnetic chains align along the hexagonal *c* axis, forming a two-dimensional triangular lattice in the *ab* plane. The intrachain coupling along c axis is ferromagnetic and the interchain coupling is antiferromagnetic and much weaker.



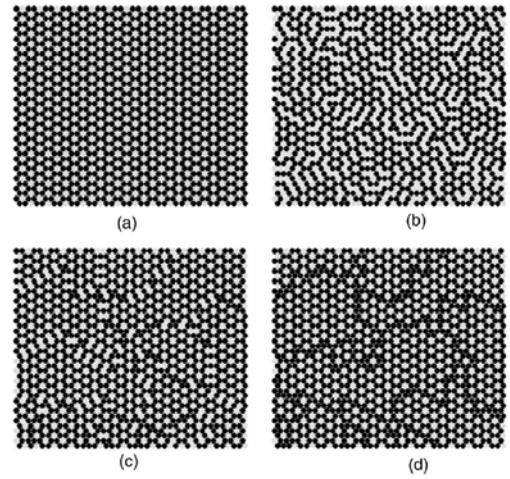
Taken from H. Kageyama et al. (1997)

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_{sat}/3 plateau where M_{sat} is the saturated *M*. As *T*<10 K, the M_{sat}/3 plateau decomposes into three nonzero and equidistant substeps.

Simulation



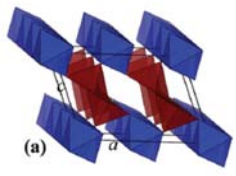
Our simulation results show the different steplike behaviors in different temperature ranges, consistent with experimental observations. The M_{sat}/3 plateau at about 10K corresponds to a homogeneous ferrimagnetic ordering. The multiple steps below 10K originate from the inhomogeneous metastable states.



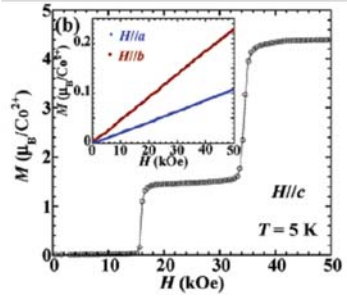
Partial spin snapshots of the triangular lattice for (a) on the M_{sat}/3 plateau at *T*=10 K. (b-d) on the three substeps at 2K.

■ Monoclinic system: CoV_2O_6

Experiment

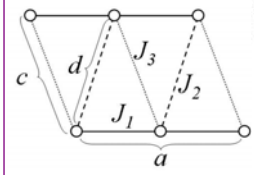


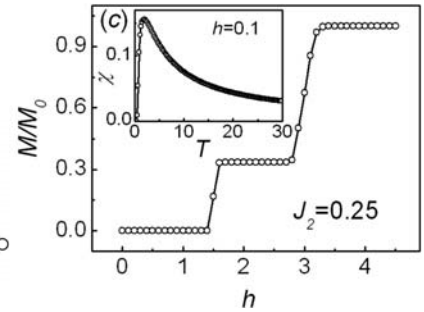
Taken from JACS 131, 7554 (2009)



The monoclinic CoV_2O_6 also shows an M_{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_{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.