

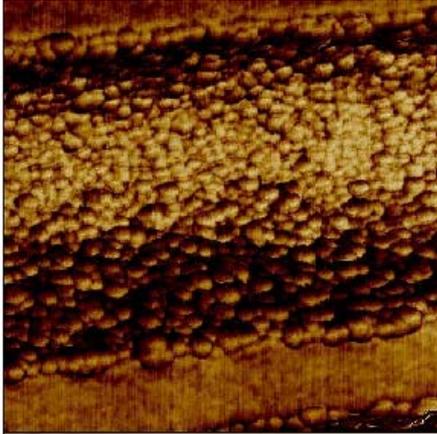
# Structure and Dynamics of Magnetic Nanoparticle Assemblies

Meigan Aronson, Sue Inderhees, Omar Yaghi, Jinsang Kim, Nick Kotov, and Glenn Strycker  
University of Michigan, Ann Arbor

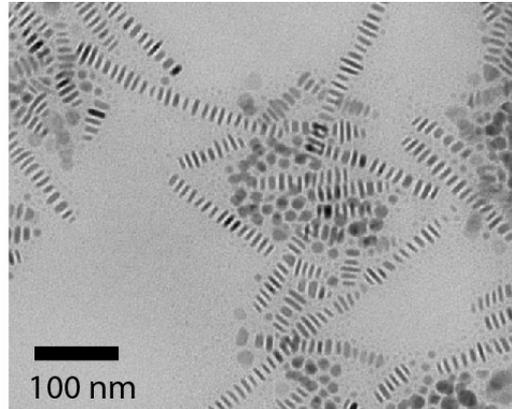
Y. Yin and A. P. Alivisatos  
Molecular Foundry, Berkeley

J. Borchers, Y. Qiu, B. Hammouda, and J. W. Lynn  
NCNR/NIST

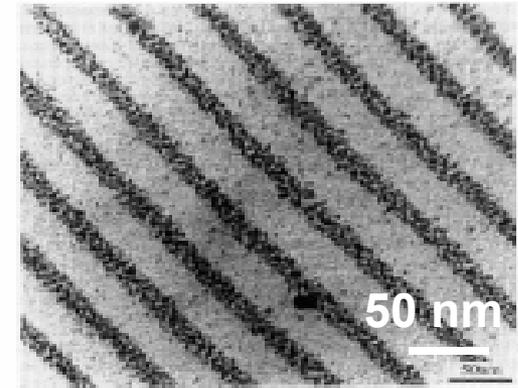
# Spatial Confinement of Magnetic Nanoparticles



8 nm Co nanoparticles  
in cylindrical  $\text{Al}_2\text{O}_3$   
pores



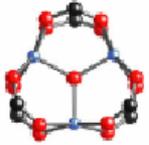
Self-assembly of  
Co nanodiscs



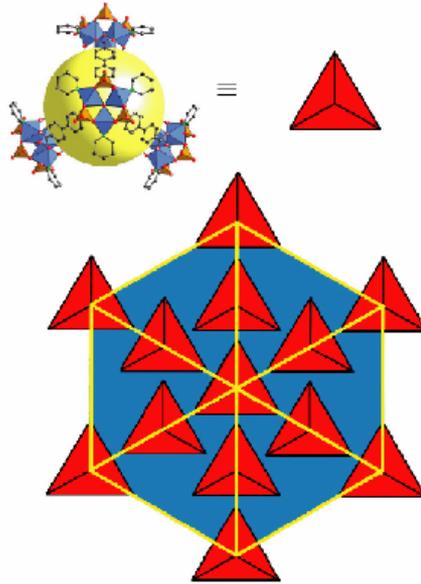
Polymer-templated assembly  
of 5 nm Co nanospheres

- Are the dynamics of the individual nanoparticles modified by spatial confinement?

# Model Magnetic Systems



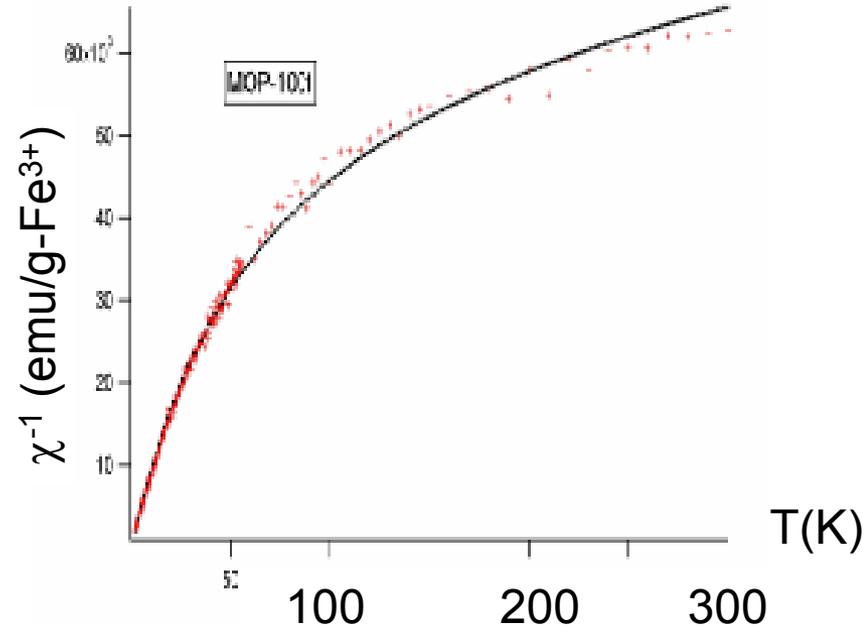
trimer building  
block ( $\text{Fe}^{3+}$ )



Intermediate assemblies



Extended solids



$$\chi(T) = (C_1/T + \theta_1) + (C_2/T + \theta_2)$$

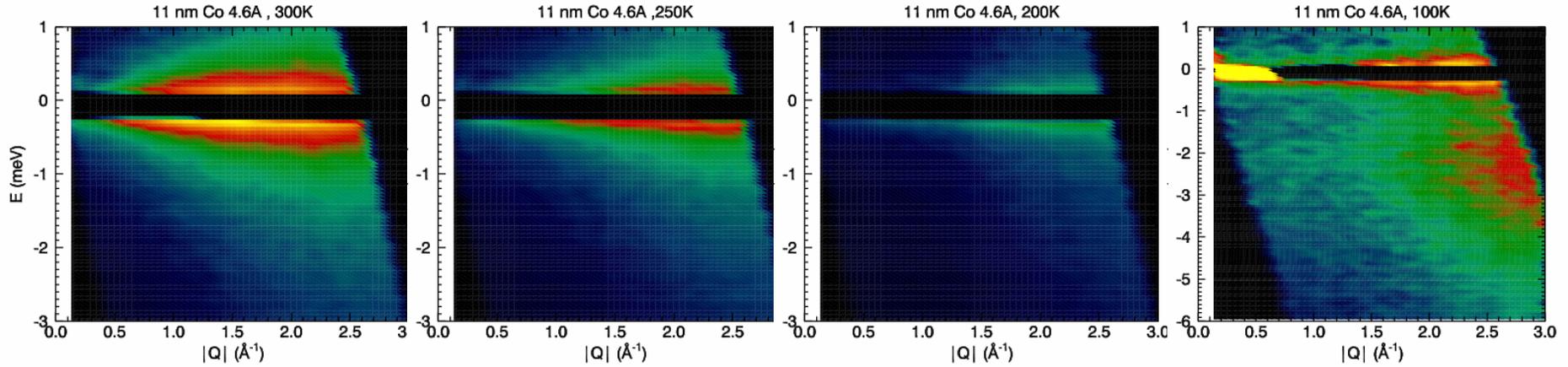
$$C_1 = 1.5 \mu_B/\text{Fe}^{3+} \quad C_2 = 0.05 \mu_B/\text{Fe}^{3+}$$

$$\theta_1 = 1988 \text{ K} \quad \theta_2 = 0 \text{ K}$$

no magnetic order for  $T > 1.8 \text{ K}$   
 $F = \theta_1/T_N > 1100$

# Moment Reversal in Individual Co Nanoparticles

Sample DCS#1:  $d=11$  nm,  $T_B = 220$  K

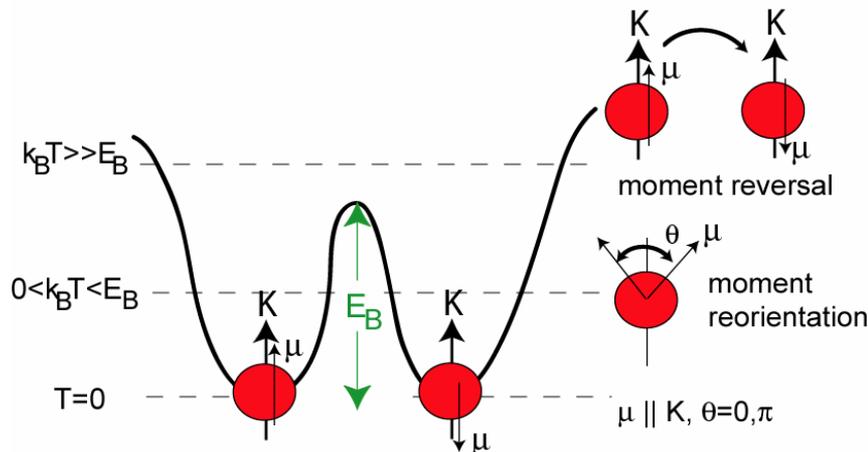


300 K =  $1.36 T_B$

250 K =  $1.1 T_B$

200 K =  $0.9 T_B$

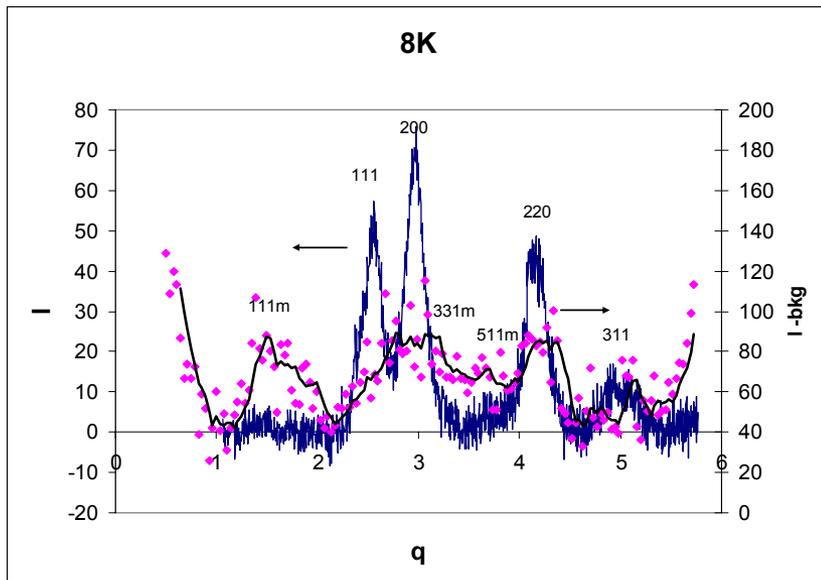
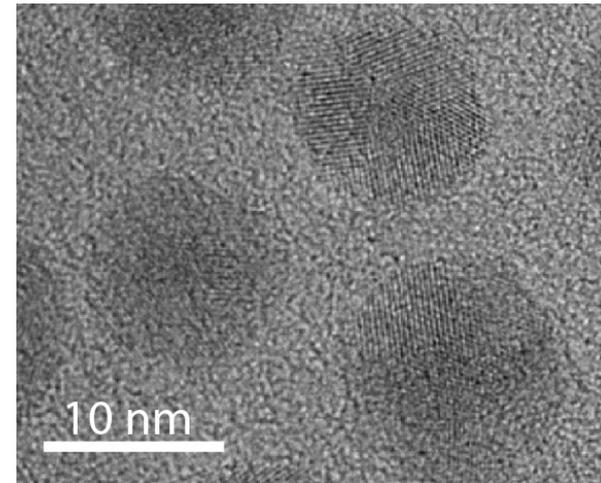
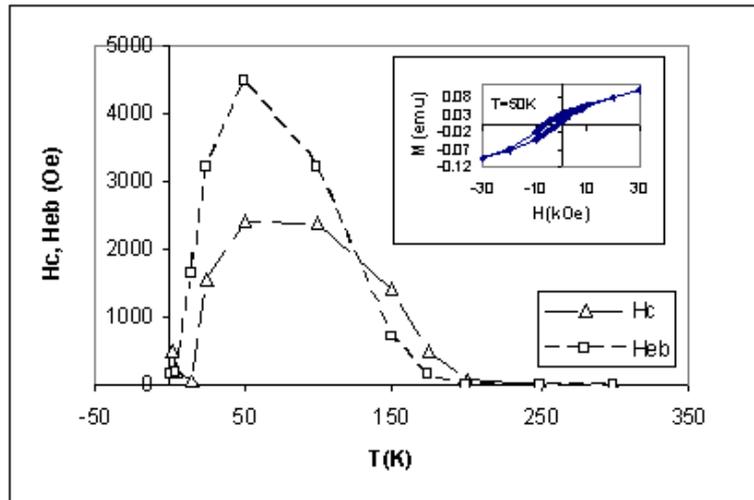
100 K =  $0.45 T_B$



Experiments carried out on DCS at NIST

Probes spin wave dynamics within particles during moment reversal

# Co/CoO Core Shell Nanoparticles



Magnetic Order in CoO Shell  
(11 nm particles)

12 hours on BT1 (NIST)

# Neutron Scattering Wish List

- Diffraction capabilities with high incident intensity, broad  $q$  coverage, low angular resolution.
- Inelastic scattering measurements for  $q < 0.1 \text{ \AA}^{-1}$ , energy ranges matched to interparticle modes (modest resolution).
- Sample environments include wide gap magnetic fields.