center for nanophysics and advanced materials

Condensed Matter Colloquium

Thursday, April 10, 2014

2 pm, Room 1201

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Putting a New Spin on the Surface Canting of Ferrite Nanoparticles

Magnetic nanoscale structures are intriguing, in part, because of the exotic properties that can emerge compared with bulk materials. For example the reduction of magnetism in ferrites (Fe_3O_4 and $CoFe_2O_4$) with decreasing nanoparticle size has been hypothesized to originate from crystalline truncation at the surface, surface dislocations, anisotropy-induced radial orientation of the spins, and size-induced thermal fluctuations, which are difficult to distinguish using conventional magnetometry. Small-angle neutron scattering (SANS) with polarization analysis of the scattered neutron spin allows the chemical and magnetic morphologies of the nanoparticles are their interactions to be probed with vector sensitivity to the magnetism. Application to close-packed, 9 nm Fe_3O_4 nanoparticles reveal that at nominal saturation of 1.2 Tesla the missing magnetic moments unexpectedly form ordered shells 1.0 to 1.5 nm thick that are canted between 23 and 42 degrees with respect to the applied field at 160 to 320 K. Conversely, 11 nm $CoFe_2O_4$ nanoparticles of higher magnetocrystalline anisotropy display an average canting of about 25 degrees that is not limited to the surface, but is uniformly distributed throughout each nanoparticle. Both nanoparticle systems show a uniform magnetization within each nanoparticle of semi-random alignment when the applied field is removed.

This work has been carried out in collaboration with Ryan Booth, Julie Borchers, Wangchun Chen, Yumi Ijiri, Kathryn Hasz, Sara Majetich, Sam Oberdick, James Rhyne, and Shannon Watson.

Refreshments at 1:30 pm in Room 1305F

HOST: Johnpierre Paglione & Nick Butch

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