Materials Science & Engineering Seminar Series

Carnegie Mellon University
Materials Science & Engineering

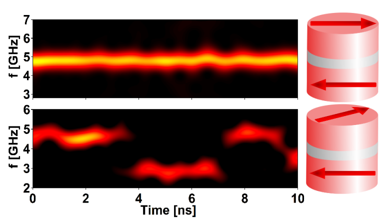
presents

Nanomagnets

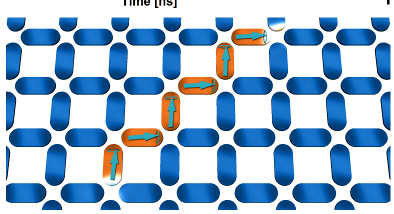
Dr. Olle Heinonen
Argonne National Laboratory and
the Department of Physics and Astronomy, Northwestern University

My research is in the areas of computational mesoscale materials science and nanoscale magnetic systems. I will start with an overview over what I mean by mesoscale materials science, and why that is interesting (at least to me!) and – hopefully – important. I will then spend most of the time talking about nanoscael magnetic systems. These have been the subject of intense research over the past decade. This has partly been driven by developments in magnetic hard disc drives, where the readback sensor is now smaller than 50 nm x 50 nm(!), but partly also driven by new emergent physics in nanoscale magnetic systems. One such example is the spin transfer torque effect, by which a dc current can induce magnetization dynamics in the GHz range. In nanoscale magnetic systems, interactions can be also be made to compete, giving rise to complex energy surfaces with interesting (and sometimes unexpected) quasi-static and dynamical behavior.

In this presentation, I will give some background on materials and interactions in these systems, and a brief overview of the spin transfer torque effect. I will then give some examples of specific systems, such as artificial spin ice lattices and spin torque oscillators, and the complex and interesting behavior they exhibit.



Frequency versus time of a spin torque oscillator: The top figure shows that frequency is stable over a long time. The bottom figure shows that the frequency is hopping with time (mode hopping). The phenomena depends on the orientation of the magnetic layers as shown in the right.



The figure shows a defect string – a Dirac string - that connects two Dirac monopoles at the string ends in an artificial spin ice lattice. The nanomagnets along the string oscillate at a specific frequency giving rise to unique oscillations that extend from one Dirac monopole to the other and can be detected experimentally.

Olle Heinonen received his M.Sc. degree from Uppsala University Institute of Technology in Sweden, and then went on to graduate studies at Case Western Reserve University. He received his Ph.D. in Physics (condensed matter theory) and then went on for a post-doctoral position at the University of Californian, Santa Barbara with Walter Kohn, and then another with Philip Taylor at Case Western Reserve University. He then joined the faculty at the Department of Physics, University of Central Florida, where he stayed for nine years. He left Florida and oranges for Minneapolis, MN, and Seagate Technology where he worked for 12 years on aspects of magnetic recording from magnetotransport and giant magnetoresistance to tunneling readers, magnetic random access memories, and resistive random access memories. For the past four years, he has been at Argonne National Laboratory, where his research is in computational materials science and nanoscale magnetic structures. He is also responsible for developing strategic programs in computational chemistry and materials science at Argonne. He has published some 80 articles, co-authored two graduate textbooks, and holds 33 US Patents.

Doherty Hall 2210, 11:30AM
Friday, September 19, 2014