

# This Week in Physics

SYRACUSE UNIVERSITY  
College of Arts & Sciences

Week of  
March 2, 2009

[http://www.phy.syr.edu/  
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## MONDAY, MARCH 2

Colloquium

4:00 PM, Rm 202 (refreshments 3:30 PM, Rm 204)

Dr. Pengpeng Zhang (The Pennsylvania State University)

*Effects of Embedded Dipoles on The Electrical Response of Self-Assembled Monolayers*

## TUESDAY, MARCH 3

Condensed Matter/Biological Physics Seminar

11:00 AM, Rm 202

Dr. Pengpeng Zhang (Pennsylvania State University)

*Structure and Electronic Transport Properties of Nanometer-Scale Silicon-on-Insulator Membranes*

Colloquium

4:00 PM, Rm 202 (refreshments 3:30 PM, Rm 204)

Dr. Spencer Chang (University of CA, Davis)

*Dark Matter Direct Detection: DAMA and Its Potential Future Confirmation*

It has been known for many years that most of the matter in the universe is not luminous, but instead is "dark." This dark matter has been observed through its gravitational effects, but has yet to be detected in the lab. However, direct detection experiments are designed to make this discovery. I give a review of the strategy and status of such experiments. Looking at the purported signal of a detection at the DAMA experiment, I will discuss dark matter models which are consistent with the DAMA signal and limits from the other direct detection experiments. I will highlight the dark matter properties that allow this consistency and show that they lead to altered predictions for direct detection signals. These changes must be taken into account at future experiments in order to discover this kind of dark matter.

## THURSDAY, MARCH 5

Colloquium

3:45 PM, Rm 202 (refreshments 3:30 PM, Rm 204)

Dr. Sergei Urazhdin (West Virginia University)

*Current-induced excitations in magnetic bilayers: why does the polarizer behave differently from the free layer?*

In the quest to increase the functionality and reduce the power consumption of electronic devices, dimensions of semiconductor-based electronic devices are now approaching the fundamental limits determined by their atomic structure. Spintronic devices based on magnetic nanostructures operate not only with the electron charge, but also its spin degree of freedom, and can potentially overcome the limitations of conventional electronic devices. Spin transfer effect (ST) is the most attractive mechanism for the operation of spintronic devices, enabling reversal of nanomagnets by spin-polarized electrical current. ST can also induce magnetic excitations for applications such as microwave generation. Magnetic nanodevices usually include two magnetic layers - a "fixed" layer to spin-polarize the current, and a "free" layer which can be excited or reversed by current. What properties determine whether a nanomagnet behaves as "fixed" polarizing or as a "free" layer?

To answer this question, we performed measurements of ST in nanopillars with similar dimensions of the "polarizer" and the "free" layer, so that both layers experience significant ST effects. In the first sample type, both layers were patterned into an elliptical nanopillar with lateral dimensions of about 100 by 50 nanometers. Spectroscopic measurements showed incoherent bipolar ST-induced excitations in these samples. Thermally-activated reversal statistics exhibited dependencies on magnetic field and applied current dramatically different from the "standard" samples with a thick polarizing layer. We also measured ST in samples with extended polarizing layer with dimensions of several micrometers. These samples exhibit coherent precession of only the extended layer, only the polarizer, or both, depending on the relative thicknesses of the two layers. The transition between the "free"-like and "fixed"-like behaviors of each layer occurred over a small range of thickness.

I will show that our results can be understood in terms of the dynamical coupling between ferromagnets induced by ST. This coupling can lead to suppression of the current-induced precession, incoherent dynamics, or for certain geometries even enhancement of current-induced dynamics in magnetic bilayers. ST-induced coupling thus provides a new mechanism to control the current-induced behaviors in magnetic nanostructures. I will further discuss other directions for improving our understanding and the ability to control the current-induced magnetic behaviors.

## FRIDAY, MARCH 6

Condensed Matter/Biological Physics Seminar

11:00 AM, Rm 202

Dr. Sergei Urazhdin (West Virginia University)

*Thermally activated reversal statistics in magnetic nanostructures: a sensitive tool for the studies of nanomagnets.*

