THE CHINESE UNIVERSITY OF HONG KONG

Department of Physics

COLLOQUIUM

Spintronics: Radiofrequency Devices and their Applications

by

Dr. Anonio Ruotolo
Department of Physics and Materials Science
City University of Hong Kong

Date: March 10, 2010 (Wednesday)
Time: 2:30 - 3:30 p.m.
Place: L2, Science Centre, CUHK

(Light refreshments will be served 20 minutes prior to the colloquium.)

ALL INTERESTED ARE WELCOME
****

Abstract

Conventional electronic devices rely on the transport of electrical charge carriers in metals and semiconductors. The possibility to exploit the 'spin' of the electron rather than its charge has paved the way for the creation of a remarkable new generation of 'spintronic' devices. The discovery of the giant magnetoresistive (GMR) effect [1] in 1988 has had a huge impact on the data storage market. The use of GMR read-head sensors in hard disk drives has assured the possibility to double the data density at a rate that is twice that predicted by Moore's law for transistors integration.

More recently, the discovery of the spin transfer torque (STT) effect [2], *i.e.* the manipulation of the local magnetization by transferring spin-angular momentum from incoming electrons, has opened up the possibility of new nanoscale devices. This concept has been used to control the orientation of the free magnetic layer in non-volatile random access memories [3]. It can also drive the magnetic orientation of a layer into an oscillation at microwave frequencies, creating a spin transfer nano-oscillator (STNO) [4].

We have used the STT to excite a magnetic vortex into a precessional motion in nanocontact spin-valves. The power generated by this vortex-based STNO is much larger than that provided by standard uniform-mode STNOs. Moreover, the system is much more harmonic, resulting in a smaller output linewidth. To further increase these performances, we have proved [5] that vortex-based STNO can lock their phase through the mediation of antivortices. The phase locked state is characterized by a decreased linewidth and an increased power. Remarkably, the best working condition in our system is the absence of externally applied magnetic field, whereas large fields are required to sustain the output in standard STNO. This feature makes these devices more alluring for applications.

[1] M. N. Baibich et al., *Phys. Rev. Lett.* **61**, 2472 (1988); G. Binasch et al., *Phys. Rev. B* **39**, 4828 (1989);
[2] J. C. Slonczewski, *J. Magn. Magn. Mater.* **159**, L1-L7 (1996); L. Berger, *Phys. Rev. B* **54**, 9353 (1996);
[3] J. A. Katine et al., *Phys. Rev. Lett.* **84**, 3149 (2000);
[4] S. I. Kiselev et al., *Nature* **425**, 380 (2003);
[5] A. Ruotolo et al. *Nature Nanotech.*, **4**, 528 (2009).