Controlling and Manipulating Nanomagnets with DC Spin-polarized Currents

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In typical magnetic devices and measurements the magnetization states of the elements are controlled with applied magnetic fields, which are typically applied using another magnet or through the field generated by a current carrying wire. However, over the last several years it has been shown that the angular momentum in a dc spin-polarized current can also be used to control and manipulate the magnetization state of thin ferromagnetic materials, through the so-called “spin-transfer interaction”. This effect is based on the transfer of angular momentum from a spin-polarized current to the ferromagnetic material, resulting in a torque being applied to the ferromagnet. At device dimensions below a few hundred nanometers, this interaction between the spin-polarized current and the ferromagnet can dominate over the effects of an externally applied magnetic field, leading to fundamentally new way to control and manipulate the magnetization states of nanoscale magnetic devices. In this talk we will give an introduction to the spin transfer effect, and a general overview of our work using the spin transfer interaction to induce high-speed (< 500 ps) switching and coherent high-frequency (GHz) precession in magnetic nanostructures. In particular, the switching measurements will focus on patterned magnetic elements similar to those being considered for storage elements. The dynamics measurements will concentrate on understanding the modes excited by the spin transfer effect and our ability to control the frequency and phase of the oscillations.