Graduate Seminar (EEL 6936)
Department of Electrical Engineering
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Engineering Building B (ENB) Room 109

Recent Advances in Nano-Contact Spin Torque Oscillators

Abstract

Spin transfer torque (STT) was first discussed by Berger in the late 1970s as a possible mechanism for the observed movement of magnetic domain walls by very large currents of up to 45 A. In 1989, Slonczewski predicted that spin currents should tunnel between two ferromagnetic layers separated by an insulator, even in the absence of an external voltage, and provide additional coupling. Experimental techniques were not at the time capable of testing these predictions; reproducible magnetic tunnel junctions (MTJs) only became available in 1995, and the required high-quality ultra-thin MgO based MTJs in 2004. In 1996, Slonczewski and Berger independently predicted that STT could directly affect the magnetization in a multilayer device, either switching it from one orientation to another or causing it to continuously precess. In 1998, this effect was for the first time demonstrated experimentally, and so began a rapidly increasing interest in spin transfer torque.

In my talk, I will focus on a particular STT device called a nano-contact spin torque oscillator (NC-STO). In this device, a high current density through a nano-contact excites spin waves in extended magnetic layers, and generates a microwave voltage at the spin wave frequency. I will discuss three particular, and dramatically different, spin wave modes: i) the original Slonczewski, or propagating, mode, ii) the later Slavin-Tiberkevich, or localized spin wave bullet mode, and finally iii) the very recently discovered magnetic droplet soliton, predicted over 35 years ago, but only now experimentally demonstrated.

Biography

Johan Åkerman has a PhD from KTH – Royal Institute of Technology in Stockholm, did a postdoc at UC San Diego, and then spent four years as a Senior Staff Scientist at Motorola/Freescale responsible for the long-term reliability of MRAM. In 2005 he returned to Sweden where he in 2008 became Full Professor at University of Gothenburg, focusing on spintronics, magnonics, and magnetoplasmonics. He is also Guest Professor at KTH and has published about 150 papers, with recent highlights including:

i) the first experimental proof of spin torque driven spin wave generation and propagation in nano-contact spin torque oscillators (Nature Nanotechnology **6**, 635 (2011), ii) the first experimental confirmation of the existence of magnetic nano-droplet solitons in these devices (Science **339**, 1295 (2013)), and iii) the first mutual synchronization of 3-, 4-, and 5-nano-contact spin torque oscillators. Nature Comm. **4**, 2731 (2013).