Speaker: Andrew Kent

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Spintronics with Magnetic Tunnel Junctions: From Fundamental Device Physics to Emerging Memory Technologies

Bio: Andrew Kent is a Professor of Physics and the Founding Director of the Center for Quantum Phenomena at New York University. He earned his B.Sc. with Distinction in Applied and Engineering Physics from Cornell University and his Ph.D. in Applied Physics from Stanford University. His research focuses on the physics of magnetic nanostructures, nanomagnetic devices, and magnetic information storage. He is a Fellow of the American Physical Society (APS) and the Institute of Electrical and Electronics Engineers (IEEE). Dr. Kent has received numerous awards and honors, including an Honorary Doctorate from the University of Lorraine, France (2013), the French Jean d'Alembert Research Fellowship (2017), and appointments as Invited Professor at the University of Lorraine in 2018 and 2023.

As society demands faster, smaller, and more energy-efficient technologies, new approaches to storing and manipulating information are required. Spintronics—an area of research that uses the spin of the electron, in addition to its charge—offers a promising path forward. One of the most impactful developments in this field is the ability to control magnetization using spin-polarized electric currents. Specifically, spin-transfer torques—where the angular momentum carried by an electrical current can exert a torque on a magnetic layer—enable efficient and scalable switching of magnetic states in nanoscale devices.

This talk will introduce the physics of spin-transfer torque and its implementation in magnetic tunnel junctions (MTJs)—layered structures composed of two ferromagnetic conductors separated by a thin insulating barrier. MTJs exhibit large magnetoresistance and are the core element of spin-transfer torque magnetic random access memory (STT-MRAM), a promising non-volatile memory technology now being commercialized by the semiconductor industry. I will explain the mechanisms that govern torque generation and magnetic switching, and discuss how spin-orbit torques provide an alternative means of control. The talk will also discuss key materials challenges and recent advances in material and device engineering that have enabled reliable switching at low current densities.

[1] A. Brataas, A. D. Kent and H. Ohno, "Current-Induced Torques in Magnetic Materials", Nature Materials 11, 372 (2012);
[2] A. D. Kent and D. C. Worledge, "A new spin on magnetic memories," Nature Nanotechnology 10, 187 (2015);

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