

Controlling the Strength and Direction of Spin-Orbit Torques

Dan Ralph, *Cornell University*

Spin-orbit torques arising from current flow in heavy metals and topological insulators have the potential to enable efficient manipulation of magnetic devices. I will review recent searches to identify materials that generate strong spin-orbit torques, and to understand how to optimize the interfaces to maximize the transmission of spin currents. In addition to enhancing the strength of spin-orbit torques, we are learning to manipulate their direction, by generating spin currents using materials that break inversion symmetry within the sample plane. I will also describe measurements of magnetic dynamics driven by spin-orbit torques in both metallic and insulating magnetic layers, and the implications for the development of fast-pulse-switched magnetic memory.



BIO: Dr. Ralph is the Horace White Professor of Physics at Cornell University. He has been a faculty member in the physics department at Cornell since 1996. From 1993-1996, he held a postdoctoral appointment in physics at Harvard University. He received his Ph.D. from Cornell in 1993. Dr. Ralph is an experimentalist in condensed matter physics and is best known for pioneering experiments on spin transfer torque in magnetic devices and on molecular electronics. He has published over 120 papers that have been cited over 10,000 times. His leadership roles include Director of the Cornell Nanoscale Science and Technology Facility (since 2010), co-PI of the NSF-funded National Nanotechnology Infrastructure Network (since 2011), Director of Cornell's

Laboratory of Atomic and Solid State Physics (2006-2010), Leader of the Nanomagnetism Thrust in the (NSF-NSEC) Cornell Center for Nanoscale Systems in Information Technologies (2001-2012), IRG co-leader in the (NSF-MRSEC) Cornell Center for Materials Research (since 2003), and PI of the ARO MURI grant "Electrical Control of Magnetic Dynamics in Hybrid Metal-Semiconductor Systems" (since 2008).