CSU PHYSICS COLLOQUIUM

"Spintronics with Antiferromagnetic and Quantum Materials"

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Monday, March 21st at 4:00pm

120 Engineering (Hammond Auditorium)

Abstract

The magnetization of a magnetic material can be excited and reversed by electric currents that transport spin angular momentum [1]. This was predicted in magnetic tunnel junctions—two metallic ferromagnetic layers separated by a thin insulating barrier—by John Slonczewski in 1989 and demonstrated experimentally about a decade later. This discovery has had an enormous impact on magnetism research and technology [2], as prior to this the primary means to reorient and excite the magnetization of a magnet was by applying magnetic fields (dating to 1819 and Oersted). Remarkable, spin currents are also able to change the magnetic order of antiferromagnetic layers. In this talk I will highlight my group's experimental x-ray imaging studies of current-induced reorientation of the Néel vector in hematite, Fe_2O_3, using the spin-Hall effect in Pt as the spin current source [3]. I will also discuss harmonic Hall effect measurement that make it possible to determine the form and magnitudes of the spin-torques that act on the Néel vector [4]. Further, I will provide a perspective and some initial experimental results on spintronic devices based on quantum materials. Specifically, I will present a spintronic resonator---a device in which spin currents excite GHz magnetization oscillations---based on a hybrid metal-insulator-transition oxide (V_2O_3)/ferromagnetic metal nanoconstriction [5].

[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)

[3] E. Cogulu, N. N. Statuto, Y. Cheng, F. Yang, R. V. Chopdekar, H. Ohldag, and A. D. Kent, "Direct Imaging of Electrical Switching of Antiferromagnetic Néel Order in α-Fe_2O_3 Epitaxial Films," Physical Review B 103, L100405 (2021)

[4] E. Cogulu, H. Zhang, N. N. Statuto, Y. Cheng, F. Yang, R. Cheng, and A. D. Kent, "Quantifying Spin-Orbit Torques in Antiferromagnet/Heavy Metal Heterostructures," arXiv:2112.12238 (2021)

[5] J-W. Xu, Y. Chen, N. M. Vargas, P. Salev, P, N. Lapa, J. Trastoy, J. Grollier, I. K. Schuller & A. D. Kent, "A quantum material spintronic resonator," Scientific Reports 11, 15082 (2021)

Biography

Andrew Kent is a Professor of Physics and Director of the Center for Quantum Phenomena at New York University. He received a B.Sc. with Distinction in Applied and Engineering Physics at Cornell University in 1982 and his Ph.D. from Stanford University in Applied Physics in 1988. He conducted post-doctoral research at the University of Geneva in Switzerland and the IBM T. J. Watson Research Center. His research interests are in the physics of magnetic nanostructures, nanomagnetic devices and magnetic information storage. He is a fellow of the American Physical Society (APS) and has served as chair of the APS topical group on magnetism and its applications (GMAG). Kent received an Honorary Doctorate from the University of Lorraine, France, in 2013, the French Jean d'Alembert Research Fellowship in 2017, and was named professor at the University of Lorraine in 2018. He was elevated to IEEE Fellow in 2022.