Materials Science & Engineering Seminar Series

Carnegie Mellon University
Materials Science & Engineering

presents

Room Temperature Magnetic Skyrmions in Engineered Multilayer Films

Geoffrey S. D. Beach
Department of Materials Science and Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139

ABSTRACT:

Magnetic skyrmions [1] are particle-like twists of the magnetization taking the form of nanoscale vortices or bubbles that are topologically protected from being continuously 'unwound'. Their small size, high stability, and ease of manipulation by electric current make them strong candidates for use as information carriers in spintronic memory and logic devices. However, magnetic skyrmions have until recently been restricted to just a few materials and observed only at low temperatures, limiting the experimental accessibility and technological application of these unique topological objects. This talk focuses on magnetic skyrmions in ultrathin ferromagnetic transition metal multilayers in which interfaces with heavy metals generate a strong Dzyaloshinskii-Moriya interaction (DMI) that can stabilize chiral magnetic order [2,3]. By tuning the relevant magnetic energy terms in inversion-asymmetric engineered multilayer stacks, we show that magnetic skyrmions can be stabilized at room temperature using materials that are amenable to integration with CMOS. Using high-resolution x-ray microscopy, we reveal the current-driven dynamics of skyrmions in racetracks, demonstrate that skyrmions can be generated deterministically by nanosecond current pulses, and present an analytical framework to compute the properties of any skyrmion in any material, allowing large-scale multi-parameter-space studies of skyrmion properties and revealing new and unexpected behaviors.

[1] U. Rößler, A. N. Bogdanov, C. Pfleiderer, C., Nature 442, 797-801 (2006)
[2] S. Emori, et al., Nat. Mater. 12, 611–616 (2013).
[3] S. Woo, et al., Nature Mater. **15**, 501 (2016)
[4] K. Litzius, et al., Nature Phys. 13, 170 (2017).

BIOGRAPHY:

Geoffrey Beach is an Associate Professor of Materials Science and Engineering at MIT. He received a B.S. in Physics from Caltech, a Ph.D. in Physics from the University of California, San Diego, and conducted postdoctoral work at the University of Texas at Austin. At MIT, Prof. Beach directs the Laboratory for Nanomagnetism and Spin Dynamics, which designs advanced materials for spin-based memory, logic, and emerging applications. Many of his ongoing research efforts center on understanding and exploiting interfacial phenomena that provide new mechanisms with which to electrically control magnetism in nanoscale devices.
His work has been recognized with numerous awards including most recently a Deshpande Center Award for Technological Innovation, the MIT Junior Bose Award for Excellence in Teaching, the MIT Class of 1958 Institute Chaired Professorship, and the Department of Energy (DoE) Early Career Award.

Doherty Hall 2315, 11:30AM
Friday, April 14, 2017