Nebraska Center for Materials and Nanoscience

2018 Spring Seminar Series

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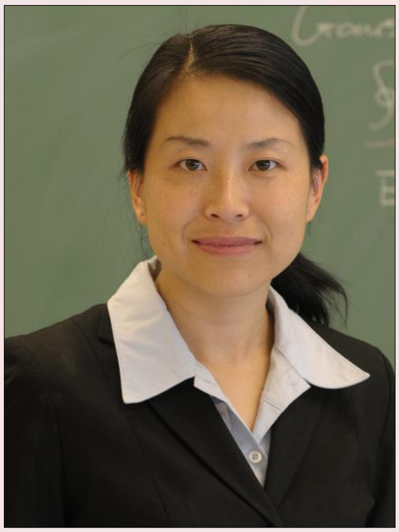
Room-temperature magnetic skyrmions in multilayers with interfacial Dzyaloshinskii-Moriya interaction



Magnetic skyrmions, topologically protected spin textures characterized by a topological integer, have an exceptional stability against transitions into trivial spin textures, such as the ferromagnetic state. Compared to the domain walls in racetrack memory devices, magnetic skyrmions not only exhibit high mobility driven at much lower current densities but also can navigate around pinning centers. Therefore, magnetic skyrmions are promising candidates for current-driven memory devices. In magnetic multilayers, the interplay of various interactions, including the Heisenberg exchange, dipolar interactions, magnetic anisotropy, and interfacial Dzyaloshinskii-Moriya interactions enables forming and stabilizing magnetic skyrmions at room temperature. A full understanding of the motion of magnetic skyrmions in fields is key to their applications in memory devices. It is also intriguing to examine whether magnetic skyrmions, quasi-particles without an electric charge but with a topological charge, show a transverse motion in magnetic and electric fields, as the electric charges in the ordinary Hall effect.

In this work, we report the formation and magneto-transport properties of robust skyrmion phase at room temperature in [Pt/Co/Heavy Metal]n multilayers with interfacial Dzyaloshinskii-Moriya interaction. Magnetic configurations and reversal processes in these multilayers with perpendicular magnetic anisotropy were imaged by magneto-optical Kerr effect (MOKE) or Lorentz transmission electron microscopy (L-TEM) depending on the feature size. Micromagnetic simulations were performed to study the effect of various interactions on the skyrmion size. We also experimentally demonstrate the skyrmion Hall effect, and the resultant skyrmion accumulation, by driving skyrmions from the creep-motion regime (where their dynamics are influenced by pinning defects) into the steady-flow-motion regime. The experimental observation of transverse transport of skyrmions due to topological charge may potentially create many exciting opportunities, such as topological selection.

Xuemei Cheng received her bachelors degree in physics from Nanjing University in 1997, and her masters degree in microelectronics and solid state electronics, also from Nanjing University in 2000. She continued her studies at the John Hopkins University where she earned masters and Ph.D. degrees in physics in 2004 and 2006, respectively. After a postdoctoral fellowship in the X-ray Science Division at Argonne National Laboratory, she joined the faculty at Bryn Mawr college in 2009. She was promoted to Associate Professor with tenure in 2016 and have been the physics department chair of Bryn Mawr College since 2016.

NCMN

January 17, 2018 | 4 p.m. | 136 Jorgensen Hall

Refreshments in 1st floor vending area at 3:45

Host: Sy-Hwang Liou

Department of Physics & Astronomy