Condensed Matter & Biophysics Seminar

Electrical Creation and Manipulation of Magnetic Skyrmion Bubbles

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THURSDAY

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RM 184 NSH

Magnetic skyrmions are topologically stable spin textures, which exhibit many fascinating features including an emergent electromagnetic fields and efficient manipulation. Nevertheless, until now their stability has been challenging to achieve at room temperature, which is a bottleneck for technological implementation of skyrmion-based spintronics. Towards this end, room-temperature electric-current creation of skyrmions in a commonly accessible materials system - heavy metal/ferromagnet/insulator (HM/FM/I) heterostructures with interfacial broken inversion symmetry - will be discussed. The experimental creation of magnetic skyrmions triggered by an electric current and its induced spin-orbit torque in Ta/CoFeB/TaOx trilayers is demonstrated. The importance of the interfacial Dzyaloshinskii-Moriya interaction will be demonstrated. The skyrmion generation is enabled by laterally inhomogeneous current-induced spin-orbit torques. This process is analogous to the spontaneous droplet formation in surface-tension driven fluid flows. We established a novel phase diagram that summarizes the dependence of skyrmion generation on the external magnetic fields, and the strength of in-plane currents [1]. We further revealed the efficient manipulation/motion of these skyrmions by electric currents in a wide variety of devices including straight and curved conduits. Some open questions and future research directions will also be identified.

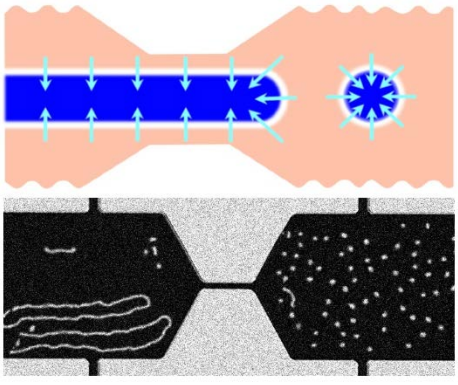

Figure 1. (Top) Theoretical proposal on the formation of magnetic skyrmions from chiral stripe domains through a geometrical constriction. (Bottom) Experimental confirmation by using Kerr Microscopy taken after applying a short current pulse, showing a large number of skyrmions formed on the right side of the constriction.

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Reference: [1] Blowing magnetic skyrmion bubbles, Wanjun Jiang, et al., Science, 349, 283 (2015).