Department of Physics and Astronomy
General Colloquium

Thursday, November 10th, 2016
PHYS 203 at 3:30 pm

(Refreshments served at 3:00 pm in PHYS 242)

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Topological Spintronics: from the Haldane Phase to Spin Devices

We provide a perspective on the recent emergence of "topological spintronics," which relies on the existence of helical Dirac electrons in condensed matter. Spin- and angle-resolved photoemission spectroscopy shows how the spin texture of these electronic states can be engineered using quantum tunneling [1] or by breaking time-reversal symmetry [2]. In appropriately designed systems, broken time-reversal symmetry transforms helical Dirac states into chiral edge states, a realization of Haldane's Chern insulator phase of matter. This is characterized by a precisely quantized Hall conductance and dissipationless edge transport without a magnetic field. We show how these edge states can be quantitatively characterized by analyzing their giant anisotropic magnetoresistance [3]. At miilikelvin temperatures, the interplay between Chern states and disordered magnetism [4] results in surprising behavior, perhaps consistent with quantum tunneling out of a 'false vacuum' [5]. Finally, we show how these helical Dirac electrons provide a possible pathway toward a spin device technology that works at room temperature [6,7].

[1] M. Neupane, A. Richardella et al., Nature Communications 5, 3841 (2014).
[2] S.-Y. Xu et al., Nature Physics 8, 616 (2012).
[3] A. Kandala, A. Richardella, et al., Nature Communications 6, 7434 (2015).
[4] E. Lachman et al., Science Advances 1, e1500740 (2015).
[5] Minhao Liu et al., Science Advances 2, e1600167 (2016).
[6] A. Mellnik, J. S. Lee, A. Richardella et al., Nature 511, 449 (2014).
[7] Hailong Wang et al., Phys. Rev. Lett. 117, 076601 (2016).