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Electronic Transport in Topological Insulator Nanostructures

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Abstract: I will describe our recent transport experiments on topological insulator materials such as Bi_2Te_3 and $BiSbTeSe_2$ nanoribbons (TINRs). We were able to successfully distinguish the bulk and surface carriers. The experiments have particularly revealed a list of unique transport signatures of the spin-helical, Dirac fermion topological surface states, and provide ways to access and utilize such surface states in novel topological quantum devices. Topological insulators (TI) are gapped band insulators in the bulk, but have nontrivial, "topologically protected", spin-helical conducting states with gapless Dirac fermion dispersion on the surface. Such "topological surface states" are considered promising platforms to explore various novel physics ranging from quantum anomalous Hall effect, Majorana fermions to excitonic condensation. However, electronic transport of topological surface states in real TI materials is easily obscured by competing conduction channels that include the bulk as well as the "conventional" 2D electron gas (2DEG) formed by band bending at the surface. This is a major challenge in current experiments and device applications involving topological insulators. In this talk, I will describe our recent electron transport experiments on TI materials based on Bi_2Te_3 and $BiSbTeSe_2$. We have explored ways to reduce the bulk conduction, and revealed a list of unique electronic transport signatures of the spin-helical, Dirac fermion topological surface states. In addition, we have also measured induced superconductivity in TINRs. These experiments may facilitate better access and control of TI surface states to explore the more exotic physics and applications in topological quantum devices.

Biographical Sketch: Dr. Luis Jauregui earned his B.S. in Electrical Engineering from National University of Engineering in Lima, Peru in 2007 and his Ph.D. in the area of micro and nanotechnology from the Department of Electrical and Computer Engineering at Purdue University in 2015. He was the recipient of the Intel Ph.D. fellowship for the years 2012 – 2013 and the Purdue Research Foundation Fellowships 2013 – 2015. Currently, he is a postdoctoral associate in the Department of Physics at Harvard University. His research focuses on experimental investigations of electron transport in low dimensional systems like nanowires, and two dimensional layered materials.

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