PHYSICS AND ASTRONOMY COLLOQUIUM

Jairo Sinova, Ph.D.

University of Mainz/Texas A&M University

Relativity shakes future technology: how the spin Hall effect and relativistic torques are opening new paths for information storage

Understanding the origin and properties of the different phases of materials and how to control them is at the heart of condensed matter physics and physics in general. One of the grand challenges of the field is to control spin-dependent properties without using magnetic fields. To do so, one must resort to the relativistic nature of electrons, which arises directly from its particle-antiparticle description that gives its spin. In the relatively slow world of solids this leads to the spin-orbit coupling (SOC) that connects the spin and charge of the electron. We have learned how to exploit the relativistic SOC to create new paradigms of spin control in complex materials and discover new unexpected connections between seemingly disparate ideas as topology, materials science, high energy physics, ferromagnetism, thermoelectricity, and current-induced magnetization manipulation. I will broadly describe joint theoretical and experimental efforts on how we now generate and manipulate spin-currents that are being used in devices relevant for future MRAM technology. I will also show in some detail how insights on the spin Hall effect have yielded novel ways to manipulate magnetization using relativistic torques, and how to extend these ideas to a new a phase of spintronics by exploiting anti-ferromagnetic materials in an active way.

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