PHYSICS
COLORADO STATE UNIVERSITY

CSU Condensed Matter Physics Seminar

A History of Spintronics Theory

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Lory Student Center Room 372

Abstract

I begin with a history of spintronics -- spin-dependent electrical phenomena in solids -- with an emphasis on theory. For a ferromagnet with magnetization M, I then show in pictures how Fermi liquid theory includes the non-equilibrium phenomenon of spin accumulation m. I next sketch out how irreversible thermodynamics leads to all the basic bulk phenomena of spintronics:

(a) anisotropic magnetoresistance,

(b) the spin Hall effect (SHE, where a voltage gradient drives a perpendicular spin current) and its inverse (ISHE),

(c) the spin Seebeck effect (SSE, where a temperature gradient drives a perpendicular spin current) and its inverse (ISHE, or spin Peltier effect), and

(d) spin transfer (ST, where a spin current flows from a normal material N to a ferromagnet F) and its inverse of spin pumping (SP, where a spin current flows from F to N).

I argue that the 1979 work Silsbee, Janossy, Monod theory (SJM) of SP from ferromagnets has a firmer basis in Fermi liquid theory than the 2002 work of Tserkovnyak, Brataas and Bauer. I suggest that, because the latter authors took some ideas of Slonczewski too literally, they could not get the SJM-like theory it seems they were trying to get.

Biography

Prof. Saslow is a native Philadelphian and an undergraduate at the University of Pennsylvania. He went to graduate school at UC Berkeley where magnetician Charlie Kittel was ramping down, and completed his PhD at UC Irvine where magnetician Doug Mills was ramping up. Following a postdoc at the University of Pittsburgh with magnetician Fred Keffer, he joined the faculty at Texas A&M University. His research has included band structures, superfluids, supersolids, spin glasses, and the electrical properties of mixed ionics and of voltaic cells. However, most recently he has returned to magnetism, and is applying the methods of irreversible thermodynamics to problems in spintronics, to obtain and apply the macroscopic but out-of-equilibrium equations of motion for spin Hall effect systems, for ferromagnetic systems, and for ferromagnets in the geometry of perpendicular ferromagnetic resonance (FMR).