

University of Rochester
Department of Electrical and Computer Engineering
Colloquia Series

Thermal Spintronics: Electronics with Spin and Heat Currents

Stephen Wu

Wednesday, February 17th
12:00PM – 1:00PM
CSB 209

Abstract: As we reach the end of Moore's law, the search for a potential successor to CMOS technology has begun. Spintronics (utilizing electron spin in electronic devices) has been identified as one potential candidate to serve this purpose. A new direction has recently emerged within this community: examining the intersection between spin transport and heat transport. This new area, known as spin caloritronics, is centered on generating and manipulating currents of spin through the application of currents of heat. The spin Seebeck effect serves as the centerpiece in this nascent field, where it is possible to thermally generate spin current from magnetic insulators due to the thermally excited transport of spin excitations known as magnons. Here, charge and spin current are completely separated, and the opportunity opens to completely rewrite the idea that charge current is at all necessary for electronic devices. Here, we report on the observation of the spin Seebeck effect in two new types of systems: antiferromagnetic and paramagnetic insulators. By exploring the low temperature regime (< 30 K), we were able to resolve a spin Seebeck effect from paramagnetic $\text{Gd}_3\text{Ga}_5\text{O}_{12}$ (gadolinium gallium garnet). While in the high magnetic field regime ($>9\text{T}$), we were able to resolve the spin Seebeck effect in antiferromagnetic MnF_2 . Both of these results were not expected from current spin Seebeck models and through using MnF_2 it was possible to enhance the magnitude of spin current generation over two orders of magnitude beyond the current record spin Seebeck effect. Since insulating antiferromagnets and paramagnets are far more common than typical insulating ferromagnetic materials, this discovery opens up a large opportunity to begin the search for even larger spin Seebeck effects through engineering existing and new materials. It is now possible to develop new applications from thermal spin current generation in both the broader spintronics community and in designing efficient thermoelectric waste heat recovery systems for energy generation.

Bio: Stephen M. Wu is a postdoctoral researcher currently at Argonne National Laboratory within the Materials Science Division. He received his Ph.D. in Physics at the University of California, Berkeley in 2012. He received his M.A. in Physics in 2009, his B.S. in Electrical Engineering and Computer Science in 2006 and B.A. in Physics in 2006 also from the University of California, Berkeley. His research interests involve using new physics and materials to create novel electronic and magnetic devices with a focus on spin based electronic computing (spintronics). His past work at UC Berkeley involved creating oxide-based multiferroic field effect devices, which led to the first demonstration of the reversible gate control of exchange bias, forming the foundation for a scalable universal magnetoelectric memory. More recently at Argonne he has explored thermal spin transport to identify and create novel spin based electronics through oxide-based materials.

Light Refreshments Provided