



KITP Conference Report: Concept in spintronics

Dates: September 30, 2013 - October 4, 2013

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Spintronics has developed rapidly over the past few years, spawning new topics and encompassing a great variety of materials and devices, based on metals, semiconductors, superconductors, and even insulators. Several microscopic degrees of freedom are known to act in concert in some of the most fascinating spintronic phenomena. The collective behavior emerging out of electronic, microwave, optical, mechanical, and nuclear building blocks of solid-state excitations, which can all carry angular momentum and energy, is fueling excitement in the field.

The conference "Concepts in Spintronics" kicked off the 12-week long KITP Program "Spintronics: Progress in Theory, Materials, and Devices." In contrast to the theory-dominated Program we aimed for a strong representation of experimentalists at the Conference. who were given the opportunity to shape the issues to be addressed by theorists. The goal of these associated events is to provide a sweeping view of the field and focus theoretical efforts on the key problems. The main brunt of the conference was carried by the invited speakers, but the posters attracted a lot of attention as well, also thanks to a lively shot-gun poster introduction. We counted 77 participants.

Specifically, the topics addressed at the conference by the different speakers can be classified as follows (see complete program is attached below):

- Geometric gauge fields in ferromagnets, topological spin textures and their dynamics reciprocally coupled to charge fluxes
Speakers: Bernevig, Galitskii, Hankiewicz, Moore, Samarth, Tokura, .
- Spin caloritronics: spin Seebeck/Peltier effects, thermal Hall effects, and thermal spin transfer
Speakers: Heremans, Mertig, Uchida
- Spin-orbit interaction and torques:

Speakers: Beach, Brataas, Buhrman, Ebert, Hayashi, Koralek, Ono, Otani, Sinova

- Spin-based quantum information

Speakers: Loss, Rudner, Tarucha, Zumbühl

- Collective spin dynamics:

Speakers: Kläui, Krivorotov, Maekawa, Silva, Wang

- New spintronic systems:

Speakers: Butov, Spielman, Wunderlich

There have been several examples by now that subjects of fundamental research lead to commercial applications one or two decades later. The conference transcended a sense of excitement instilled by recent breakthroughs in materials and devices that encourage optimism that such feats can be repeated. However, our understanding of, e.g., spin-orbit torques, the interaction of magnetization textures with electron currents, the importance of topology in general, is still insufficient and was hotly debated. These debates are continued in the KITP Program and will undoubtedly further the field by finding at least partial solution and affect the research program of the attendees in the years to come.

Diversity:

We strived to attract the leading female researchers in the field to the conference as well as the subsequent program with some success. While some agreed to attend both conference and program (Lopez, Klinovaja, Hankiewicz), for others participating at a later stage of the program, it was impractical to come to Santa Barbara twice (Marinescu, Felser, Everschor-Sitte). We were not aware of experienced researchers in our field that belong to US underprivileged groups and could serve as invited speakers nor did we receive applications from contributors that fitted this profile.

The meeting attracted a diverse international group of researchers from Europe (14), Asia (15), and South America (2), who amounted to almost half of the total number.

Detailed conference program

Monday, September 30, 2013		
	Session: Spin-Orbit-Induced Spin Torques, Chair: Yaroslav Tserkovnyak (UCLA)	
8:50am	Lars Bildsten (KITP Director)	Welcome
9:00am	Robert Buhrman (Cornell)	The Giant spin Hall effect, spin torque, and interfacial spin-orbit phenomena in multilayer ferromagnetic/normal metal nanostructures
9:45am	Masamitsu Hayashi (NIMS)	Spin orbit torques and current induced domain wall motion in magnetic heterostructures
10:30am	Morning Break	
	Session: Spin Torques and Pumping, Chair: Yaroslav Tserkovnyak (UCLA)	
11:00am	Arne Brataas (Trondheim)	Symmetry of current-induced spin-orbit torques
11:45am	Tom Silva (NIST)	New directions in spin current research at NIST, Boulder
12:30pm	Lunch Break	
	Session: New Spintronic Materials, Chair: Allan MacDonald (UT Austin)	
2:00pm	Yoshinori Tokura (RIKEN)	Skyrmion dynamics and topological transport phenomena
2:45pm	Leonid Butov (UCSD)	Spin currents in a coherent exciton gas
3:30pm	Afternoon Break	
4:00pm	Ian Spielman (Maryland)	The spin-Hall effect observed in an atomic Bose-Einstein condensate
4:45pm	Jake Koralek (UC Berkeley)	Spin transport in the 2D electron gas and strongly spin-orbit coupled materials
5:30pm	SHUTTLE TO BWSCI	

<u>Tuesday, October 01, 2013</u>		
	Session: Topological Materials, Chair: Leon Balents (UCSB)	
9:00am	Nitin Samarth (Penn State)	Interfacing topological surface states with magnetism
9:45am	Joel E. Moore (UC Berkeley)	Topological edge and surface states: effects of magnetic and superconducting perturbations
10:30am	Morning Break	
11:00am	Victor Galitski (Maryland)	Topological Kondo insulators
11:45am	Andrei Bernevig (Princeton)	Topological insulators without spin orbit coupling
12:30pm	Lunch Break	
	Session: Current-Induced Domain-Wall Motion, Chair: Gen Tatara (RIKEN)	
2:00pm	Mathias Kläui (Mainz)	Field- and current-induced domain wall dynamics
2:45pm	Xiang-Rong Wang (Hong Kong)	Instability of Walker propagating domain wall solution of 1D LLG equation
3:30pm	Afternoon Break	
4:00pm	Teruo Ono (Kyoto)	Current-induced domain wall motion: Spin-transfer torque vs spin Hall torque
4:45pm	Geoffrey Beach (MIT)	Current-driven dynamics of chiral ferromagnetic domain walls
5:30pm	RECEPTION	
6:00pm	SPECIAL EVENTS DINNER	
8:00pm	SHUTTLE TO BWSCI	

<u>Wednesday, October 02, 2013</u>		
	Session: Nonelectrical Spin Generation, Chair: Gerrit E. W. Bauer (Sendai/Delft)	
9:00am	Joseph Heremans (Ohio State)	Heat transport by magnons, phonon-drag, and their role in the spin Seebeck effect
9:45am	Ken-ichi Uchida (Sendai)	Generation of spin currents from heat, sound, and light
10:30am	Morning Break	
	Session: Spin-orbit-induced currents and torques, Chair: Gerrit E. W. Bauer (Sendai/Delft)	
11:00am	Sadamichi Maekawa (JAEA)	Theory of spin current generation in spintronics
11:45am	Jairo Sinova (Texas A&M)	Anti-damping intrinsic spin-orbit torque arising from Berry phase
12:30pm	Lunch Break	
	Session: Nonferromagnetic Spintronics, Chair: Jelena Klinovaja (Harvard)	
2:00pm	Ewelina Hankiewicz (Würzburg)	Spin helical transport in superconducting topological insulators
2:45pm	Joerg Wunderlich (Cambridge)	Antiferromagnetic spintronics
3:30pm	FREE AFTERNOON/ SHUTTLE TO BWSCI	

<u>Thursday, October 03, 2013</u>		
	Session: Quantum Dots and Nanowires, Chair: Igor Zutic (SUNY)	
9:00am	Seigo Tarucha (Tokyo)	Josephson Effects for Quantum Dots and Nanowires
9:45am	Mark Rudner (Copenhagen)	Dynamical nuclear polarization oscillations in quantum dots: Key aspects of electron-nuclear spin dynamics revealed
10:30am	Morning Break	
11:00am	Daniel Loss (Basel)	Helical spin textures and Majorana fermions
11:45am	Dominik Zumbühl (Basel)	Evidence for helical nuclear spin order in GaAs quantum wires
12:30pm	Lunch Break	
	Session: Spin-Orbit Interactions in Metals, Chair: Jelena Klinovaja (Harvard)	
2:00pm	Ingrid Mertig (Halle)	Spin Hall and Spin Nernst Effect from first principles
2:45pm	Hubert Ebert (Munich)	Theoretical description of the anomalous and spin Hall effects in disordered alloys using the Coherent Potential Approximation
3:30pm	Afternoon Break	
	POSTER PITCH TALKS, Chair: Jelena Klinovaja (Harvard)	
4:00pm	Presenters	Poster Pitches
	POSTER SESSION	
5:30pm	RECEPTION	
6:00pm	SPECIAL EVENTS DINNER	
8:00pm	SHUTTLE TO BWSCI	

<u>Friday, October 04, 2013</u>		
	Session: Electrical Control/Detection of Magnetization Dynamics, Chair: Jose-Carlos Egues (Univ. Sao Paulo)	
9:00am	Ilya Krivorotov (UC Irvine)	Nanowire spin Hall oscillator
9:45am	Yoshichika Otani (Tokyo)	Inverse spin Hall effect as a means to study non-linear spin fluctuation
10:30am	Morning Break	
11:00am	Axel Hoffmann (Argonne)	Electric control and detection of spin waves
11:45am	Rosa Lopez (Univ. Balearic Islands)	In Memoriam: Markus Büttiker
11:50am	Gerrit E. W. Bauer (Sendai/Delft)	Closing Remarks
12:30pm	Lunch Break	
2:00pm	END OF CONFERENCE/ SHUTTLE	